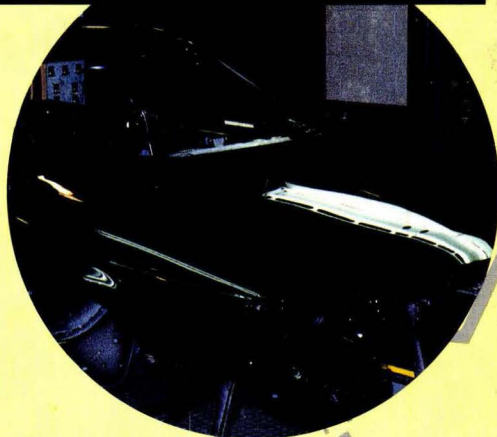


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JCTAX 65 (819) 1-84 (1993)

April 1993



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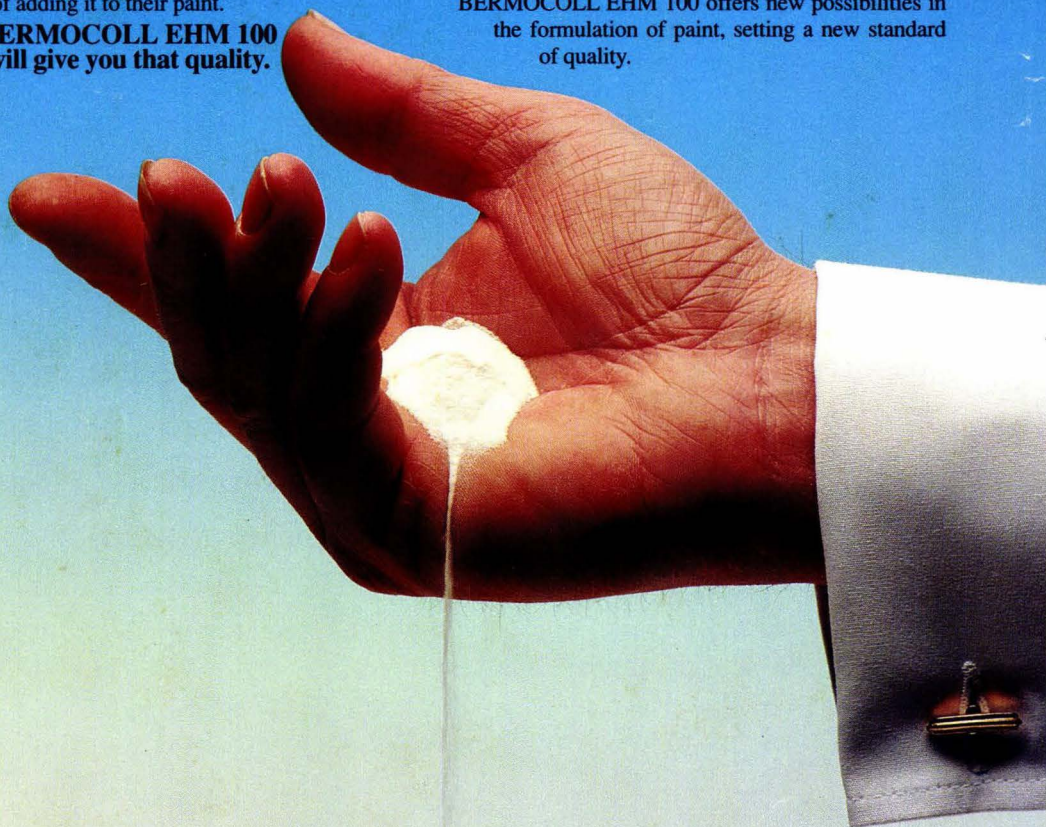
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VOLUME 65 NUMBER 819

Technical Articles

- 24 Polyurethane Polyols: Ester Bond-Free Resins for High Solids Coatings—J.L. Gardon
- 35 Infrared Microscopic Analysis of Multiple Layers of Automotive Paints—D.J. McEwen and G.D. Cheever
- 43 Low-Temperature Curing Higher-Solids Polyester Coatings with Melamine-Formaldehyde Resins Crosslinkers—G. Chu and F.N. Jones
- 49 Recent Advances in UV-Curing Chemistry—C. Decker and K. Moussa
- 59 Effect of Polyethyleneimine on Phosphate Coatings on Mild Steel—U.B. Nair and M. Shubbaiyan

Committee Activities

- 13 Federation Technical Advisory Committee and Society Technical Committee Chairmen Met Sept. 24-25, 1992, in Raleigh-Durham, NC

Federation News

- 19 Spring Week Registration and Hotel Reservation Form
- 20 Current List of 1993 Paint Industries' Show Exhibitors

Departments

| | | | |
|--------------------------------------|----|----------------------------|----|
| Comment | 7 | People | 73 |
| Abstracts | 8 | Obituary | 73 |
| Regulatory UPDATE | 17 | CrossLinks | 74 |
| Government & Industry | 21 | Meetings/Education | 75 |
| Cleveland Society Seminar Form | 23 | Letter to the Editor | 77 |
| Society Meetings | 65 | Literature | 78 |
| Future Society Meetings | 71 | Coming Events | 81 |
| Elections | 72 | Humbug from Hillman | 84 |



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Comment

Spring Week, Anyone?

As anyone who plays tennis knows, a carefully developed strategy can increase the odds of winning. Simply hitting the ball across the net may work sometimes (if you are extremely lucky or your opponent is having a *really* bad day). Usually, though, the match goes to the player who is able to adjust to such variables as playing surface, weather conditions, and, most importantly, the strengths and weaknesses of the challenger. After considering these variables, a "plan of attack" can be implemented.

When it comes to coating a particular substrate, developing a similar strategy can mean the difference between effective coverage and costly error. On May 18-19, at the South Shore Harbour Resort in League City (near Houston), Texas, the FSCT will assemble a panel of experts to assist attendees in formulating such strategies. Presented as part of the FSCT "Spring Week" activities and developed by the FSCT Professional Development Committee, the two-day program will focus on "The Influence of Substrates and Application Methods/Techniques on Coatings Performance."

Participants will examine the factors which are involved in the process of coating a substrate, including methods of application, the surface to be coated, the actual coating being applied, and other conditions which must be considered.

Presentations will detail the characteristics and surface preparation requirements for coating such substrates as concrete and masonry, sheet rock, wood, hardboard, pressure-treated wood, plywood, OSB and Com-Ply panels. In addition, attendees will benefit from discussions on application methods since paint formulators need to be concerned with the manner of applying paint as well as the applicators used. Panel discussions following each day's presentations will provide an opportunity for participants to ask questions on specific concerns and needs.

The world of coatings can be a competitive one. To successfully overcome problems and meet the needs of end users, you must be armed with as much information as possible. Attendance at the program in League City is designed to give you the advantage — Game . . . Set . . . Match. (Of course, don't forget to bring your racquet!)



Patricia D. Viola,
Editor

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- 6 ก.ค. 2536

Abstracts of Papers in This Issue

(Translations provided by: French—Montreal Society Member Alain Brisson, of Hoechst Canada, Inc. and Spanish—Francisco Gonzalez, of Instituto Mexicano de Tecnicos en Pinturas y Tintas.)

Polyurethane Polyols: Ester Bond-Free Resins for High Solids Coatings—J.L. Gardon

JCT, 65, No. 819, 24 (Apr. 1993)

A new class of polyurethane (PPO's) was synthesized by reacting polyisocyanates with 1,2- or 1,3-diols at a stoichiometry of one mole of a diol per one equivalent of NCO group. Such diols were found to react with NCO groups single-endedly with at least 90% efficiency. The single-ended reaction product is believed to be sterically hindered, effectively suppressing further reaction with NCO groups. The predominantly single-ended reaction caused the resultant PPOs to be only slightly more polydisperse than the precursor polyisocyanates. The reaction of 1,2- or 1,3-diols with the nominally trifunctional isocyanurate of hexamethylene diisocyanate tends to have an exceptionally low polydispersity (M_w/M_n) of about 1.4 to 1.7. In contrast, diols with four or more carbon atoms between OH groups lead to very polydisperse or gelled products. Although steric hindrance seems to be the dominating cause for the single-ended reaction of 1,2- or 1,3-diols, the selectivity of the reaction is enhanced for asymmetric primary/secondary diols compared to symmetric primary diols.

Oligomeric polyols prepared from several nominally trifunctional isocyanates and hindered diols gave useful melamine-cured automotive high-solids coatings. Good acid etch resistance was achieved only if the precursor, 1,2- or 1,3-diols were based on backbones with five or more carbon atoms. It would seem that large alkyl groups on the PPO resins provide molecular shielding to the acid catalyzed degradation of the melamine crosslinked coatings.

The best one-component melamine cured PPO coatings outperformed commercial acrylic thermoset coatings with respect to acid rain resistance, weatherability, and scratch resistance. Their utility was demonstrated on an automotive production line.

Infrared Microscopic Analysis of Multiple Layers of Automotive Paints—D.J. McEwen and G.D. Cheever

JCT, 65, No. 819, 35 (Apr. 1993)

A five-layer paint system for sheet molding compound (SMC), consisting of molded coating, conductive primer, primer surfacer, basecoat, and clearcoat, was analyzed by infrared microscopy. The results of three

Polyols Polyuréthanes: Résines sans Liens Esters pour des Revêtements à Hautes Teneurs en Matières Solides—J.L. Gardon

JCT, 65, No. 819, 24 (Apr. 1993)

Une nouvelle classe de polyols polyuréthanes (PPO) a été synthétisée en régissant des polyisocyanates avec des diols, 1,2- ou 1,3- avec une stoechiométrie d'une mole de diol par équivalent de groupe NCO avec une efficacité d'au moins 90%. On croit que le produit de la réaction est encombré stériquement, empêchant la réaction de se poursuivre avec les groupes NCO. La réaction prédominante à causé que les PPO résultant sont légèrement plus polydispersés que les précurseurs polyisocyanates. La réaction des diols 1,2- ou 1,3- avec l'isocyanurate tri-fonctionnel de diisocyanate hexaméthylène a tendance à posséder une polydispersité exceptionnellement basse (M_w/M_n) d'environ 1.4 à 1.7. Par contre, les diols avec quatre carbones ou plus entre les groupes OH donnent des produits très polydispersés. Même si l'encombrement stérique semble être le facteur dominant pour la réaction des diols 1,2- 1,3-, la sélectivité de la réaction est améliorée pour des diols asymétriques primaires/secondaires comparés aux diols primaires symétriques.

Les polyols oligomériques préparés à partir de plusieurs isocyanates trifonctionnels et diols entravés ont donné d'intéressants revêtements automobiles à haute teneur en matières solides durcissant avec l'aide de la mélamine. Une bonne résistance à l'acide a été obtenue seulement si les diols 1,2- ou 1,3- étaient basés sur des squelettes de 5 atomes de carbones ou plus. Il semble que les larges groupes alkyl sur les résines PPO procurent une protection moléculaire pour la dégradation catalysée à l'acide des revêtements durcis avec la mélamine.

Les meilleurs revêtements PPO durcis avec la mélamine sont supérieurs aux revêtements acryliques commerciaux pour la résistance aux pluies acides, résistances aux intempéries et la résistance aux égratignures. Leur utilité a été démontrée sur une ligne de production automobile.

Analyse Microscopique Infra-Rouge de Couches Multiples de Peintures Automobiles—D.J. McEwen and G.D. Cheever

JCT, 65, No. 819, 35 (Apr. 1993)

Un système de revêtement fait de 5 couches pour les composés de moulage de feuille

Poliolos de Poliuretano: Resinas Libres de Enlaces Ester Para Recubrimientos de Altos Solidos—J.L. Gardon

JCT, 65, No. 819, 24 (Apr. 1993)

Se sintetizó una nueva clase de poliols de poliuretano (PPOs), mediante reacción de poliisocianatos con diols 1,2 ó 1,3 en una relación estequiométrica de 1 mol de diol por un equivalente de grupo NCO. Se encontró que tales diols reaccionaron con grupos terminales NCO con una eficiencia de por lo menos el 90%. Se cree que el producto de la reacción de terminación individual es estorbado estéricamente, suprimiendo de manera efectiva la reacción posterior con los grupos NCO. La reacción predominante de terminación individual ocasiona que los PPOs resultantes sean solo ligeramente mas polidispersados que los poliisocianatos precursores. La reacción de diols 1,2 ó 1,3 con el isocianurato nominalmente trifuncional del diisocianato hexametileno, tiende a tener una baja polidispersión (M_w/M_n) de alrededor de 1.4 a 1.7. En contraste, los diols con 4 o mas átomos de carbono entre grupos OH generan productos muy polidispersados o gelados. Aunque el impedimento estérico parece ser la causa dominante de la reacción de terminación individual, de los diols 1,2 ó 1,3, la selectividad de la reacción aumenta con diols asimétricos primario/secundario comparados con los diols simétricos primarios.

Los poliols oligoméricos preparados a partir de varios isocianatos nominalmente trifuncionales y diols con impedimento estérico, produjeron recubrimientos automotrices, de altos sólidos, curados con melamina. Se obtuvo buena resistencia al manchado con ácido, solamente si los diols precursores 1,2 ó 1,3 estaban basados en cadenas de 5 ó mas átomos de carbono. Parecería que los grupos alquílicos largos de las resinas PPO proporcionan protección molecular contra la degradación de los recubrimientos reticulados de melamina, la cual es catalizada por ácidos.

El mejor recubrimiento monocompuesto de PPO curado con melamina, tuvo un mejor desempeño en exteriores comparado con recubrimientos acrílicos termofijos comerciales, con respecto a la resistencia a la lluvia ácida, a la intemperie y la resistencia al rayado. La utilidad fue demostrada en una línea de producción automotriz.

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sample preparation methods were compared: polishing the paint-SMC at 5 and 90° to the top surface, and microtoming a paint chip. The quickest and easiest method was taking reflection spectra of the individual paint layers polished at 5° to the top surface. The best infrared spectra were obtained by the difficult procedure of microtoming a cross section of the paint and analyzing the individual layers by transmission spectroscopy. Experience has shown that the 5° reflection method is the preferred method and the one we most frequently use.

Low-Temperature Curing Higher-Solids Polyester Coatings with Melamine-Formaldehyde Resins Crosslinkers—G. Chu and F.N. Jones

JCT, 65, No. 819, 43 (Apr. 1993)

Polyester (PE)/melamine-formaldehyde (MF) coatings that cure rapidly at low bakes (<80°C) and appreciably at ambient temperature are described. They are formulated from enhanced-reactivity MF resins having very low levels of >NH and >CH₂OH functional groups and from conventional higher-solids PE resins. Of the PE resins studied, those made from 1,4-cyclohexanedimethanol are the fastest curing. Coatings with 0.5 parts per hundred (phr) of para-toluene sulfonic acid (p-TSA) catalyst develop hardness, solvent resistance, and impact resistance that would be acceptable for many commercial applications at bakes of 60-70°C for 30 minutes. With 1.5 to 2 phr of catalyst, ambient temperature curing PE/MF coatings for certain applications appear feasible. The rate of apparent cure was correlated with the rate of disappearance of -OCH₃ groups observed by FTIR.

Recent Advances in UV-Curing Chemistry—C. Decker and K. Moussa

JCT, 65, No. 819, 49 (Apr. 1993)

The efficiency of newly developed photoinitiators and acrylic monomers has been evaluated in UV-curable resins, by using real-time spectroscopy techniques. The kinetic profiles of these ultrafast photopolymerizations have been directly recorded by following either the monomer disappearance by infrared spectroscopy, or the photoinitiator loss by ultraviolet spectroscopy. The best performance was obtained with formulations based on a morpholino-type photoinitiator and on cyclic-carbonate monoacrylates. One of the great advantages of these new monomers lies in their high reactivity, which leads to fast and extensive cure upon exposure to UV-radiation or laser beams. Chain transfer reactions play an important role in the formation of such strongly crosslinked polymers, which exhibit remarkable mechanical

(SMC), consistant en un revêtement moulu, apprêt conducteur, apprêt de surface, couche de fond et couche transparente, a été analysé par microscopie infra-rouge. Les résultats de 3 méthodes de préparation ont été comparés: polissage du revêtement-SMC à 5° et 90° par rapport à la surface supérieure et obtention d'un microtome d'une écaïlle de peinture. La méthode la plus facile et la plus rapide consistait à prendre le spectre de réflectance des couches individuelles de peintures polies à 5° par rapport à la surface supérieure. Les meilleurs spectres infra-rouges ont été obtenus avec l'aide des microtomes et l'analyse individuelle des couches par spectroscopie de transmission. Il est démontré que la méthode de la réflectance à 5° est la méthode de choix, ainsi que celle qui est la plus souvent utilisée.

Durcissement à Basse Température de Revêtements Polyester à Haute Teneur en Matières Solides avec des Résines Réticulantes à Base de Mélamine-Formaldehyde—G. Chu and F.N. Jones

JCT, 65, No. 819, 43 (Apr. 1993)

Des revêtements à base de polyester (PE) mélamine-formaldéhyde (MF) qui durcissent rapidement à basses températures (< 80°C) sont décrits. Ils sont formulés à base de résines MF contenant de bas niveaux de groupes fonctionnels > NH et > CH₂OH et de résines PE conventionnelles. Des résines PE étudiées, celles à base de 1,4-cyclohexanediméthanol ont le temps de durcissement le plus rapide. Les revêtements avec 0,5 parties par cent (p.h.r.) d'acide sulfonique para-toluène (p-TSA) ont développé la dureté, résistance aux solvants et la résistance à l'impact qui sont acceptables pour la plupart des applications commerciales pour des cuissons de 60-70°C pour 30 minutes. Avec des catalyseurs à 1,5-2 phr, les revêtements PE/MF durcissent à la température de la pièce sont réalisables pour certaines applications. Le taux de durcissement a été corrélé avec le taux de disparition des groupes -OCH₃ observés par FTIR.

Progrès Récents de la Chimie des Revêtements Durcissant aux Rayons Ultra-Violet—C. Decker and K. Moussa

JCT, 65, No. 819, 49 (Apr. 1993)

L'efficacité de nouveaux photoinitiateurs et de monomères acryliques a été évaluée avec des résines durcissant aux rayons ultra-violet, en utilisant des techniques spectroscopiques en temps réel. Les profils cinétiques de ces photopolymérisations ultra-rapides ont été enregistrés en suivant soit la disparition du monomère par spectroscopie infra-rouge ou par la perte du photoinitiateur par spectroscopie ultraviolet. La meilleure performance a été

Analisis Microscopico Infrarrojo de Capas Múltiples de Pinturas Automotrices—D.J. McEwan and G.D. Cheever

JCT, 65, No. 819, 35 (Apr. 1993)

Empleando la técnica de microscopía de infrarrojo se analizó un sistema de pintura de cinco capas para el laminado de un compuesto (SMC), el cual consistió en un recubrimiento moldeado, un primario conductivo, un primario de superficie, un recubrimiento base y un recubrimiento claro. Se compararon los resultados de 3 métodos diferentes de preparación de la muestra: puliendo la pintura-SMC a 5° y 90° sobre la superficie alta y tomando una pequeña muestra de la pintura. El método más rápido y más fácil fue tomar el espectro de reflexión de las capas individuales de pinturas pulidas a 5° sobre la superficie alta. El mejor espectro de infrarrojo se obtuvo por el procedimiento difícil, en el cual se toma una muestra microscópica de la sección transversal de la pintura y se analizan las capas individuales por la técnica de espectroscopía de transmisión. La experiencia ha mostrado que el método de reflexión 5° es el preferido y es uno de los empleados con más frecuencia.

Curado a Baja Temperatura de Recubrimientos de Poliester de Altos Sólidos con Resinas Reticulantes de Melamina-Formaldehído—G. Chu and F.N. Jones

JCT, 65, No. 819, 43 (Apr. 1993)

Se describen los recubrimientos de poliester (PE)/melamina-formaldehído (MF), los cuales curan rápidamente a bajas temperaturas de horneado (<80°C) y de manera apreciable a temperatura ambiente.

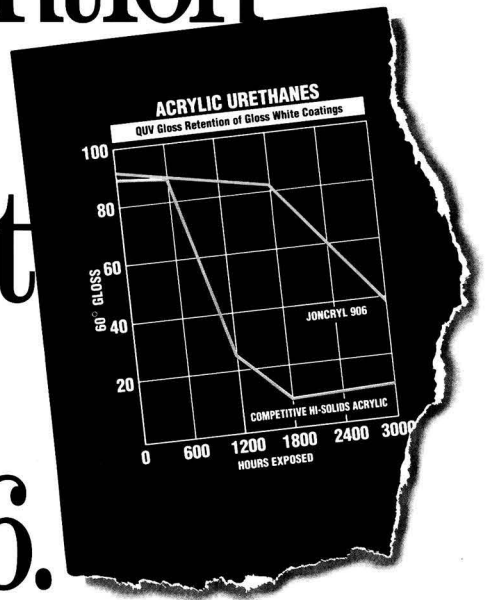
Son formulados a partir de resinas MF de reactividad mejorada, las cuales tienen niveles muy bajos de grupos funcionales >NH y >CH₂OH y también son formulados a partir de resinas de PE de altos sólidos. De las resinas estudiadas, las hechas a partir de 1,4-ciclohexanodimetanol son las de curado más rápido. Los recubrimientos con 0.5 partes por cien de catalizador de ácido para-tolueno sulfónico desarrollaron dureza, resistencia al impacto, lo cual sería aceptable para muchas aplicaciones comerciales a temperaturas de horneado de 60-70°C durante 30 minutos. Para ciertas aplicaciones parece factible el curado de recubrimientos de PE/ME con 1.5 a 2 partes por cien de catalizador. El promedio de curado aparente se correlacionó con el promedio de desaparición de grupos -OCH₃ observados mediante FTIR.

Avances Recientes en la Química del Curado Con Luz Ultravioleta—C. Decker and K. Moussa

JCT, 65, No. 819, 49 (Apr. 1993)

La eficiencia de los fotoinitadores desarrollados recientemente, así como de

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properties, such as hardness, scratch resistance, flexibility, and impact resistance.

Effect of Polyethyleneimine on Phosphate Coatings on Mild Steel—U.B. Nair and M. Subbaiyan

JCT, 65, No. 819, 59 (Apr. 1993)

The interposition of a phosphate layer between a metal substrate and its paint finish has become a well known method of improving adhesion between them. This paper describes efforts to improve the protective and paint-base properties of phosphate coatings, through the incorporation of polymeric compounds as additives in phosphating compositions. In the present study, a high molecular weight, water-soluble polymer, polyethyleneimine (PEI), was evaluated as an additive in an optimized Ca-Zn cold phosphating formulation. The incorporation of PEI in the bath resulted in the formation of coatings having desirable properties and good corrosion resistance.

obtenue avec des formulations basées sur des photoinitiateurs de type morpholino et de monoacrylates cycliques. Un des plus grands avantages de ces nouveaux monomères est leur haute réactivité qui mène à un durcissement rapide lors de l'exposition aux radiations ultra-violettes ou rayons laser. Des réactions de transfert de chaîne jouent un rôle important pour la formation de tels polymères hautement réticulés qui exhibent des propriétés mécaniques remarquables, tels la dureté, la résistance à l'égratignure, la flexibilité et la résistance à l'impact.

Effet du Polyéthylèneimine sur les Revêtements de Phosphate pour le Métal—U.B. Nair and M. Subbaiyan

JCT, 65, No. 819, 59 (Apr. 1993)

Intercaler une couche de phosphate entre un substrat métallique et son fini de peinture est devenu une méthode usuelle pour l'amélioration de l'adhésion entre eux. Cette publication décrit les efforts pour améliorer les propriétés de protection des revêtements de phosphate, à travers l'incorporation de composés polymériques comme additifs dans les compositions de phosphatage. Dans cette étude, un polymère soluble à l'eau possédant un haut poids moléculaire, le polyéthylèneimine (PEI) a été évalué comme additif dans une formulation de phosphatage Ca-Zn. L'incorporation du PEI dans le bain a permis la formation de revêtements avec des propriétés intéressantes et de bonnes résistances à la corrosion.

los monómeros acrílicos ha sido evaluada en resinas curables con luz ultravioleta, empleando técnicas de espectroscopia con tiempos reales. Los perfiles cinéticos de estas fotopolimerizaciones ultra-rápidas se han registrado directamente siguiendo ya sea la desaparición del monómero, por espectroscopia de infrarrojo, o la pérdida del fotoiniciador mediante espectroscopia ultravioleta.

El mejor desempeño se obtuvo con formulaciones basadas en un fotoiniciador tipo morfolino y en monoacrilatos ciclo-carbonados. Una de las grandes ventajas de estos nuevos monómeros recae en su alta reactividad, lo cual conduce a un curado más rápido y extenso en la exposición a radiación ultravioleta o a rayos laser. Las reacciones de transferencia de cadena juegan un papel muy importante en la formación de tales polímeros fuertemente reticulados, lo cual exhibe propiedades mecánicas remarcadas tales como dureza, resistencia al rayado, flexibilidad y resistencia al impacto.

Efecto de Polietilénimina en Recubrimientos Fosfatados Sobre Acero—U.B. Nair and M. Subbaiyan

JCT, 65, No. 819, 59 (Apr. 1993)

La interposición de una capa fosfatada entre un sustrato metálico y su acabado (pintura) se ha convertido en un método bien conocido para mejorar la adhesión entre ellos. Este trabajo describe los esfuerzos para mejorar las propiedades protectoras y de la pintura de los recubrimientos fosfatados, mediante la incorporación de compuestos poliméricos en forma de aditivos en las composiciones fosfatizantes. En el presente estudio la polietilénimina (PEI), un polímero soluble en agua y de peso molecular elevado, se evaluó como aditivo en una formulación fosfatizante fría optimizada con Ca-Zn. La incorporación de PEEI en la cuba produjo la formación de recubrimientos con propiedades deseables y con buena resistencia a la corrosión.

Committee Activities

Federation Technical Advisory Committee and Society Technical Committee Chairmen Met Sept. 24-25, 1992, in Raleigh-Durham, NC

Thirteen Society Technical Committee representatives met with members of the Federation's Technical Advisory Committee (TAC) on September 24-25, 1992, at the Guest Quarters Suite Hotel in Raleigh-Durham, NC.

The meeting was called to order by Technical Advisory Committee Chairman Gail Pollano with the following in attendance: Mary Somerville (Baltimore), Roland Staples (Birmingham), Ben Carozzo (Cleveland), Dave Siller (Houston), V.C. "Bud" Jenkins (Los Angeles), Daniel Letourneau (Montreal), Larry Waelde (New York), Walter Naughton (Southern), and David Moher (Toronto).

Technical Advisory Committee members in attendance were: Richard Max (Chicago), Rose Ryntz (Detroit), Robert Athey (Golden Gate), Ed Ferlauto (Northwestern), and John Flack (Toronto).

Guests attending the meeting included: Colin D. Penny (FSCT President-Elect), Bob Matyka (Piedmont), and Carter Johnson, guest speaker.

Also present were Patricia D. Viola, Editor, JOURNAL OF COATINGS TECHNOLOGY, and Michael G. Bell, FSCT Director of Educational Services.

Motivational Presentation

FSCT President-Elect Colin Penny delivered a presentation on the educational direction of the Federation. Mr. Penny stated that providing educational opportunities for the professional growth of FSCT members and the industry is a primary goal of the Federation.

He said that while many FSCT members refer to themselves as Paint Chemists, they are really Coatings Technologists because of the many subjects that need to be mastered in the industry, such as Chemistry, Physics, Physical Chemistry, Engineering, Hygiene-related subjects, and Ecology. It is his feeling that the industry tends to undersell itself and that Coatings Technologists must be recognized as professionals.

Mr. Penny also touched on the discussions underway with NPCA regarding cooperative efforts to benefit the industry. He pointed out that if Coatings Technologists do not develop products, the companies would not have a business.

He encouraged the attendees to take this message back to their companies, because

of the significance to the future of the industry. He feels there is a need to be more vocal about the importance of technical issues. One method of achieving this is by supporting technical activities of the Societies on the local level and of the Federation on the national level.

Mr. Penny urged every attendee to provide a written report to his or her superiors to let them know what was of benefit at the meeting, and what the attendee personally got out of the meeting. He felt that this will help promote recognition of the professionalism of the organization.

Society Reports

Baltimore

Currently working on five projects: "Public Perception of the Performance of VOC Compliant Alkyd Enamels vs Non Compliant Alkyd Enamels," was initially presented at the March 1992 Society meeting, and is now undergoing more work . . . "Lead Paint Abatement," done in conjunction with the Northwestern Society . . . "Effect of Priming and Surface Preparation on Performance of Architectural Coatings," will hopefully result in a point-of-sale video . . . "The Effect of Degree of Dispersion on the Physical and Performance Properties of Architectural Coatings," was presented as a paper at the 1990 Annual Meeting.

Birmingham

The Birmingham Club has six members on its Technical Committee . . . Hopes to present a paper at the 1993 Annual Meeting on "Solids/Density" . . . The Club is still working on the Coatings Museum project, but has suffered a slight setback due to the economics and has deferred the project for 12 months . . . Latest project is nearing completion, involving the collection of information on the carbon content of many solvents . . . New projects include investigating the various methods of measuring viscosities . . . The seminar held in February 1992 was a success and the Club plans to hold another in the winter of 1993.

Chicago

Currently working on project to create a central repository and distribution center containing Material Safety Data Sheets

(MSDSs) for virtually every raw material used by the coatings industry. Following a five-step approach, the Committee investigated CD-ROM vendors to develop the system. The committee reviewed a prototype on April 21 and FSCT staff viewed the same demo in June. Final demo was made to the FSCT Executive Committee in September and the unit will also be demonstrated at the 1992 Annual Meeting and Paint Industries' Show in the FSCT booth. Comments received will be evaluated and additional work will be done to improve final result.

Cleveland

Presented two papers at 1991 Annual Meeting, which each tied for first place in the Voss Award competition . . . Two papers which were presented at earlier meetings were published in *JCT* this year . . . The committee will present a paper at the 1992 Annual Meeting entitled, "Changes in Hiding During Latex Film Formation—Part V" . . . Plans are in place to work on a corrosion study on "Clear Liquid Separation" for 1993.

Detroit

Two active projects currently underway: A research effort in conjunction with the University of Detroit-Mercy entitled, "The Effect of Siloxane Modification on the Physical Attributes of an Epoxy-Urethane-Acrylic Interpenetrating Polymer Network (IPN)" . . . In conjunction with Eastern Michigan University, a project entitled, "The Role of 'Odor Quantified' Solvents on the Viscosity Behavior of High Solids Resins and the Physical Behavior of Formulated Paints" . . . The committee's goal is to prepare papers for the 1993 FSCT Annual Meeting in Atlanta.

Golden Gate

The Society has 10 to 12 participants, with three to four being extremely active . . . The committee's 1991 project was a paper on uses of ground consumer waste recycled glass in paints and coatings as a pigment, albeit as an inexpensive filler . . . Current project is a collaborative study of the pencil hardness test for precision and correlation to Sward Hardness . . . Several projects are being considered for the 1993 Annual Meeting.



Houston

Presented a paper at the 1991 Annual Meeting entitled, "Variable Characteristics of Titanium Dioxide Using SEM and Particle Size Analysis" . . . Have expressed some concerns about the JCT review and requested assistance of Technical Advisory Committee in evaluating work for publication consideration in JCT . . . Also planning to complete work on project dealing with a water-based epoxy, a vinyl-acrylic latex and an acrylic latex formulation for evaluating pigment variability as related to the micromorphology of the specific pigments . . . Hope to deliver paper at the 1993 Annual Meeting.

Kansas City

Difficulties getting full committee together due to the decline of the industry in the area . . . Currently working on three projects, "Performance of Exterior Finishes on Medium Density Hardboard," "Compliant Coatings: Artificial vs Natural Weathering," and "Performance of Extender Pigments in Exterior Latex Finishes." Hope to be able to present findings at a future Annual Meeting.

Los Angeles

The Society's 1992 project is a paper, to be delivered at the FSCT Annual Meeting, entitled, "Color Standards—Wet, Dry or Photometric" . . . Developing handbook entitled, "Graffiti Abatement and Prevention" and are accepting articles for input, with distribution plans to include municipal leaders and newspaper editors wherever there is a graffiti problem . . . Also working on another project, "The Limit of Paint Performance as VOC Approaches Zero," which will test a variety of low VOC coatings to determine if they are suitable for use.

Montreal

Three projects currently underway: One is with the Northwestern Society and deals with the Effects of Acid Rain. Another deals with a new method to determine the oil absorption of organic pigments compared to old ASTM D 281-84 method. The final project is the study of the new Ultra-fine TiO₂ in latex varnish for the possible replacement of UV absorbers in coatings . . . Also worked with the Toronto Society in the preparation of a paper for the 1992 Annual Meeting.

New York

Thirty-six active members on the committee . . . Four subcommittees are working on projects this year, with all projects well on the way to completion. They include: "Defoamers in Waterborne Systems"; "Color Computer Usage Survey"; "Rheological Modifiers for High Solids Coatings"; and "Silicone Additives for High Solids

Coatings" . . . Seeking a co-chairman for the Technical Committee this year, since the level of work is growing . . . Committee follows up with a phone call to each new member to get more participation . . . Hold short meetings prior to the monthly Society meetings . . . Provide a technical committee report at the dinner meeting as a useful way of keeping the members informed on the actions and accomplishments of the committee.

Piedmont

The Piedmont Society has six to seven members on its Technical Committee . . . Planning to hold a Mini Technical and Exhibition Show on March 10, 1993 in High Point, NC . . . The theme for the technical session is "Compliance: Plain and Simple" . . . Plans are underway to begin the study "The Effects on Total System Hardness that is Comprised of a Hard Aqueous Topcoat Over a Softer Aqueous Undercoat or Sealer." The substrate will be Maple Veneer.

St. Louis

Submitting a paper at the 1992 Annual Meeting. The paper deals with the application of the color computer method to ground in corrosion inhibiting pigments. This project is now completed and the Society is looking for new ideas as well as a new committee chairman for the Technical Committee.

Southern

Seeking help to bring together the members of the Society, since it covers such a large geographic area. Need to have some mechanism to bring these people together. Several ideas were suggested for this.

Toronto

Currently planning to deliver a paper at 1992 Annual Meeting in Chicago, in cooperation with the Montreal Society. The title of the paper is "A New Method for Determining the Vehicle Demand of Organic Pigments" . . . Two other projects currently underway deal with mildewcides in latex paints (in final stages of evaluation and interpretation) and a study of heat aging and weathering behavior of basic coil coating polyesters (now being analyzed at exposure sites).

Overview of Technical Advisory Committee Activities

Guide for Society Technical Directors

John Flack addressed the meeting regarding the revised edition of the "Guide for the Society Technical Director" which was distributed at the meeting. He said the guide provides answers to the questions that the Tech Chairs have. He stressed that the piece is a living document and thus requires

constant improvement and input from the users. He closed by saying the Technical Advisory Committee welcomed any comments from the attendees.

Collaborative Testing Services Update

Richard Max reviewed the FSCT Proficiency Testing Program, done in conjunction with Collaborative Testing Services in Reston, VA. He provided the attendees with the history of the relationship and how it came to be that the Technical Advisory Committee became involved in monitoring the program over the last three years.

He stated that CTS is withdrawing from the coatings testing program for several reasons. He requested feedback from the attendees regarding the need for such a program. He added that the TAC would be providing input to the FSCT Executive Committee and Board of Directors regarding possible alternatives to the program.

Mr. Max asked the attendees to provide input to the subcommittee which was formed to monitor the program. This group is looking for the most useful tests for this type of program, any organizations which do these tests, and other data which will be helpful in analyzing the program.

He also stated that one reason for the dropping of the program was that it was never effectively marketed to the proper audience.

ASTM/NIBS Update

Ed Ferlauto reported on the status of this activity on Lead Abatement and said that the committee is monitoring the program and providing input as needed.

Presentation on a Technical Committee Success Story

Ben Carozzo, Technical Committee Chair of the Cleveland Society, addressed the meeting and discussed the factors which make the Cleveland Society a success in presenting technical papers at the FSCT Annual Meeting.

He stated that most of the areas he planned to discuss were included in the "Guide for Society Technical Directors." Mr. Carozzo explained that four things are very important for a successful technical project: Good Leaders, Good Volunteers, Good Projects, and Good Style.

GOOD LEADERS—He asked each attendee to consider how he or she got the job as Technical Chair and said it most likely was because of leadership skills. It is up to the Tech Chair to be a good motivator and cheerleader for the projects.

He added that another skill the Technical Chair should possess is the ability to tie the entire project together, using the input of all the participants.

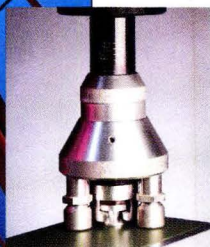
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GOOD VOLUNTEERS—You need to ask everyone possible to participate, and most people will be flattered at being asked. He stressed the importance of never wasting the time of volunteers. This can be done by delineating the activities so no one is wasting time, and is best accomplished by being organized at all times and knowing exactly what needs to be done.

GOOD PROJECTS—Have a good idea what you want to do in advance, since most projects determined by consensus of committee do not work. Stick with the things that you know. This is not to say that the committee should not be consulted on the selection of projects, but that it is important to have an idea of what to pursue in advance of any meeting to provide a foundation on which to build the project.

GOOD STYLE—This means having the final project appear very well in print and goes further than having good writing skills. This includes supplementing the paper with graphs and other things that look good in print. This helps the reader analyze trends, and can be a source of future topics.

He stated that every paper he has worked on was prepared in accordance with the *JCT* style and he encouraged people to adhere to the "Guide for Authors." He stressed the importance of this because the ultimate goal of any Technical Committee is to have a paper published.

Mr. Carozzo then listed the steps to writing: (1) Compile Data, (2) Chart or Graph the Data, (3) Work on Procedure, (4) Write the Results Section, (5) Write Discussion, and, finally, (6) Write the Introduction After You Know What You Are Doing.

Mr. Carozzo cited several miscellaneous points regarding the preparation of projects: you do not need expensive equipment to do good science and you should always set a time frame for the amount of commitment you need from a volunteer.

He closed by citing a potential problem, dealing with the use of labs for projects. This is due to legal reasons. He suggested that all lab work be done as quickly as time permits and that you should try to find participants from potential labs for testing.

He said the Voss Award was always something worth shooting for and that most of the Cleveland Society's success was due to the fact that it followed the simple plan he explained. He gets good response from

people who participate and they realize the added benefits received from this activity. The participant gains background experience in a variety of subjects and receives valuable training for future use.

Demonstration on Planning an Effective Technical Presentation

Carter Johnson, of Buying Time Seminars, in Darien, IL, addressed the group regarding the development and delivery of winning presentations. He began by saying that we always are involved in a variety of presentations (technical, sales, "save your job," etc.) and the way these are done determines the success or failure of the proposal.

According to Mr. Johnson, every time you speak, it is in a sense a presentation and every presentation has something to sell.

He stressed the importance of using the audience to do the work and to exert control over the audience to see the point you are trying to get across.

He said it is important to examine the presentation area before you give your talk and to learn the good and bad points of the room. A good idea is to speak with the maintenance staff in advance of the meeting, since they usually know from experience the best way to arrange a room.

Mr. Johnson stated that a presentation is a "spoken message punctuated by visual aids," and a winning presentation is "a spoken message designed to elicit a predetermined audience response, completely cued by reinforcing visuals." The visuals should be slides, viewfoils or handouts—all which accentuate the message.

He reviewed the attitude of the audience and how it is important to know what is going on with the audience's feelings. There are six categories of audiences, each with different characteristics in the areas of attitude and interest:

POSITIVE/HIGH—They love your topic and are eager to hear you.

NEUTRAL/HIGH—They need to make a decision based on your presentation.

NEGATIVE/HIGH—An unexploded bomb!
POSITIVE/LOW—It's nice, but they've heard it before.

NEUTRAL/LOW—They're bored before you start.

NEGATIVE/LOW—They don't want to be there and they don't like you or your subject.

He also covered the design of the visuals and said you should design the last visual first because this is the major and concluding thesis and it allows you to know where you are going. From there you can determine the sub-benefits that yield the major benefit. The major thesis includes what you are talking about and why your audience should be listening to you. This includes determining what is the major benefit to them.

After designing the first visual, you then design the additional visuals in the order they will be presented. The visuals you use should have the following logical flow toward its conclusion and request: Intro—Description—Benefit—Benefit—Benefit—Conclusion.

Mr. Johnson recommended including a sentence or thesis on every visual. He stressed the need to avoid using organizational charts in presentations and that any input of over six at a time challenges the memory. He proved this to the audience as he asked them to list numbers in sequence. As the list got longer, the number of attendees with the right answer diminished.

He closed by urging the audience not to fight the simple technique of addressing visuals because it works. This technique is: Read the thesis—Explain the graphics, symbols, and acronyms—Accent important items—Move on to next visual.

Open Forum

The attendees made suggestions to the TAC request for assistance in planning future meetings. In addition, the TAC discussed items of interest to participants.

Dinner Speaker

Jim Berry of the Environmental Protection Agency was the dinner speaker and he provided the attendees with the opportunity to discuss their concerns. He reviewed the 1990 Clean Air Act and explained some of the ways the EPA functions both in North Carolina and throughout the United States. He encouraged attendees to ask questions and his answers covered a wide variety of topics.

Plant Tours

The attendees attended a plant tour and presentation at Reichhold Chemical plant and a tour of the EPA facilities.

Regulatory UPDATE

APRIL 1993

This digest of current regulatory activity pertinent to the coatings industry is published to inform readers of actions which could affect them and their firms, and is designed to provide sufficient data to enable those interested to seek additional information. Material is supplied by National Paint and Coatings Association, Washington, D.C. and edited by member of the FSCT Environmental Affairs Committee.

Hazardous Materials Transportation; Registration and Fee Assessment Program—The Research and Special Programs Administration is reminding all those who transport or offer for transportation certain hazardous materials that they are required to register with the Department of Transportation (DOT). The final rule implementing this requirement, which was published in the Federal Register on July 9, 1992 (57 FR 30620), requires that "after September 15, 1992, each person as defined by the Hazardous Materials Transportation Act, who engages in any of the specific activities relating to the transportation of hazardous materials register annually with the DOT and pay a fee." The proceeds will fund a grant program available to states for emergency response planning and training.

Those affected by the rule include anyone who offers or transports any of the following materials:

1. Any highway route controlled quantity of a Class 7 (radioactive) material;
2. More than 25 kilograms (55 pounds) of a Division 1.1, 1.2, or 1.3 (explosive materials) in a motor vehicle, rail car, or freight container;
3. More than one liter (1.06 quarts) per package of a material extremely toxic by inhalation (Division 2.3, Hazard Zone A, or Division 6.1, Packaging Group I, Hazardous Zone A);
4. A hazardous material in a bulk packaging having a capacity equal to or greater than 13,248 liters (3,500 gallons) for liquids or gases or more than 13.24 cubic meters (468 cubic feet) for solids; or
5. A shipment of 2,268 kilograms (5,000 pounds) gross weight or more (in other than a bulk packaging) of a class of hazardous materials for which placarding of a vehicle, rail car, or freight container is required for that class.

The registration requirement is now in effect. If those people subject to the requirement have not filed a registration statement or paid the \$300.00 fee, contact RSPA immediately. Failure to register for the registration year in which that activity occurred will result in civil penalties for each day a covered function is performed. A late fee and interest in addition to a civil penalty may also be imposed.

For further information, contact David Donaldson, Office of Hazardous Materials Planning and Analysis, Hazardous Materials Safety, RSPA, Department of Transportation, Washington, D.C., (202) 366-4109.

Hazardous Materials Transportation; Computerized Tracking System—A study on a nationwide computer tracking system for shipments of hazardous materials has been pushed back until late April by the Transportation Research Board.

The controversial study, which was due to be released in November 1992, was mandated by the 1990 amendments to the Hazardous Materials Transportation Act. During consideration of the implementing legislation, Rep. Douglas Applegate (D-OH) aggressively pushed for a computerized tracking system to be required by the 1990 amendments. Under his plan, shippers and carriers would have been charged fees to pay for the multi-billion dollar system. The plan was strongly opposed by both industry and the DOT because it was "costly, unnecessary, and probably unworkable." Accordingly, Congress instead ordered a study of the idea. The National Academy of Sciences' Transportation Research Board was directed to establish a committee to oversee the research.

The research, which will take into account various, existing computer technology and use of the current hazardous materials placarding system, is expected to be completed "sometime in March." The delay is being attributed to production problems and general bureaucracy. Once the study is released, the DOT has six months to review it and make recommendations to Congress as to whether a national computerized tracking system should be approved. Reportedly, the committee will probably not recommend the implementation of a single nationwide system.

Hazardous Substances—On March 1, the White House Office of Management and Budget (OMB) agreed to let the Occupational Safety and Health Administration (OSHA) release a proposed worker health standard that would regulate four glycol ether chemicals suspected of damaging the reproductive systems of exposed workers. OMB also signed off on a job safety standard known as the lockout/tagout rule.

These are the first two worker health and safety standards cleared by the new Administration since OMB put a hold on all regulatory notices prepared at the end of the Bush Administration.

Under the proposed glycol ethers standard, four substances used as chemical intermediates, jet fuel additives,

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and industrial coatings and solvents would be regulated. The substances are 2-methoxyethanol and its acetate and 2-ethoxyethanol and its acetate. The lockout/tagout rule includes requirements for disconnecting and locking or tagging energized equipment to prevent injury to workers during maintenance and general workplace functions.

While OMB's clearance of the two rules allows the Department of Labor to publish them as policy in the Federal Register, no date for publication has been set.

Regulatory Negotiations—As a result of a February 10 executive order signed by President Clinton requiring all federal agencies to reduce the present number of committees formed under the Federal Advisory Committee Act (FACA), two regulatory negotiations (reg neg) have been put on hold—one of which is the development of the wood furniture regulations. Reportedly, a limit on FACA groups could inhibit EPA's ability to develop regulations in consultation with outside groups.

In determining a regulatory negotiation, EPA forms a group consisting of industry, environmentalists, state and local regulators, and public interest groups for the purpose of developing specific regulations acceptable to all sides. Reportedly, reg negs have been used more frequently in recent years because when all sides are in relative agreement, the amount of lawsuits filed against EPA rules and regulations significantly decline.

Because of the apparent confusion over the impact of the executive order, EPA is moving slowly on certain issues for which reg negs have been considered. It is uncertain as to when a final determination will be made.

Process Safety—Representatives from the government, unions and trade associations will sponsor a series of conferences throughout the United States in April, May, and June to help employers comply with the OSHA's process safety rule.

The process safety rule, most of which took effect in May 1992, is designed to reduce the risk of injury or death to workers in the petrochemical and chemical industries. The rule requires employers to analyze highly hazardous chemical processes, identify potential risks, and develop measures to avert chemical releases.

Included in the conferences will be seminars conducted by OSHA, the U.S. EPA, the National Petroleum Refiners Association, the American Petroleum Institute, the Chemical Manufacturers Association, Organization Resources Counselors, Inc., and the Synthetic Organic Chemical Manufacturers Association. Union representatives include the Building and Construction Trades Department; AFL-CIO; the United Steelworkers; and the Oil, Chemical and Atomic Workers Union.

The seminars will highlight employer compliance with the process safety standard and the process safety management compliance mandate. Also on hand will be OSHA enforcement personnel who will provide details on the agency's latest interpretation of employer performance criteria. During the second day of meetings, discussion will center around EPA's proposed risk management regulations, which are expected to be published in November.

The conferences will be held as follows: Philadelphia—April 13-14, contact: Joanne Liohard, ORC, (402) 293-0963; Houston—April 27-28 contact: Ken Leonard, API, (202) 682-8135; Los Angeles—May 11-12, contact: Joy Orteza, CMA, (202) 887-1326; Chicago—May 25-26, contact: George Dominguez, SOCMA, (202) 262-1316; and Hous-

ton—June 8-9, contact: Helen Kutska, NPRA, (202) 457-0480.

Indoor Air Quality—A revised indoor air bill is expected to be reintroduced by Rep. Joseph Kennedy II in late March. Rep. Kennedy's proposal will exclude language from his earlier indoor air bills that would have required the OSHA to set standards. Instead, the measure will focus on funding for additional research much like Sen. Mitchell's legislation that passed the Senate last year. Sen. Mitchell is expected to re-introduce similar legislation later this year.

The Kennedy bill would drop such controversial provisions as a product emission labeling requirement and an OSHA ventilation-based standard. Those provisions brought last year's bill to a standstill.

An essential element to passage of an indoor air bill will be the support of the Clinton Administration. However, at this point in time, it is difficult to predict the priority status of the issue because two key positions—the assistant administrator for air and radiation at the U.S. EPA and OSHA administrator—have yet to be filled.

Water Quality—According to an announcement by Sen. Max Baucus (D-MT), Chairman of the Senate Environment and Public Works Committee, Sen. Bob Graham (D-FL) will, over the next few months, begin developing a comprehensive plan to reauthorize the Clean Water Act.

The reauthorization discussion will focus primarily on funding, pollution prevention and non-point pollution source control. Congress will also debate such issues as allowing states to use revolving loan fund money for projects mandated under the safe Drinking Water Act. Currently, the fund may only be used for sewage treatment projects. The Clean Water Act authority to eliminate pollutants that pose special threats to water quality, wildlife, and human health will also be reviewed.

Other issues that will undoubtedly resurface during the debate include the need to provide a concrete funding base for water programs, problems associated with small communities' waste water compliances costs, and storm water discharges and combined sewer overflows.

The Senate Environment and Public Works Committee also has jurisdiction over infrastructure and public works projects—a top priority for the Clinton Administration. Accordingly, it is still too early to predict a time frame for the Clean Water Act debate.

EPA Cabinet Legislation—Legislation to elevate the U.S. EPA to Cabinet level has been temporarily withdrawn at the request of the Clinton Administration.

The Senate Government Affairs Committee has scheduled a markup of the EPA Cabinet bill (S. 171) for February 25 but withdrew the bill after the White House requested additional time to reconcile several crucial issues. Reportedly, the key controversy is the abolition of the White House Council on Environmental Quality (CEQ).

On February 8, President Clinton announced he would abolish the CEQ and create a new Office of Environmental Policy (OEP). It was initially predicted that OEP would fill the requirements of the CEQ, but according to a White House Office of Management and Budget draft that is circulating among administration officials, that will not be the case.

The draft reportedly indicates that all CEQ functions will be taken over by the EPA. EPA will also be authorized to

veto actions by other federal departments that are determined to be environmentally objectionable. An EPA veto decision could only be overturned by the President.

Sen. Glenn (D-OH), Chairman of the Senate Government Affairs Committee and sponsor of S. 171, intends to amend the CEQ elimination to the bill.

Further complications have also arisen in recent weeks. In addition to jurisdictional conflicts between House and Senate committees with authority to elevate the EPA to Cabinet level and committees that govern CEQ, many senators are concerned over attempts to add non germane and excessive amendments to the bill. On top of that, there are still persistent rumors that the new head of the Office of Environmental Policy would be given CEQ authority.

Despite the controversy surrounding the legislation, Ad-

ministration support for the issue remains high, and markup could begin shortly after the spring recess.

Truck Back-Billing—Legislation that would address back-billing claims against shippers has been re-introduced in the Senate. The Undercharge Equity Act of 1993 (S. 412), sponsored by Sen. James Exon (D-NE), would establish a settlement procedure where shippers would pay significantly less than they owe under current law. Currently, back-billing claims are estimated to total \$32 billion. The bill is pending before the Surface Transportation Subcommittee, and markup is expected in late March or early April. Similar legislation passed the Senate last year, but the House—reportedly because of opposition by the International Brotherhood of Teamsters—never considered the bill.

States Proposed Legislation and Regulations

Arizona

Lead—AZ H. 2376 (E. Richardson) relates to lead and chemical poisoning; establishes a lead poisoning prevention program; provides that the state is to develop a way to screen children and pregnant women for high lead levels; requires that nursery schools and preschools obtain screening certificates; imposes requirements for reporting by hospitals and doctors; makes it illegal to use paint with more than .5% metallic lead; sets standards for tableware glazes. The bill was introduced on February 9 and referred to the House Committee on Health.

Arkansas

Air Quality—AR S. 638 (Bradford) gives the Commission on Pollution Control and Ecology 45 days to rule on application for permit for relief from provisions of Clean Air Act and an additional 30 days to consider any appeal of that decision; defines the term Commission as Arkansas Committee on Pollution Control and Ecology. The bill was introduced on March 3 and referred to the Senate Committee on Public Health, Welfare and Labor.

California

Lead (Regulatory Activity)—On February 1, 1993, the California Department of Health Services' long awaited regulations to implement the Childhood Lead Poisoning Prevention Act of 1991 were approved by the State Office of Administrative Law. While the final regulations included a tax or fee on the sale and distribution of paints and coatings in the state, the paint industry's share of the total assessment is much lower than in earlier drafts of the regulations. Furthermore, a joint proposal by the California Paint Council (CPC) and the Western States Petroleum Association (WSPA) to include additional parties—including businesses that continue to use lead in their products of industrial process—was partially adopted into the funding mechanism.

Adopted as emergency regulations, a process which escapes the usual notice and comment requirements of the Administrative Procedures Act, the new rules impose "fees" on paint distributors, petroleum distributors, and facilities reporting emissions of lead under SARA Title III. Exact amounts to be collected from each group will vary from year to year.

While earlier versions of the funding mechanism divided responsibility for historical environmental lead contamination equally between the paint and petroleum industries, the

final rules hold the paint industry responsible for less than 16% while deeming leaded gasoline accountable for the remaining 84%. With the inclusion of present sources into the funding scheme, the paint industry's share, once set at \$7.5 million per year, will not exceed \$2.5 million annually. Still, however, the CPC and other industry groups are opposed to the regulations and will continue to support the California Manufacturers Association (CMA) in an anticipated lawsuit to have the regulations and the law authorizing them declared invalid.

The CPC's opposition to the regulations remains strong, according to CPC Executive Director Matt Dustin, although he admits that the final regulations "leave us in a much better position than we were before, should the lawsuits not turn out as we hope they will." He went on to state that CMA's decision of whether to proceed with litigation will likely be made "very soon," and that the increase in the petroleum industry's share will likely mean an even greater push from WSPA and its members.

The paint and coatings industry's share of the total fees will be assessed distributors on the basis of their sales in the calendar year two years prior to the annual assessment. The State Board of Equalization has already sent the "fee returns," which will be used by individual companies to determine the amount owed by them, to over 55,000 companies that distribute architectural coatings in the state. While CPC is exploring the possibility of a preliminary injunction to stop the collection of the "fees" or an extension of the due date for the fees returns, Mr. Dustin warned individual companies to be prepared to pay the "fees" on April 1, in case an extension or an injunction on the collection of fees pending the outcome of litigation is not granted.

The childhood Lead Poisoning Prevention Act authorizes the DHS to collect \$16 million in the first year to fund a program to screen children under the age of six for elevated blood-lead levels. CPC, WSPA, and CMA have argued that the "fees" to be collected are actually taxes and that the law is therefore invalid because it was passed by only a simple majority in both houses of the California legislature. California law requires bills imposing a tax to be passed by a two-thirds vote of both the Senate and Assembly. For further information, contact CPC's Matt Dustin at (916) 443-5095.

Graffiti—CA A. 612 (Connolly) revises a list of offenses authorizing a traffic hearing officer to hear and dispose of cases in which a minor is charged to include the unlawful purchase or possession of an aerosol container of paint, as

specified. The bill was introduced on February 22 and referred to the Assembly Committee on Public Safety.

CA A. 663 (Baca) requires the court to consider whether any defendant who has been convicted of a nonviolent and nonserious offense and ordered to participate in community service as a condition of probation shall be required to engage in the removal of graffiti or in the performance of hospice services for senior citizens in the performance of community service. The bill was introduced on February 23 and referred to the Assembly Committee on Public Safety.

CA A. 839 (Basa) authorizes a city or county to enact an ordinance or ordinances that provide that the parent or legal guardian of a minor adjudicated guilty of a violation of provisions prohibiting affixing graffiti shall be financially responsible, up to a specified amount, for the cost incurred by the governmental entity for the removal of graffiti under this provision, in order to reimburse the city or county fund. The bill was introduced on February 25.

CA S. 527 (Presley) defines "maintain" and "maintenance," for purposes of the Landscaping and Lighting Act, to specifically include cleaning, sandblasting, and painting of improvements to remove or cover graffiti. The bill was introduced on March 1.

CA S. 583 (Lewis) requires a minimum of 40-hours community service as punishment for any person who writes, sprays, scratches, or otherwise affixes graffiti on or in the facilities or vehicles of governmental entities, as specified, for which any of the entities incur costs of less than \$250 for cleanup, repair, or replacement. The bill was introduced on March 1.

CA A. 169 (Horcher) provides that every person who maliciously sprays, scratches, writes on, or otherwise defaces any real or personal property with paint or any other liquid is punishable as a misdemeanor or felony depending on the amount of the defacement, damage, or destruction. Provides that in addition to the penalty that may be imposed for a misdemeanor violation, a person violating this offense may be required to perform community service of at least 100 hours. The bill was released from the Assembly Committee on Public Safety on March 1, amended and re-referred to the committee.

CA A. 1121 (Nolan) makes the offense of affixing graffiti a misdemeanor if the amount of the defacement, damage, or destruction is equal to or less than \$400 and a felony if the amount of the defacement, damage, or destruction is greater than \$400 or if the person has been previously convicted of a violation of this offense. The bill was introduced on March 2.

CA A. 1179 (Epple) makes it a misdemeanor or a felony for a person having been convicted of maliciously defacing, with paint or other liquid, damaging, or destroying any real or personal property not his or her own and having served a term therefore in any penal institution or having been imprisoned therein as a condition of probation for that offense, to be subsequently convicted of that offense. The bill, aimed at repeat offenders, was introduced on March 2.

CA A. 1416 (Haynes) provides that any person who writes, sprays, scratches, or otherwise affixes graffiti on any real or personal property not his or her own is guilty of a misdemeanor punishable by a fine of \$1,000, imprisonment in a county jail for not to exceed one year, or both the fine and the imprisonment if the amount of the defacement, damage, or destruction is less than \$1,000. Requires the court to order any person convicted to participate in community service, or graffiti cleanup, or both.

CA A. 1530 (Caldera) provides in the cases of a person who maliciously defaces with paint or any other liquid, damages or destroys any real or personal not his or her own, that the burden of proof to raise a reasonable doubt that the

property was that of the accused or that the act was done with the consent of the owner shall be upon the person charged with committing a violation of these premises. The bill was introduced on March 4.

CA S. 374 (Hill) provides that upon conviction of acts of vandalism consisting of writing graffiti, the court, in addition to any other punishment imposed under existing law, shall order the defendant to complete a minimum of 24 hours of community service, not to exceed 48 hours for the first offense. Also provides that upon the second subsequent conviction, the court shall order the defendant to complete a minimum of 48 hours of community service, not to exceed 96 hours. Introduced in February, the bill was referred to the Senate Committee on Judiciary on March 3.

Spray Paint Restriction—CA S. 375 (Hill) provides that every retailer selling or offering for sale, in this state, aerosol containers of paint capable of defacing property shall keep or display the containers in an area inaccessible to the consumer. Provides that the retailer, or his or her representative, shall make an aerosol container of paint accessible to a consumer only upon request of the consumer. Introduced in February, the bill was referred to the Senate Committee on Judiciary on March 3.

CA S. 808 (Ayala) provides that every retailer selling or offering for sale, in this state, aerosol containers of paint capable of defacing property shall keep or display the containers in an area inaccessible to the consumer. Provides that the retailer, or his or her representative, shall make an aerosol container of paint accessible to a consumer only upon request of the consumer. The bill was introduced on March 4.

CA A. 1361 (Karnette) provides that a city, county, or city and county with a population over 100,000 may adopt ordinances or regulations, that further restrict the size or use of aerosol containers of paint or the storage of those containers prior to sale. Provides that these ordinances or regulations also may include penalties for enforcement purposes.

Recycled Paint—CA S. 734 (Rosenthal) requires all state and local public agencies to purchase refined automotive lubricants, recycled or nonrecycled antifreeze made of propylene glycol, recycled solvents and recycled paints all of which is defined by this bill. The purchase of the listed materials is required only when they are available and of a fitness and quality equal to their nonrecycled counterparts. The bill was introduced on March 3.

CA S. 1091 (Killea) specifies in the State Assistance for Recycling (STAR) Markets Act of 1989 that public agencies are required, when purchasing paint, to give a preference to suppliers of recycled paint that meets the recycled product requirements of the act. The bill was introduced on March 5.

Air Quality—CA A. 223 (Quackenbush) would abolish existing air quality management districts and grant all regulatory authority to the State Air Resources Board. The bill was referred to the Assembly Committee on Natural Resources on February 1.

Occupational Safety and Health—CA S. 55 (Leonard) establishes maximum expenditures for rehabilitation services, and otherwise revises benefits and makes other changes relative to rehabilitation service for workers' compensation. Limits compensation under the workers' compensation system to injuries that are specific and serious, and requires that employment be the predominant cause of the injury. Imposes additional requirements for compensation for psychiatric injuries. Provides employers with certain rights in regards to insurers. On February 24, the bill was released from the Senate Committee on Industrial Relations, amended on the Senate Floor, and re-referred to the committee.

Environmental Marketing—CA A. 1112 (Sher) revises the definition of “recyclable” for purposes of regulating advertising. The bill was introduced on March 2.

Colorado

Recycling—CO H. 1146 (Gordon) requires all documents submitted to state agencies to be on recycled paper, beginning January 1, 1994. The bill passed the House on February 24. On March 2, it was reported favorably with amendments from the Senate Committee on State, Veterans, and Military Affairs.

Connecticut

CT H. 7193 (Committee on General Law) requires “conspicuous warning labels” for drying oil and drying oil products. The bill was introduced on March 9 and referred to the Joint Committee on General Law.

Florida

Recycling—FL H. 1367 (Brennan) requires nonpaper products to contain recycled content; provides recycled-content standards for glass containers and plastic containers and recycling standards for certain rigid plastic containers used for foods, drugs, or cosmetics; requires periodic certification and reporting by manufacturers. The bill was introduced on February 9 and is currently in the House Committee on Natural Resources.

Packaging—FL S. 978 (Brown-Waite) prohibits the use of certain toxic materials in packaging; prohibits the use of certain packaging materials; provides exceptions; allows the Department of Environmental Resources to grant exemptions; prohibits certain false representations about effects of consumer products on the environment; creates the Florida Packaging Waste Reduction Council; provides for council membership, purposes, duties, and organization; requires the council to report annually to the Governor and the legislature. The bill was introduced on February 11 and was reported with amendments from the Senate Committee on Natural Resources and Conservation on February 19.

Georgia

Lead—GA S.R. 136 (H.A. Ragan) creates the Senate Childhood Lead Poisoning Study Committee. The bill was introduced on February 5 and referred to the Senate Committee on Rules.

Returnable Containers—GA H. 369 (Holmes) relates to selling and other trade practices; prohibits the sale, offering for sale, or giving to consumers a nonreturnable container. The bill was introduced on February 1 and referred to the House Committee on Natural Resources and Environment.

Hawaii

Lead—HI H. 1787 (Shon) provides that before the sale of residential real estate property, the seller shall test the property for unacceptable levels of lead-based paint; provides that any real property which the purchaser will be receiving “as is,” with all defects which may exist, shall also be subject to a test for unacceptable levels of lead-based paint; provides that the seller shall furnish to the purchaser a residential property disclosure statement to include the result of a test for unacceptable levels of lead based paint. The bill was withdrawn from the House Committee on Housing on February 11 but is being considered by both the House Committee on Energy and Environmental Protection, and the Committee on Consumer Protection and Commerce. A companion bill,

S. 1609 (Chang), is currently in the Senate Committee on Judiciary.

Air Quality—HI S. 1691 (Aki) relates to clean air; defines “covered source” and “regulated air pollutant”; provides public display of emissions and enforcement data. The bill was amended and released from the Senate Committee on Government Operations, Environmental Protection, and Hawaiian Programs on February 19. It is currently in the Senate Committee on Judiciary.

Idaho

Inhalant Abuse—ID S. 1012 (Committee on Judiciary and Rules) relates to possession of inhalants by minors; prohibits the possession of inhalants or aerosol spray products by minors for the purpose of utilizing the contents to become under the influence of such aerosol substance; defines “inhalant”; provides that minors illegally possessing inhalants shall not come under the purview of the Youth Rehabilitation Act unless the court orders otherwise. The bill passed the Senate on February 4 and was sent to the House.

Illinois

Graffiti—IL H. 272 (Martinez) makes it illegal for a person to possess a can of spray paint, with intent to harm, on a public way between 10:00 PM and 6:00 AM. The measure defines a can of spray paint as an aerosol can that contains paint, dye, or other like substance. On February 17 the bill was referred to the House Committee on Judiciary II.

Note—The Illinois Paint Council supports the bill.

IL H. 329 (Frias) imposes an additional 5.25% sales tax on spray paint. On February 17 the bill was referred to the House Committee on Revenue.

Note—The Illinois Paint Council reports that the sponsor of the bill has indicated that he will amend the measure to make it a statewide user fee of \$1.00 per can instead of the higher sales tax. The user fee will be deposited in the Crime Victims of Graffiti Fund.

IL H. 574 (Martinez) provides for automatic adult criminal prosecution of a minor, at least 15 years of age, who knowingly damages the property of another, by defacing, deforming, or otherwise damaging that property by use of paint or any other similar substance. The bill was referred to the House Committee on Judiciary II on February 26.

Note—The Illinois Paint Council is closely monitoring this bill.

Air Quality—IL H. 389 (Schoenberg) relates to toxic chemicals emissions fee; imposes a fee of 15 cents per pound on emissions of certain toxic chemicals into the air, with the revenues to be used to support programs relating to air pollution, hazardous waste management, and monitoring of health effects; creates the Toxic Air Pollution Reduction Fund. The bill was introduced on February 17 and referred to the House Committee on Environment and Energy.

Packaging—IL H. 551 (Ostenburg) amends Municipal Code; authorizes cities to regulate product packaging in order to encourage reduction of packaging material and use of recyclable materials. The bill was introduced on February 23 and referred to the House Committee on Environment and Energy.

Recycled Content of Containers—IL H. 560 (Cowlshaw) establishes the Container Fee and Deposit Act; imposes a refundable advance disposal fee on certain containers that are not being recycled at a rate of at least 50%; requires payment of a refundable deposit on the containers; sets penalties for business offenses. The bill was introduced on Feb-

ruary 23 and referred to the House Committee on Environment and Energy.

IL H. 695 (Kotlarz) requires publishers of phone directories and manufacturers of glass containers and rigid plastic containers to have their products contain a certain percentage of recycled materials; provides for certain exemptions; sets penalties and fines for violations. The bill was introduced on February 25 and referred to the House Committee on Environment and Energy.

Indiana

Container Safety—IN S. 295 (Weatherwax) concerns the safety and maintenance requirements for containers used to transport hazardous materials to the list of Federal Regulations enforced in Indiana. The bill passed the Senate on February 8 and is currently in the House Committee on Environmental Affairs.

Iowa

Lead—IA H. 179 (Bernau) establishes a lead inspector and lead abatement contractor training and certification program, and provides a penalty. Introduced on February 10, the bill is in the House Committee on Human Resources.

Kansas

Container Labeling—KS S. 133 (Oleen) prohibits the distribution or sale of any plastic bottle or rigid plastic container, unless it is labeled with a code indicating the plastic resin used to produce it. The bill passed the Senate on February 24 and is currently in the House Committee on Energy and Natural Resources.

Maine

Tributyltin (TBT)—ME H. 7 (Heino) repeals an increase in the restriction on the release of tributyltin from antifouling marine paints. States that the current standard of release of 4.0 micrograms per square centimeter per day remains in effect. The bill was released from the Joint Committee on Marine Resources on March 2.

Lead—ME S. 244 (Conley) concerns violations of the Lead Poisoning Control Act and equitable relief. The bill was introduced on March 2, and referred to the Joint Committee on Judiciary.

Maryland

Lead—MD H. 852 (Anderson) creates a state debt with a matching fund requirement, for a grant to the Board of Directors of St. Ambrose Housing Aid Center, Inc. to plan, design, repair, renovate, rehabilitate, reconstruct, construct, and equip buildings in the Baltimore area by the Center in order to sell or to rent to low-income families and individuals, to provide maintenance assistance to low-income homeowners, and to test for and eliminate lead paint in the buildings. The bill was introduced on February 4 and referred to the House Committee on Appropriations. An identical bill was introduced in the Senate (S. 488—Lapides) and referred to the Senate Committee on Budget and Taxation.

MD H. 1325 (Thomas) increases the membership of the Lead Paint Poisoning Committee. The bill was introduced on February 11 and referred to the House Committee on Environmental Matters.

Container Safety—MD S. 258 (Boozer) requires a manufacturer of rigid plastic containers solid, offered for sale, or used in association with the sale or offer for sale of a product in the state to ensure that the container meets the established requirements; specifies exemptions; requires the

manufacturer of those plastic containers to maintain records that certify the designated information; requires the Department of the Environment to review periodically those certifications for compliance with the Act. The bill passed the Senate on March 4 and is currently in the House Committee on Environmental Matters.

Massachusetts

Lead—MA H. 1650 (Fitzgerald) prevents lead poisoning through increased deleading and through more equitable distribution of existing funding. The bill was introduced on February 6 and referred to the Joint Committee on Health Care.

MA H. 2015 (Local Sponsor) improves safety and reduces the cost of lead-paint abatement. The bill was introduced on February 6 and referred to the Joint Committee on Health Care.

MA H. 2017 (Local Sponsor) increases the availability of lead safe housing and reduces chronic childhood lead poisoning. The bill was introduced on February 6 and referred to the Joint Committee on Health Care.

MA H. 2162 (Peters) increases the scope of the special committee of the House established to make an investigation and study of the lead paint laws to include the subject-matter of providing a non-refundable credit under the income tax laws for owners or tenants for the removal of lead paint from dwellings. The bill was introduced, considered, and released from the House Committee on Ways and Means on February 11.

MA H. 2798 (Jehlen) authorizes the use of market share liability in civil actions brought against certain producers or manufacturers of lead-based paints. The bill was referred to the Joint Committee on Health Care on February 25.

MA H. 2967 (Mariano) helps pinpoint the real sources of lead poisoning. The bill was referred to the Joint Committee on Health Care on February 25.

MA H. 2969 (Mariano) further regulates the covering of lead paint or material. The bill was referred to the Joint Committee on Health Care on February 25.

MA H. 2014 (Local Sponsor) relates to the bill to encourage lead abatement and reduce its financial burden. The bill was referred to the Joint Committee on Health Care on February 19.

MA H. 2016 (Local Sponsor) reduces the incidence of chronic childhood lead poisoning. The bill was introduced and referred to the Joint Committee on Health Care on February 6.

Automotive Paint—MA H. 2082 (Angelo) prohibits the sale of automotive paint to any person not registered pursuant to chapter 100A. The bill was referred to the Joint Committee on Public Safety on February 19.

MA H. 2349 (Valianti and Durand) regulates the sale of automotive paint products. The bill was referred to the Joint Committee on Commerce and Labor on February 23.

Michigan

Lead—MI H. 4099 (Stallworth) establishes Lead Poisoning Screening Program for children ages two-five. The bill was introduced on February 2 and referred to the House Committee on Public Health.

Minnesota

Lead—MN S. 613 (Berglin and Benson) relates to lead abatement programs; specifies that residence assessments must be conducted regardless of availability of state or federal funding and must be conducted by lead inspectors licensed by the Commissioner of Health; requires contractor to give

notice before beginning work at each lead abatement worksite; imposes surety bond requirement on lead abatement contractors; allows local boards of health to adopt more stringent standards; requires contractor analysis in older residence. The bill was introduced March 1 and referred to the Senate Committee on Health Care.

Missouri

Lead—MO H. 160 (Troupe) requires the Department of Health to establish a lead poisoning information reporting system. Attending physicians of patients of lead poisoning would report, in writing, specific information regarding the patients involved. The bill was released from the House Committee on Public Health and Safety on February 15 and amended on the House floor on March 1.

Toxics-in-Packaging—MO S. 100 prohibits the selling of packages, packing material or components containing specified concentrations of lead, cadmium mercury or hexavalent chromium. The bill was amended on the Senate floor in mid-February and is currently in the Senate Committee on State Budget Control.

Montana

Liquified Petroleum Containers—MT H. 165 (Larson) defines liquified petroleum containers and identifies unlawful acts regarding such containers. The bill was signed by the Governor on February 18.

Nebraska

Container Labeling—NE L.B. 63 (Elmer) creates the Plastic Container Coding Act to prohibit the manufacture or distribution of any plastic bottle or rigid plastic container unless it is imprinted with a code identifying the appropriate resin type used to produce the structure of the container. The bill passed the Legislature on March 4 and was sent to the Governor for signature.

New Hampshire

Lead—NH S. 231 (Shaheen) relates to lead poisoning and control and continually appropriates a fund to the Director of Public Health Services; concerns lead paint laws. The bill is currently in the Senate Committee on Public Institutions, Health and Human Services.

New Mexico

Environmental Marketing—NM H. 456 (Picraux) provides for the use of environmental marketing claims. The bill was released from the House Committee on Consumer and Public Affairs on February 19. It is currently in the House Committee on Judiciary.

Graffiti—NM S. 792 (Benavides) bans the sale of spray paint cans to minors. The bill introduced on February 18, released from the Senate Committee on Judiciary on March 4, and is currently in the Committee on Public Affairs.

New York

Environmental Marketing—NY A. 3460 (Cochrane and Townsend) requires recyclable materials to be labeled as "recyclable" if offered for sale, sold or distributed in New York. The bill was introduced on February 11 and is currently in the Assembly Committee on Consumer Affairs and Protection.

Lead—NY A. 1789 (Lentol) requires physicians, health care facilities and health maintenance organizations to screen all patients less than 72-months old for lead poisoning, sets

forth screening schedule for diagnosis of lead poisoning in children; mandates the report of lead poisoning cases to the Commissioner, and sets forth criteria for determining whether or not certain children are at high risk for lead poisoning. The bill was introduced on January 26 and referred to the Assembly Committee on Health.

NY S. 2578 (Mendez) establishes a Division of Prevention within the Department of Health; provides for appointment of a Director of Health Commission and establishes powers and duties of such division in the areas of prevention and recognition of lead poisoning and/or iron deficiency in young children. The bill was introduced on March 1 and referred to the Senate Committee on Health.

NY A. 5244 (Crowley) prohibits the manufacture and sale of toys, furniture, and other articles intended for the use of children which have been painted with paint containing lead; allows commissioner to place warning or demand discontinuance of a hazard on any property of a lead contaminated area. The bill was introduced on March 2 and referred to the Assembly Committee on Health.

TRI Reporting—NY A. 4930 (Brotsky and Dianpoli) enacts the multi-media toxic chemical release inventory act; requires reporting on facilities where toxic chemicals are stored; provides for assessment of data, fees per facility and related provisions. The bill was introduced on March 2 and referred to the Assembly Committee on Environmental Conservation.

Packaging—NY S. 3366 (Spano) mandates scheduled reduction in the amount of packages or packaging components for sale, lease, distribution, or promotion by packagers, thus reducing the amount of solid waste disposed of within the state. The bill was introduced on March 2 and referred to the Senate Committee on Environmental Conservation.

Oregon

Environmental/OSHA Crimes—OR H. 2996 (Local Sponsor) directs a public contracting agency to disqualify a bidder convicted of a crime relating to environmental protection or worker health or safety. The bill was introduced on February 17 and referred to the House Committee on General Government.

Pennsylvania

Toxics-in-Packaging—PA H. 337 (Vitali) regulates toxic materials used in packaging and components thereof. Provides for additional duties of the Department of Environmental Resources, for certain procedures, for remedies and for enforcement, and for civil and criminal penalties. Prohibits packaging that includes inks, dyes, pigments, adhesives, stabilizers, or any other additives containing lead, cadmium mercury or hexavalent chromium which has been intentionally introduced as an element during manufacturing. The bill was referred to the House Committee on Conservation on February 8.

Hazardous Waste (Regulation)—On January 16, the Pennsylvania Environmental Quality Board adopted major amendments to the state's hazardous and solid waste program, including the definition of what constitutes a "hazardous waste." For further information, contact the Pennsylvania Department of Environmental Resources' Bureau of Waste Management at (717) 787-6239.

Rhode Island

Environmental Marketing—RI H. 5316 (Palangio) prohibits the labeling, with a triangle of arrows, of plastic bottles or rigid plastic containers if the bottle or container cannot be

presently recycled in Rhode Island. The bill was introduced on February 3 and referred to the Joint Committee on Environment and Energy.

Lead—RI H. 5639 (Newsome and Mesoelle) prohibits the Department of Administration from purchasing paint products or contracting for the painting of public buildings using lead-based paints. The bill was introduced on February 23 and referred to the House Committee on Finance.

RI H. 5651 (Newsome) relates to lead poisoning prevention; creates a restricted receipt account for the prevention of lead poisoning and funds said account with an increase in the state gasoline tax. The bill was introduced on February 23 and referred to the House Committee on Finance.

RI H. 6238 (Newsome) relates to tax credit for residential lead abatement. The bill was introduced on February 23 and referred to the House Committee on Finance.

RI H. 6807 (Coderre) relates to lead paint poisoning. The bill was introduced on February 24 and referred to the House Committee on Health, Education and Welfare.

RI S. 756 (Izzo) provides a tax credit for homeowners for residential lead removal or abatement. The bill was introduced on February 11 and referred to the Senate Committee on Finance.

South Dakota

Occupational Safety and Health (Tax)—SD S. 309 (Committee on Commerce) provides for taxation of worker's compensation insurance policies and for payments in lieu of premium taxes to fund the promotion of safety in the workplace and the automation of the administration of the worker's compensation laws. The bill passed the Senate on February 22 and was referred to the House Committee on Judiciary.

Texas

Inhalant Abuse—TX H. 1235 (Place) relates to offenses and punishments involving controlled substances, simulated controlled substances, dangerous drugs, and abusable glues and aerosol paints. The bill was introduced on February 26.

Containers—TX H. 1439 (Oakley) relates to symbols imprinted on or molded into certain plastic containers. The bill was introduced on March 3 and referred to the House Committee on Environmental Affairs.

Air Quality (Regulation)—On February 22, the Texas Air Control Board proposed amendments to the program that regulates the construction or modification of major stationary sources of air pollutants (the New Source Review Program). For further information, contact the Texas Air Control Board at (512) 908-1451.

Occupational Safety and Health (Regulation)—On February 9, the Texas Department of Health adopted new regulatory workplace standards concerning threshold limit values of airborne contaminants, exposure to toxic and hazardous substances, respiratory protection, ventilation, and access to employee exposure and medical records. For more information, contact the department at (512) 834-6600.

Utah

Recycled Content for Containers—UT H. 294 (David) establishes criteria for minimum percentages of recycled plastic in plastic containers; requires reporting; provides penalties for violations; and provides procedures for waivers or reductions of percentages. The bill was introduced on February 9 and referred to the House Committee on Health and Environment.

Vermont

Lead—VT S. 198 (Rivers) establishes a program for the training, certification and licensing of lead hazard abatement workers; makes blood lead screening and testing of children available upon the request of parents and mandatory if warranted; provides for the inspection and testing of child care facilities; ensures that lead-based paint hazards are disclosed in the sale or rental of pre-1978 housing; specifies a standard of reasonable care on the part of the owners of pre-1978 housing and day care facilities. The bill was introduced on February 25 and referred to the Senate Committee on Health and Welfare.

Air Quality—VT S. 149 (Ready) adopts measures required to meet the state's obligations under the Federal Clean Air Act Amendments of 1990; establishes a requirement that fixed sources of air contaminants obtain operating permits; requires a plan be developed and implemented for the reduction of hazardous air contaminants from sources affecting areas which may exceed the relevant standards for those contaminants; requires new motor vehicles to meet emissions standards identical to those adopted in California. The bill was introduced on February 18 and referred to the Senate Committee on Natural Resources and Energy.

Virginia

Occupational Safety and Health—VA S. 982 (Gartlan) establishes a register of contractors who flagrantly violate the Occupational Safety and Health Act laws and regulations; forbids the use of any contractor on the flagrant-violation register on construction projects of any state agency; requires that the register will be established and maintained within the Department of Labor and Industry. The bill passed the Senate on February 9 and was sent to the House.

Lead—VA S.J.R. 245 (Schewel) establishes a joint subcommittee to study the abatement of lead-based paint in Virginia. Introduced on January 26, the bill passed the Senate on February 10 and the House on February 23.

Washington

Air Quality—WA H. 1089 (Kohl) revises the funding sources for operation of the state operating permit program approved by the Federal Clean Air Act. The bill was released from the House Committee on Environmental Affairs on February 22. It is currently in the House Committee on Revenue.

Water Quality—WA S. 5215 (Talmadge) strengthens the regulation of the Puget Sound water quality. Revises provisions establishing the Puget Sound water quality authority. Extends the termination date to June 30, 1997. Authorizes the counties to create one or more watershed protection districts. Revises provisions for storm water management. Establishes requirements for sealer disclosure of septic system in sensitive areas. Revises pesticide application guidelines to protect water quality purposes. The bill was released from the Senate Committee on Ecology and Parks on March 3. It is currently in the Committee on Ways and Means.

Paint Contractors Certification—WA S. 5412 (Prentice) requires the adoption of a program to educate, test, and certify paint and coatings applicators in handling hazardous materials applicable to paint or coatings application; establishes monetary penalties for employer and employee infractions; creates the paint and coatings applicators account. The bill was amended and released from the Senate Committee on Labor and Commerce on March 3. It is currently in the Committee on Ways and Means.

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Government and Industry

Paint Industry Caucus Provides Responses At AIM Reg-Neg Meeting, February 11-12

The National Paint and Coatings Association (NPCA), Washington, D.C., has reported that the Paint Industry Caucus presented detailed responses to questions and issues raised concerning its initial proposal to control the volatile organic compound (VOC) content of architectural and industrial maintenance (AIM) coatings through a national command-and-control rule during the regulatory negotiation (reg-neg) meeting held February 11-12, in Newport Beach, CA.

The initial proposal was made to the full AIM Reg-Neg Committee during a meeting in January. The proposal included suggested VOC limits for AIM coatings which were based on the results of a recently tabulated industry-wide emissions survey. As proposed, the rule would achieve an estimated 7.5% nationwide reduction in VOC emissions from AIM coatings compared to 1990 emissions, based on projected data from the survey.

In response to the industry's initial proposal, other members of the AIM Reg-Neg Committee—including representatives from environmental organizations, state regulatory agencies, and the U.S. Environmental Protection Agency—developed a list of 24 issues and questions concerning the proposal that they wanted the industry group to address.

In response to this request, the paint industry representatives presented detailed oral and written responses to the questions and issues posed. According to officials at NPCA, data from the emissions survey will continue to play a crucial role during the negotiating process. Also, paint companies who have not completed the survey are still urged to do so as soon as possible.

The Environmental/State Caucus of the AIM Reg-Neg Committee is now expected to review the paint industry's new data and answers, and to provide a written response to the industry caucus. This response, expected to be in the form of a counter proposal, is expected to be completed this month. The next reg-neg meeting tentatively is scheduled for April 22-23.

In other news, NPCA announced that the second and final exploratory meeting to consider whether to use the regulatory negotiations process in the development of air pollution control regulations for the wood furniture manufacturing industries was held January 26-27, in Raleigh, NC.

The purpose of the meeting was to provide the convener with a sense of whether there was sufficient common ground among potentially affected groups to make negotiations likely to succeed. If the convener recommends that a reg-neg is feasible and should go forward, and the EPA accepts that recommendation, a full reg-neg would begin sometime this spring.

Participants in the meeting included members of the wood furniture and kitchen cabinet coatings manufacturing industry, along with wood, business, and institutional furniture manufacturers; kitchen cabinet manufacturers; and miscellaneous wood parts manufacturers. Also present were state regulators and representatives from public interest and environmental groups.

During the meeting the following issues were discussed: the scope of rules that would be addressed; the feasibility of different

regulatory approaches which might be considered; permitting and market incentives; and consideration of adequate representation of small businesses, particularly small furniture and cabinet manufacturers.

This meeting was a follow-up to the first exploratory meeting, held last December, in Chapel Hill, NC.

If successfully chartered, this reg-neg will address the development and eventual issuance of either a Control Technique Guideline (CTG) or a National Emission Standard for Hazardous Air Pollutants (NESHAP), or both. EPA is required to publish a CTG for the wood furniture industry by November 1993, and a NESHAP by November 1994.

For more reg-neg information, contact Allen Irish or Bob Nelson, NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005.

Construction Contracting Rises 7% in January

Newly started construction in January increased 7%, reversing a two month decline, according to the F.W. Dodge Division of McGraw-Hill, New York, NY.

Both nonresidential and residential building remained fairly close to the levels reported in December of last year. A surge in the often volatile nonbuilding construction sector (public works and utilities) was responsible for January's increase. The pattern of nonbuilding construction often reflects the impact of very large projects (in January, the inclusion of three power plant starts and a large waste treatment facility boosted the nonbuilding total).

Dodge officials stated that "the sharp declines for nonresidential building appear to be over, while housing is taking a breather from the strong gains of recent months."

Nonresidential construction was up 3% in January. A rebound for the institutional categories (schools, hospitals, detention facilities, passenger terminals, etc.) was the source of the nonresidential advance. Meanwhile, office construction in January remained extremely depressed, and new store projects fell from the improvement shown at the end of 1992.

January's residential construction receded 2%. Single-family housing eased back from the preceding month's robust amount, while the multifamily side of the market

held close to the very weak levels over the past year.

Nonbuilding construction rose 41% in January, spurred by the start of four huge projects and a rebound for public works from December's very weak level. The three large power plant projects (located in Massachusetts, New York, and South Carolina) has a combined value in excess of \$600 million. These projects, together with the start of a \$178 million waste treatment facility, accounted for 21% of January's nonbuilding surge. The balance of the increase came from the public works categories bouncing back from a lackluster December and does not itself represent a major shift for this market. The average for December 1992 and January 1993 is within 1% of the general level of public works activity reported in 1992.

On an unadjusted basis, January's contracting for new construction, at \$16.4 billion, was down 2% from the same month a year ago. The South Atlantic, with a 20% gain, was the only region to show considerable growth. Two regions held close to last year's volume—the Northeast, up 1%, and the South Central, down 2%. Two regions had a substantially weaker January—the West, down 11%, and the North Central, down 18%.

Dr. Larry F. Thompson, of At&T Bell Laboratories To Receive 1993 Roy W. Tess Award in Coatings

The 1993 Roy W. Tess Award in Coatings will be presented to Dr. Larry F. Thompson, of AT&T Bell Laboratories. The presentation of the award, bestowed by the



American Chemical Society's (ACS) Division of Polymeric Materials: Science and Engineering, will take place during the 206th Meeting of ACS, on August 22-27, 1993, in Chicago, IL.

The Roy Tess Award, which is given in recognition

of outstanding achievement in the areas of coatings science, technology, and engineering, will be given to Dr. Thompson for his seminal contributions to the field of microlithographic resists. Beginning in 1970,

with his promising work in the field of high sensitivity electron beam resist materials, and continuing in an unbroken arc of activity to his most recent publications on the chemistry and processes for deep-UV resists, have established Dr. Thompson's pre-eminence in the field of modern lithography.

His invention of COP [poly (glycidyl methacrylate-co-ethyl acrylate)], PBS [poly (butene-1-sulfone)], GMC [poly (glycidyl methacrylate-co-chlorostyrene)], NPR (Novolac Positive Resists), and many other important polymers used as high resolution electron beam resists has formed the basis for modern lithography, and his development of critical processes and manufacturing methods has resulted in the acceptance of these materials as standards for the manufacturing of very large scale integrated circuits (VLSI).

Dr. Thompson received the B.S. and M.S. Degrees in Chemistry-Nuclear Engineering from Tennessee Technological

University, and the Ph.D. Degree from the University of Missouri-Rolla. He joined AT&T Bell Laboratories immediately upon graduation.

His 17 patents include six which cover all negative resists used in the electron beam lithographic fabrication of both masks and integrated circuit devices. Another important patent covers the novolac-based positive electron beam resist coating material NPR that is used in the direct fabrication of solid-state devices, and yet another discloses the use of halogen atoms in a polymer structure to provide increased radiation sensitivity, contrast, and resolution. Through 75 innovative and highly creative publications and 73 presentations (50 invited), Dr. Thompson has demonstrated his exceptional ability to apply fundamental science and engineering principles to technologically relevant areas. International recognition of his work resulted in two IR 100 Awards, an R&D Award, and the 1992 New Jersey Inventor of the Year Award, among others.

In 1989, Dr. Thompson was elected to the National Academy of Engineering, and he serves as a member of the Advisory Council of the Department of Chemical Engineering, Cornell University. He is Chairman of the National Science Foundation's Advisory Committee, and a member of the Steering Committee for the Gordon Research Conference on "Chemistry of Electronic Materials." This month, Dr. Thompson became the recipient of the ACS Award in Industrial Chemistry, sponsored by Akzo Chemicals Inc. He also is a member of the Editorial Board of *Solid State Technology*, and an Advisory Editor for both *Solid State Technology* and the *Journal of Microelectronic Engineering*. Dr. Thompson served as Chairman of the ACS Division of Organic Coatings and Plastics (now PMSE) in 1979, and served from 1985-1992 as a Councillor for the PMSE Division.

Amoco Chemical to Build Polyester Raw Material Plant; Plans Underway to Exit Resin 18 Business on June 1

Amoco Chemical Company, Chicago, IL, has received board approval to build a commercial facility to produce Amoco NDC (TM), a polyester raw material.

Amoco NDC is dimethyl-2, 6-naphthalenedicarboxylate (Amoco NDC).

The plant will be constructed at the company's Decatur, AL, site, where paraxylene and purified terephthalic acid (PTA) currently are produced. Construction of this new facility is expected to begin in mid-year. Startup is anticipated during the first quarter of 1995. Costs of the project were not disclosed.

The new facility will have an initial capacity of 100 million pounds per year of naphthalenedicarboxylic acid (NDA). This feedstock facility will be linked to the NDC unit.

NDC is a raw material used in the production of polyethylene-2, 6-naphthalate (PEN), which has applications in magnetic recording tapes, and in electronic and specialty films.

Also, Amoco Chemical has started production of purified isophthalic acid (PIA), the highest quality isophthalic acid available.

The product will be marketed as Amoco PIA, and is being produced at the company's Joliet, IL, facility. Plant expansion and modification at Joliet and at Amoco's Geel, Belgium plant is expected. The annual production capacity at the Joliet and Geel plants will be 200 million and 260 million pounds, respectively.

Costs of the expansion projects were not disclosed.

In other news, Amoco Chemical has announced that it will withdraw from the Resin 18 manufacturing and marketing business effective June 1, 1993.

The company, which has produced Resin 18 since 1962, currently makes approximately 23 million pounds of the product annually at its Texas City, TX plant.

Officials at Amoco have disclosed that the decision to exit the business is based on its inability to meet the standards of business performance and strategic criteria established for product lines within the company.

ARCO Dedicates New PO/SM Plant; New Propylene Glycol Ether Facility Approved

ARCO Chemical Company, Newtown Square, PA, formally dedicated a new state-of-the-art propylene oxide/styrene monomer (PO/SM) plant at its Channelview, TX complex.

The plant can produce 500 million pounds of propylene oxide and 1,125 million pounds of styrene monomer. The startup brings the Channelview facility to a total PO capacity of 1,100 million pounds, and the total SM capacity up to 2,525 million pounds.

The plant also produces 30,000 barrels a day of methyl tertiary butyl ether, and 260 million pounds of slab polyol.

In other news, ARCO announced that its Board of Directors has approved the construction of a new propylene glycol ether plant at the site of its subsidiary in Rotterdam, Netherlands.

The plant will produce 70,000 metric tons a year of propylene glycol ethers. Construction will begin this year, and startup is expected in mid-1995.

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John L. Gardon

John Gardon received his Chemical Engineering Degree at the Swiss Federal Institute of Technology, Zurich, in 1951, and his Ph.D. at the McGill University/Pulp & Paper Research Institute of Canada, Montreal, in 1955. His five publications from this research concerned polyelectrolytic properties of lignin sulfonates, polymer fractionation by dialysis and ultrafiltration, and correction of osmometry for imperfect semipermeability.

For three years, Dr. Gardon was employed by the Canadian International Paper Company. There he developed lignin-based dispersants and thermosetting binders, resulting in two patents and two publications.

Following this, he began his ten-year employment with Rohm and Haas as a Senior Chemist in the Textile Finishes Laboratory. Later, he became a Group Leader in coatings, a Research Associate, and lastly the Manager of the Leather Finishes Laboratory. In two publications, he established quantitative correlations between crosslink density and wash-and-wear properties of cotton. He obtained the Roon Award for his correction of the solubility parameter concept for polarity. In five papers, he established correlations between solubility parameters, critical surface tensions, ultimate strength of polymers and metals, and of adhesive bonds. His interest in adhesion led to two papers concerning a continuum analysis of peel strength. Ten of Dr. Gardon's papers provided a detailed, theoretical analysis of emulsion polymerization and extensive experimental data. He extended the Smith-Ewart theory for quantitative prediction of particle sizes, molecular weights, and kinetics. He showed how radicals can accumulate in particles under certain conditions. He also extensively studied emulsion copolymerization and the swelling of latex particles by monomers. The author of five patents on textile and leather finishing and on nonaqueous dispersion, he participated in the development of many commercially successful products, including latexes, nonaqueous dispersions, leather and textile finishes, and binders for nonwoven fabrics.

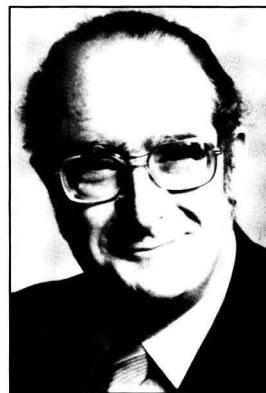
Subsequently, Dr. Gardon became employed by the M&T Chemicals subsidiary of American Can/Elf Aquitaine. For five years, he was Director of Corporate Research and for five years Director of Research of the Coatings and Ink Division. He continued his work on emulsion polymerization and published a patent on core/shell morphology of latexes. Dr. Gardon took charge of American Can's cationic UV cure project and co-authored one patent in this field. He was instrumental in developing the first commercial UV-curable ink and end-varnishes for beer and beverage cans. His group pioneered the use of latexes in industrial baking finishes for business machines and automotive interior coatings. He was instrumental in establishing M&T Chemicals in the powder coatings business by bringing in licensed technology and being one of the first to use twin screw extruders.

For the next six years, Dr. Gardon was Vice President of Research for Sherwin-Williams Company, first in the Chemical Coatings Division, later in Corporate Research. By this time, his present focus on nonpolluting coatings dominated his interest. On this topic he co-edited a textbook. He provided technical guidance for developing commercially successful high solids and aqueous and industrial coatings, electrocoatings, and for pioneering novel chemical approaches for car refinishes. His group developed new associative thickeners and microvoid trade sales coatings.

Joining Akzo Coatings Inc. in 1986 as Vice President, R&D, Dr. Gardon remains a scientifically involved manager. He is principal inventor of a new acidetch resistant automotive coating. His interests now include new crosslinking mechanisms, latexes for wood finishes, aerospace coatings, car finish coatings for plastics, and coil coatings.

Currently Chairman of the Scientific Committee of the NPCA and Alternate Counselor of ACS, Dr. Gardon was Chairman of the ACS Polymeric Materials Science & Engineering Division and of a Gordon Research Conference of the Science of Adhesion. He established the Sherwin-Williams Student Award of the PMSE. Earlier, he established the Group Life Insurance Plan for the Philadelphia Section of the ACS; the national plan was patterned after this. He served many years as a Trustee of the Paint Research Institute. Dr. Gardon organized ACS symposia on nonpolluting coatings and on emulsion polymerization. He was the principal organizer of the Workshop on the Science of Organic Coatings at Kent State University in 1978. He has served on several academic advisory boards, editorial boards of technical publications and on various committees of the Federation, ACS, SME, and of the Industrial Research Institute.

Dr. Gardon is the editor of four textbooks and has authored eight textbook chapters, 29 papers, and 15 patents.



Polyurethane Polyols: Ester-Bond Free Resins For High Solids Coatings

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A new class of polyurethane polyols (PPOs) was synthesized by reacting polyisocyanates with 1,2- or 1,3-diols at a stoichiometry of one mole of a diol per one equivalent of NCO group. Such diols were found to react with NCO groups single-endedly with at least 90% efficiency. The single-ended reaction product is believed to be sterically hindered, effectively suppressing further reaction with NCO groups. The predominantly single-ended reaction caused the resultant PPOs to be only slightly more polydisperse than the precursor polyisocyanates. The reaction of 1,2- or 1,3-diols with the nominally trifunctional isocyanurate of hexamethylene diisocyanate tends to have an exceptionally low polydispersity (M_w/M_n) of about 1.4 to 1.7. In contrast, diols with four or more carbon atoms between OH groups lead to very polydisperse or gelled products. Although steric hindrance seems to be the dominating cause for the

single-ended reaction of 1,2- or 1,3-diols, the selectivity of the reaction is enhanced for asymmetric primary/secondary diols compared to symmetric primary diols.

Oligomeric polyols prepared from several nominal trifunctional isocyanates and hindered diols gave useful melamine cured automotive high solids coatings. Good acid etch resistance was achieved only if the precursor 1,2- or 1,3-diols were based on backbones with five or more carbon atoms. It would seem that large alkyl groups on the PPO resins provide molecular shielding to the acid catalyzed degradation of the melamine crosslinked coatings.

The best one-component melamine cured PPO coatings outperformed commercial acrylic thermoset coatings with respect to acid rain resistance, weatherability, and scratch resistance. Their utility was demonstrated on an automotive production line.

1. INTRODUCTION

1.1 Molecular Weight Distribution of Resins for High Solids Coatings

The design of polyols for high solids coatings traditionally involves a compromise concerning the number and weight average molecular weights (M_n and M_w). The commonly used acrylics, polyesters, and alkyds are polydisperse so that the number of OH groups per molecule varies within each resin. If a significant fraction of mole-

cules contains less than 2 OH groups, these molecules will incorporate inefficiently into the melamine or isocyanate cured network, resulting in weak points in the film. Some fraction may even be OH free. To counteract this, it is customary to design polyols with about 2.5 to 4 OH groups per average molecule to assure the presence of at least 1 or 2 OH groups on molecules at the low end of the distribution.

For many high solids systems, an OH equivalent weight of about 250 to 600 seems to give the best results. For example, an OH equivalent weight of 400 at a number average functionality of 3 corresponds to an M_n of 1200. For good physical and chemical properties of cured films, even higher M_n may be desirable if the polydispersity is high.

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Table 1 — Properties of PPOs Derived from Tolonate HDT-LV and 1,2-Hexanediol, 1,2-Octanediol, 1,2-Dodecanediol, 2-Ethyl-1,3-Hexanediol, 1,4-Pentanediol, and 1,5-Hexanediol. Commercial Type Thermoset Acrylic Controls Developed Coating Damage after 2-Hr Acid Exposure for the Data of Tables 1-3

| | Primary- Secondary Diols | Resin M_w/M_n | Coating Acid Test Hours |
|-------------|--|--------------------|-------------------------------|
| 1,2-HDO | $\begin{array}{c} \text{CH}_2 - \text{CH} - (\text{CH}_2)_3 - \text{CH}_3 \\ \quad \\ \text{OH} \quad \text{OH} \end{array}$ | 1.52 | 7 |
| 1,2-ODO | $\begin{array}{c} \text{CH}_2 - \text{CH} - (\text{CH}_2)_5 - \text{CH}_3 \\ \quad \\ \text{OH} \quad \text{OH} \end{array}$ | 1.65 | 9 |
| 1,2-DDO | $\begin{array}{c} \text{CH}_2 - \text{CH}(\text{CH}_2)_7 - \text{CH}_3 \\ \quad \\ \text{OH} \quad \text{OH} \end{array}$ | 1.86 | 12+ |
| 2-E-1,3-HDO | $\begin{array}{c} \text{CH}_2 - \text{CH} - \text{CH}(\text{CH}_2)_2 - \text{CH}_3 \\ \quad \quad \\ \text{OH} \quad \text{C}_2\text{H}_5 \quad \text{OH} \end{array}$ | 1.40 | 12+ |
| 1,4-PEDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_2 - \text{CH} - \text{CH}_3 \\ \quad \quad \quad \\ \text{OH} \quad \quad \quad \text{OH} \end{array}$ | 3.21 | 6 |
| 1,5-HDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_3 - \text{CH} - \text{CH}_3 \\ \quad \quad \quad \\ \text{OH} \quad \quad \quad \text{OH} \end{array}$ | 3.61 | 7 |

For practical high solids coatings, the resin viscosity must be kept as low as possible. The resin viscosity increases with the M_w . Consequently, the compromise for designing oligomeric polyols for high solids coatings requires maximal M_n and minimal M_w , i.e., low polydispersity, as measured by the M_w/M_n ratio.

The ideal "most probable" molecular weight distribution achieved in the synthesis of linear, free radical polymerized acrylics and of linear polyester condensation polymers leads to an M_w/M_n ratio of 2. Special synthesis techniques allow reduction of M_w/M_n to about 1.8 for acrylics. For achieving relatively high OH functionality, polyesters and alkyds must be branched. For such nonlinear polymers, the value of M_w/M_n is much higher than 2.¹

"Living" ionic or group transfer polymerizations provide almost monodisperse polymers with M_w/M_n substantially less than 2. However, these synthesis techniques have limited utility in the coatings industry due to the difficulties in large scale production.

A purpose of the present work is to provide nonlinear oligomeric polyols which are convenient to manufacture with $M_w/M_n < 2$, and suitable for thermosetting high solids coatings.

1.2 The Role of Ester Bonds in Conventional Coatings Resins

The conventional acrylic, polyester, and alkyd resins for crosslinkable coatings have OH groups tied to the main polymer backbone through ester bonds. A hypothesis underlying the present work is that the ester bonds contribute to the poor acid rain resistance of commercial melamine cured automotive coatings. As will be shown later, this hypothesis is fruitful, but does not fully explain

acid etch resistance. Also it was found that the new coatings have outstanding UV-related weathering resistance. This is likely to be due to the absence of the ester bonds.

In this context, it should be emphasized that modern needs for automotive coatings include both low VOC and good acid rain resistance.²⁻⁸ With respect to acid etch resistance, two-component acrylic urethanes are better than melamine cured, one-component acrylic thermosets, but are expensive to apply. The present work resulted in a one-component high solids coating system with an exceptionally good acid etch resistance.

1.3 Background to Polyurethane Polyols

Urethane modified polyesters and alkyds are commonly used in industrial coatings, but have not shown particular merit for VOC or acid etch control. Such resins, unlike the polyurethane polyols (PPOs) of this work, contain ester bonds. In this paper, a new class of PPOs is described which are ester bond-free, multifunctional, low in molecular weight, and less polydisperse than linear acrylics and polyesters. These properties were achieved by exploiting the discovery that 1,2- and 1,3-diols (i.e., with two or three carbon atoms between OH groups) react predominantly single-endedly with NCO groups if the ratio of reactants is one mole of such diol per one equivalent NCO. Melamine crosslinked high solids coatings based on some PPOs synthesized in this manner gave excellent acid etch resistance.

Relatively monodisperse and ester bond-free PPOs were described in the past by Ambrose⁹ and Blank.¹⁰⁻¹² Ambrose reacted a large stoichiometric excess of diols with polyisocyanates, thus forcing the reaction to become predominantly single-ended. Ambrose's reaction products are rich in unreacted diols, which are difficult to remove. Blank prepared monodisperse polyurethane diols by the reaction of cyclic carbonates with diamines. Neither of these authors described high solids coatings having good acid etch resistance.

2. EXPERIMENTAL

2.1 Preparation of PPO Derived from 1,3-Butanediol and Hexamethylene Diisocyanate Isocyanurate Trimer

A 1000 mL four-neck round bottom flask, equipped with a mechanical stirrer, heating mantle, reflux condenser, and inlets for nitrogen and the addition of reagents was used. The initial charge consisted of 150.3 g of 1,3-Butanediol (BD) (1.67 moles, Kodak Fine Chemicals), 97.0 g of methyl amyl ketone (MAK), and 0.45 g of a 10% n-butyl acetate solution of dibutyltin dilaurate (T-12[®], Air Products, 0.01% based on theoretical resin solids). After heating the reaction mixture to 70°C, a solution of 302.3 g of hexamethylene diisocyanate (HMDI) trimer (HDT-LV[®], 1.67 eq, eq wt = 181, Rhone Poulenc) and 97.0 g of MAK was added over 2.5 hr. After stirring for an additional 45 min, the heating mantle was removed and the solution allowed to cool to room temperature. Complete reaction of isocyanate was confirmed by loss of

the IR band at 2250 cm^{-1} . The final product was a water white liquid with a viscosity of 2120 mPaS and a % NV of 68.2 (theoretical % NV = 70.0).

2.2 Preparation of Other Polyurethane Polyols

Other PPOs were prepared in a manner similar to those previously shown, with 1,3-BD replaced by other glycols on an equimolar basis. Tin catalyst was maintained at 0.01% based on resin solids (BORS), and MAK was adjusted to maintain a theoretical solid content of 70%. Such PPOs were also successfully prepared on a commercial scale in a 3000 gal standard acyclic reactor. The exotherm generation and stirring requirements are similar to those in acrylic polymerization.

2.3 Molecular Weight Determination

Molecular weights were measured on a Waters GPC equipped with a refractive index detector using a bank of 100Å, 500Å, and mixed bed linear columns. The calibration curve was developed with a mixture of monodisperse polyethylene glycol and polystyrene standards for the low and high molecular weight regions, respectively.

2.4 Measurement of Residual Glycols

The overall solid content and some measure of the residual glycol were determined by drying at 110°C for one hour using 0.5 g samples diluted with one mL of MAK. If the 1,2- or 1,3-diols were used in the reaction, the measured solid contents were in the 68-69% range (below the theoretical 70%), corresponding to a diol conversion of 90 to 94%. These gravimetric data will not be further discussed because of their lack of precision when high boiling glycols are used. Residual glycol for the data of Tables 6 and 7 was measured by GC using a 25 m × 0.2 micron HP-5 capillary column, with an initial temperature of 80°C, temperature programmed at 10°C/min, with decane as an internal standard. The injector port temperature was kept at 135°C. The more precise GC data on a single sample are discussed in detail in Section 4 in the context of Tables 6 and 7.

2.5 Preparation of Clear Coatings for Acid Spot Testing

Hexamethoxymethylmelamine (HMMM, Cymel® 303, American Cyanamid) and PPO resins were combined at a ratio of 40:60 based on solids, combined with 0.5% blocked dodecylbenzenesulfonic acid (DDBSA, Nacure® 5226, King Industries), and modified with 0.05% poly-(butyl acrylate) flow aid (Coroc® A-620-A2, Cook Paint and Varnish Co.). After reduction to about 60% NV with tetrahydrofuran, the coatings were applied to taupe primed panels (Advanced Coatings Technologies, Inc., Code APR18353) with a #55 roll bar, flashed for 10 min at ambient conditions, and cured for 17 min at 265°F in a Despatch forced air oven.

2.6 Preparation of Spray Applied Automotive Clearcoat

The spray applied clearcoat was prepared using a 61.1:38.9 ratio of the PPO (or commercial-type acrylic

Table 2 — Properties of PPOs Derived from Tolonate HDT-LV and Ethylene Glycol, 1,3-Propanediol, 1,4-Butanediol, 1,5-Pentanediol, and 1,6-Hexanediol

| | Symmetric Primary Diols | Resin M_w/M_n | Coating Acid Test Hours |
|----------|--|-----------------|-------------------------|
| EG | $\begin{array}{c} \text{CH}_2 - \text{CH}_2 \\ \quad \\ \text{OH} \quad \text{OH} \end{array}$ | 1.97 | 7 |
| 1,3-PDO | $\begin{array}{c} \text{CH}_2 - \text{CH}_2 - \text{CH}_2 \\ \quad \quad \\ \text{OH} \quad \quad \text{OH} \end{array}$ | 1.60 | 7 |
| 1,4-BDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_2 - \text{CH}_2 \\ \quad \quad \quad \\ \text{OH} \quad \quad \quad \text{OH} \end{array}$ | 7.51 | 7 |
| 1,5-PEDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_3 - \text{CH}_2 \\ \quad \quad \quad \\ \text{OH} \quad \quad \quad \text{OH} \end{array}$ | Gel | — |
| 1,6-HDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_4 - \text{CH}_2 \\ \quad \quad \quad \\ \text{OH} \quad \quad \quad \text{OH} \end{array}$ | Gel | — |

polyol) to HMMM. Based on resin solids, it also contained 3.46% of Sanduvor® 3206 UV absorber (Sandoz Chemicals Corp.), 1.38% of Tinuvin® 440 hindered amine light stabilizer (HALS, Ciba-Geigy), 0.4% of a nonsilicon flow aid, and 0.4% of blocked DDBSA. The solvent blend for the coating was composed of a mixture of MAK, methyl propyl ketone, n-butanol, and 2-butoxyethylacetate. Final let down with Solvesso 100 resulted in a paint with a measured VOC of 3.5 lb/gal, 58.0 wt % NV, 52.0% volume solids, and 8.31 lb/gal density at a spray viscosity of 30 sec. Ford #4 cup at 80°F. The clearcoat was sprayed wet-on-wet over a conventional

Table 3 — Properties of PPOs Derived from Tolonate HDT-LV and from 1,3-Propanediol, 2-Methyl-Propanediol, Neopentyl Glycol, 2,2-Diethyl-Propanediol, and 2-Ethyl-2-Butyl-Propanediol

| | 1-3 Diprimary Propane Diols | Resin M_w/M_n | Coating Acid Test Hours |
|---------|--|-----------------|-------------------------|
| 1,3-PDO | $\begin{array}{c} \text{CH}_2 - \text{CH}_2 - \text{CH}_2 \\ \quad \quad \\ \text{OH} \quad \quad \text{OH} \end{array}$ | 1.60 | 7 |
| MPDO | $\begin{array}{c} \text{CH}_2 - \text{CH} - \text{CH}_2 \\ \quad \quad \\ \text{OH} \quad \text{CH}_3 \quad \text{OH} \end{array}$ | 1.60 | 7 |
| NPG | $\begin{array}{c} \text{CH}_3 \\ \\ \text{CH}_2 - \text{CH} - \text{CH}_2 \\ \quad \quad \\ \text{OH} \quad \text{CH}_3 \quad \text{OH} \end{array}$ | 1.45 | 11 |
| DEPD | $\begin{array}{c} \text{C}_2\text{H}_5 \\ \\ \text{CH}_2 - \text{C} - \text{CH}_2 \\ \quad \quad \\ \text{OH} \quad \text{CH}_2\text{H}_5 \quad \text{OH} \end{array}$ | 1.34 | 12+ |
| BEPD | $\begin{array}{c} \text{C}_4\text{H}_9 \\ \\ \text{CH}_2 - \text{C} - \text{CH}_2 \\ \quad \quad \\ \text{OH} \quad \text{C}_2\text{H}_5 \quad \text{OH} \end{array}$ | 1.41 | 12+ |

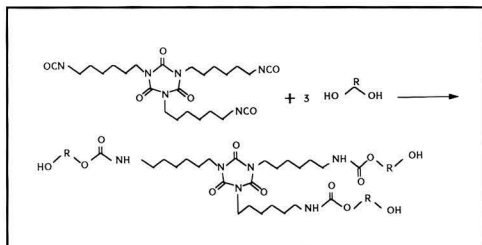


Figure 1—Idealized presentation of the reaction of one mole of HMDI isocyanurate trimer with three moles of a diol in a manner that a triurethanetriol is obtained. Critical for the outcome of this reaction is the structure of the diol symbolized by the “R” group

acrylic dark blue metallic basecoat to a dry film thickness (DFT) of 1.8 to 2.0 mils, and baked at 250°F for 30 min.

2.7 Preparation of Spray Applied Black Automotive Topcoat

The spray applied black monocoat was prepared using a 65:35 (BORS) ratio of the PPO to HMMM. Based on resin solids, it also contained 3.0% of Sanduvor 3206 UV absorber, 1.0% of Tinuvin 440 HALS, 0.2% of a nonsilicon flow aid, 0.4% of blocked DDBSA, and 1.8% carbon black. The carbon black was ground directly into the PPO resin in a steel ball mill to full development of jetness (with the aid of 7.5%, based on pigment, of a pigment wetting agent). The solvent blend for the coating was composed of a mixture of MAK, methyl propyl ketone n-butanol, and 2-butoxyethyl acetate. Final let down with Solvesso 100 resulted in a paint with a measured VOC of 3.9 lb/gal, 53.0 wt % NV, and 8.32 lb/gal density at a spray viscosity of 30 sec, Ford #4 cup at 80°F. A formula identical to this was also prepared without the UV absorber and HALS. Some acrylic coatings were used for purposes of comparison and were formulated in a similar manner. The coatings were baked at 250°F for 30 min.

2.8 Measurement of Acid Etch Resistance

The testing solution was prepared by combining 1 N solutions of acids in the volume proportions of 65 parts sulfuric, 30 parts nitric, and 5 parts hydrochloric. Test panels were marked with a grid containing 12 rectangles.

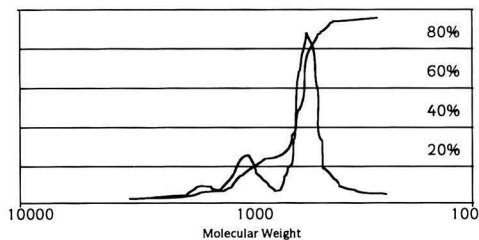


Figure 2—GPC results of the reaction product of one mole of TMXDI and two moles of EHDO

Each test spot was begun by placing three drops of the acid solution in the middle of the rectangle. A new spot was added every hour, at which time the evaporated liquid from the older spots was replenished to maintain a roughly constant drop size. After 12 hr, all the drops were rinsed off the panel with distilled water, and wiped with a soft cloth to remove any salt. The number of hours of exposure leading to the first barely visible surface damage are shown in *Tables 1-3*. An alternate test is described in the caption of *Figure 3*.

3. PPOs BASED ON ISOCYANURATE TRIMER OF HMDI

3.1 General Principles

The two HMDI isocyanurate “trimers” investigated, Tolonate HDT-LV (Rhone Poulenc) and Desmodur 3390 LV (Miles Inc.), are in fact not trifunctional. According to suppliers, both contain about 3.25 NCO groups per number average molecule. This is believed to be due to the presence of higher molecular weight adducts. The M_w/M_n was determined by GPC of the methanol blocked forms to be 1.21.

The schematic presentation of *Figure 1* ignores the actual polydispersity of HDT-LV (or Desmodur 3390 LV) and shows its ideal trifunctional state. For convenient illustration of the principles of synthesis, *Figure 1* shows the reaction of the ideally trifunctional isocyanate with exactly three moles of a diol. In actual experiments, the Tolonate HDT-LV was reacted with diols at a ratio of one mole of HDT-LV and 3.25 moles of the diol. (One NCO equivalent per one mole of diol.)

The schematic presentation of *Figure 1* also shows an ideally monodisperse polyurethane triol as the sole reaction product. In fact, a 3.25 functional PPO was the principal reaction product of 1,2- and 1,3-diols. However, as mentioned in Section 2.4, about 6 to 10% of such diols remained unreacted at the end of the reaction when all NCO groups had disappeared. Consequently, small amounts of higher than 3.25 to 1 adducts were also produced. *Tables 1-4* show the M_w/M_n values of the PPOs to be higher than 1.21, the value for Tolonate HDT-LV. This increase in polydispersity will be explained in Section 4.

In the first phase of the present work, the effect of the structure of the diol on its reaction with Tolonate HDT-LV was established. The structure of the diols is symbolized by the group “R” in *Figure 1*.

3.2 Structure of PPOs Based on Primary/Secondary Diols and Tolonate HDT-LV

An early hypothesis was that asymmetric primary/secondary diols would react with isocyanates selectively. The 1,2- and 1,3-diols of *Table 1* gave narrow polydispersity, 1.40 to 1.66, actually lower than commercial high solids acrylic polyols, which usually have polydispersity of 2 or slightly higher. The data of *Table 1* also show that 1,4- and 1,5-primary/secondary diols did not fulfill this expectation, but led to M_w/M_n values of 3.21

Table 4 — Comparison of Symmetric and Asymmetric 1,4- and 1,5-Diols in Their Reactivity with Tolonate HDT-LV

| | Diols Based on 5-7 Carbon Atoms | Tolonate HDT-LV-Based PPOs | |
|------------------|---|----------------------------|--------------------------------|
| | | M _n | M _w /M _n |
| | Typical 1,2 Diols and 1,3 Diols | 1390-1660 | 1.35-1.52 |
| 1,4 Diols | | | |
| 1,4-PEDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_2 - \text{CH} - \text{CH}_3 \\ \qquad \qquad \qquad \\ \text{OH} \qquad \qquad \qquad \text{OH} \end{array}$ | 2528 | 3.21 |
| 1,4-BDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_2 - \text{CH}_2 \\ \qquad \qquad \qquad \\ \text{OH} \qquad \qquad \qquad \text{OH} \end{array}$ | 3446 | 7.51 |
| 2,5-HDO | $\begin{array}{c} \text{CH}_3 - \text{CH}(\text{CH}_2)_2 - \text{CH} - \text{CH}_3 \\ \qquad \qquad \qquad \\ \text{OH} \qquad \qquad \qquad \text{OH} \end{array}$ | Gel | Gel |
| 1,5 Diols | | | |
| 1,5-HDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_3 - \text{CH} - \text{CH}_3 \\ \qquad \qquad \qquad \\ \text{OH} \qquad \qquad \qquad \text{OH} \end{array}$ | 2733 | 3.61 |
| 1,5-PEDO | $\begin{array}{c} \text{CH}_2 - (\text{CH}_2)_3 - \text{CH}_2 \\ \qquad \qquad \qquad \\ \text{OH} \qquad \qquad \qquad \text{OH} \end{array}$ | Gel | Gel |

and 3.61, substantially higher than that of Tolonate HDT-LV, 1.21.

Not shown in Table 1 are the number average molecular weights, M_n. The M_n values were between 1,500 and 1,700 for the 1,2- and 1,3-diols, and >3000 for 1,4- and 1,5-diols.

The reaction product of 2-ethyl-1,3-hexanediol with Tolonate HDT-LV was subjected to NMR analysis. If the selectivity of the isocyanate/diol reaction would have been solely due to the reactivity difference between the primary and the secondary OH groups, the resultant PPO would have contained only secondary OH groups. Instead, the NMR data showed that 60% of the OH groups on this PPO were secondary and 40% primary. It is now concluded that the asymmetry of primary/secondary diols contributes to selective reaction, but the effect of steric hindrance inherently due to the structure of 1,2- or 1,3-diols/NCO adducts is more important. This will be further discussed in Section 4.

3.3 Acid Etch Resistance of Melamine Crosslinked Coatings Based on PPOs Derived from Primary/Secondary Diols and Tolonate HDT-LV

Table 1 shows excellent (> 12 hr) acid etch resistance (cf. Sections 2.5 and 2.8) for PPO/melamine coatings derived from PPOs based 1,2-dodecanediol and 2-ethyl-1,3-hexanediol. The 1,2-octanediol-based resin gave a respectable nine hour rating in the acid etch test. It should be noted that in this test thermoset acrylic coatings (formulated similarly to the PPO-based coatings) showed only two hours acid etch resistance, even less than those which are based on PPOs synthesized from diols containing six or fewer carbon atoms.

It now seems that being ester-bond free in itself does not maximize the acid etch resistance of PPOs. It is also very

important that the OH groups attached to PPOs be shielded by bulky alkyl groups.

3.4 Adducts of Symmetric Primary Diols and Tolonate HDT-LV

The results of Section 3.2 suggested that 1,2- and 1,3-diprimary diols would also react selectively with Tolonate HDT-LV, since such diols are structurally similar to their primary/secondary counterparts. Consistent with this hypothesis, the pattern of results with diprimary diols, shown in Tables 2 and 3, is quite analogous to the results of Table 1.

Nine diprimary diols were tested. Five of these were of the 1,3-type and led to M_w/M_n of 1.30 to 1.60 with M_n in the 1500 to 1800 range. The only 1,2-diol of this series, ethylene glycol, gave M_w/M_n of 1.90, but in a different solvent system, a less polydisperse resin was prepared. The reaction product of 1,4-butanediol had M_w/M_n of 7.51; the 1,5- and 1,6- diprimary diols gave gelled reaction products.

With respect to acid etch resistance, the results with diprimary 1,3-diols followed the previously obtained pattern. Melamine cured PPOs based on diols with seven or nine carbon atoms gave more than 12 hr acid etch resistance (2,2-diethyl- and 2-ethyl-2-butyl-1,3-propanediol). Neopentylglycol with five carbon atoms gave a respectable 11 hr acid etch rating. All other lower molecular weight diols with not enough shielding for the pendant OH group gave poorer acid etch resistance of seven hours, although better than the two hours acid etch resistance obtained with melamine cured acrylic polyols.

4. FACTORS CONTRIBUTING TO POLYDISPERSITY OF PPOs

Tables 1-3 show that both the asymmetric (primary/secondary) and the symmetric (diprimary) 1,2- or 1,3-diols give about the same polydispersity. Apparently, the M_w/M_n values obtained with these diols do not discrimi-

COMMERCIAL ACRYLIC BASED CLEARCOATS

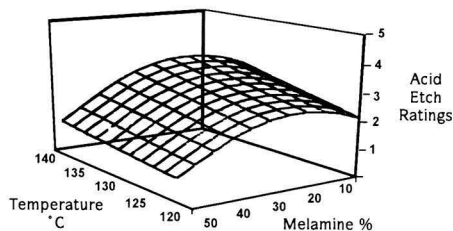


Figure 3—Results of acid etch testing conducted at Akzo Coatings GmbH in Germany. Clearcoated panels were cured for 25 min at the temperatures indicated. After immersion at room temperature in a 28% H₂SO₄ solution for 24 hr and rinsing, the damage was rated against a standard; 5 is perfect, 0 is very bad

PPO-BASED CLEARCOATS

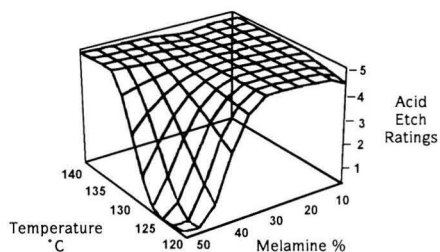


Figure 4—Same tests as in Figure 3, conducted with a PPO based on Tolonate HDT-LV and 2-ethyl-1,3-hexanediol

Table 5 — Properties of Polyurethane Diols Prepared from 1 Mole Diisocyanate and 2 Moles of a Hindered or Unhindered Diol

| Diisocyanate (DI) | Diol (DO) | Oligomer Oligomer | |
|----------------------------|--------------------------------|-------------------|--------------------------------|
| | | M _n | M _w /M _n |
| Isophorone DI | 2,2-Diethyl-1,3-Propane DO | 677 | 1.18 |
| | 2-Ethyl-1,3-Hexane DO | 618 | 1.12 |
| | 1,6-Hexane DO | 1613 | 1.51 |
| Trimethyl hexamethylene DI | 2-Butyl-2-Ethyl-1,3-Propane DO | 727 | 1.18 |
| | Neopentyl Glycol | 835 | 1.27 |
| | 1,6-Hexane DO | 1178 | 1.53 |
| | Cyclohexane - 1,3-Dimethanol | 1024 | 1.60 |
| Methylene dicyclohexyl DI | 2-Butyl-2-Ethyl-1,3-Propane DO | 853 | 1.17 |
| | 1,6-Hexane DO | 1153 | 1.60 |

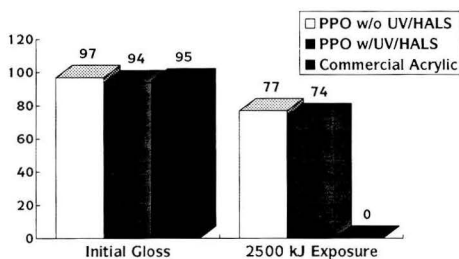


Figure 5—Black monocoat durability in xenon arc weatherometer

nate between symmetric and asymmetric structures, though the NMR observations of Section 3.1 indicate some preferential reactivity of primary relative to secondary OH groups. For 1,2- and 1,3-diols, the steric hindrance seems to be the dominating cause for reaction selectivity. Once the first OH group of such a diol forms a urethane link, the second OH group becomes less reactive than any OH group on an as yet unreacted diol molecule.

Table 4 compares 1,4- and 1,5-diols in their reactivity toward Tolonate HDT-LV. It is evident that 1,4- or 1,5-asymmetric (primary/secondary) diols give lower polydispersity and lower molecular weights than analogous symmetric (diprimary) diols. Actually, 1,5-pentanediol led to gel formation. Interestingly, the symmetric disecanary diol with four carbons between the OH groups (2,5-hexanediol) also caused gelation.

The discrimination of selectivity of 1,2- or 1,3-hindered diols is also notable when compared to two unhindered diols (HDO and cyclohexane dimethanol) in their reaction with three different diisocyanates leading to diurethane diols. Table 5 shows that the hindered diols (DEPD, EHDO, BEPD, and NPG) gave lower molecular weights and lower M_w/M_n values than the unhindered ones.

The selectivity of the reaction of hindered diols with isocyanates is not perfect, since the M_w/M_n of the PPO is always somewhat higher than that of the precursor polyisocyanate. The observed degree of selectivity must be the consequence of the differing reaction rates of various types of OH groups with an NCO group. An OH group of an as yet unreacted diol molecule reacts faster than an OH group pending on a PPO molecule. In the absence of kinetic data, the selectivity of the reaction is assessed below from the conversion of the diol at the end of the reaction.

Tetramethylxlylene diisocyanate (TMXDI) is practically monodisperse being >99% pure according to the data of the American Cyanamid Co. At the end of its reaction with 2-ethyl-1,3-hexanediol, 7.84% of the diol was found to remain unconverted (cf. Section 2.4).

Table 6 shows a mathematical model to calculate the mole fractions of the 2/1, 3/2, 4/3, and higher adducts in the reaction mixture from the fractional diol conversion.

The GPC data of Figure 2 provide a basis for comparison of the theoretical and experimental data in Table 7. The agreement is remarkably good. For example, the calculated and experimental M_n values are 611 and 622, and the M_w/M_n ratios are 1.103 and 1.120, respectively.

It should be noted that the fractional conversion of EHDO in its reaction with TMXDI and Tolonate HDT-LV is about the same. The increase in polydispersity is higher with Tolonate HDT-LV as a result of its higher initial functionality.

Based on the available results, it may be justifiable to assume that the hindered diols react selectively with at least 90% efficiency.

It should be noted that all PPO reaction products prepared with hindered diols inherently contain small amounts of unreacted precursor diols. These diols act as reactive diluents and at low levels do not seem to detract from the properties of the coatings.

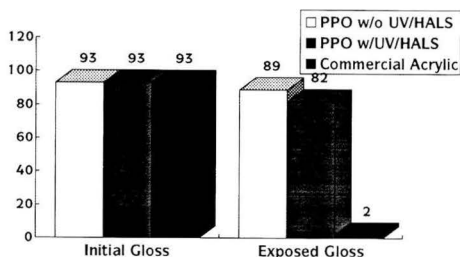


Figure 6—QUV durability at 3500 hr black monocoat

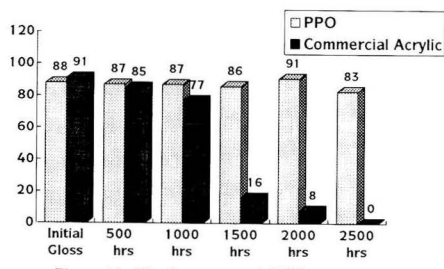


Figure 7—Black monocoat QUV exposure

5. PRACTICAL COMPARISONS BETWEEN ANALOGOUS PPO/MELAMINE AND ACRYLIC/MELAMINE COATINGS

5.1 Various Resin Structures

Many versions of PPO resins have been investigated. In particular, the biuret trimer of HMDI, the isocyanurate trimer of IPDI, and the tri-IPDI adduct of trimethylolpropane were also used as isocyanate precursors. These were combined with the hindered 1,2- or 1,3-diols previously described, and gave resins differing from those based on the isocyanurate trimer of HMDI only in subtle ways. All these resins had low polydispersity and gave crosslinked coatings having good acid etch resistance. Various melamines and blocked isocyanates were successfully used as crosslinkers. Several, but not all, of these resin/crosslinker combinations gave VOC values less than 4 lb/gal at spray viscosity.

The practical performance of the PPO resin prepared from Tolonate HDT-LV and 2-ethyl-1,3-hexanediol was extensively compared to acrylics in HMMM crosslinked coatings. Typical automotive grade acrylic resins have about the same viscosity as the PPO resin (2000 to 3000 mPaS at about 70% solids) and have similar OH equivalent weight, about 400. Unlike the PPO, these acrylic resins are linear and have M_w/M_n of at least 2 at an M_n higher than that of the PPO. Formulating guidelines are shown in Sections 2.6 and 2.7.

5.2 Response to Melamine Level and to Cure Temperature

Figures 3 and 4 show that the PPO-based coatings give better acid etch resistance than the acrylic coatings over a wider range of melamine levels and curing temperatures. Not shown in these data is the finding that, if the acid catalyst level is increased, PPO/HMMM coatings cure very well at low temperature repair conditions (85°C at 20 min) and have UV and acid etch resistance similar to the coatings baked under regular conditions (125°C, 30 min). The acrylics do not respond that well to low temperature bake even with increased acid catalyst.

5.3 Field Experience and Results Obtained in Accelerated Weathering

Coatings described in Table 8 and in Sections 2.6 and 2.7 were exposed in Jacksonville, FL, in three consecu-

tive summers by automotive companies and by Akzo. The PPO/melamine coatings consistently outperformed the commercial high solids thermoset acrylics with respect to acid rain resistance. As far as information is available, the PPO/melamine coatings were the only high solids, one-component coatings giving good results in Jacksonville, although recent literature² describes other chemical approaches for high solids, one-component, acid etch resistant coatings. Acid rain resistance of PPO/melamine coatings approached those of the best quality, two-component acrylic urethanes. It should be stated that some, but not all, experimental two-component coatings, reputedly based on fluoropolymers or silicone modified polymers, gave better acid rain resistance than the one-component PPO/melamine coatings.

The available information on the chemistry of various coatings used in the Jacksonville tests is admittedly cursory. At its face value, this information indicates that coatings based on some very polar resins (PPO/HMMM or acrylic urethane) and some possibly nonpolar (fluorine or silicone containing) resins performed very well.

Sections 3.2 and 3.3 show that not all PPO resins are suited for optimal acid etch resistant coatings. No such structure/property relationships are currently available for other classes of coatings designed to be acid etch resistant.

According to tests run by automotive companies, the PPO/melamine coatings have outstanding scratch and carwash resistance. It is possible that the regular spacing of crosslinks helps to achieve these properties.

The commonly used Kesternich test, mentioned in Table 8, involves exposure of coated panels to a humid

Table 6 — Calculation of the Molecular Weight Distribution from the Fraction of Unreacted Diol for the Reaction Product of 1 Mole of Tetramethyl Xylylene Diisocyanate and 2 Moles of 2-Ethyl-1,3-Hexanediol

Model: Monodisperse Diisocyanate, TMXDI (1 mole), "Selective" Diol, EHDO (2 moles)
 X = Fraction of unconverted EHDO at the end of reaction = 0.0784 (by experiment)
 $P_1 = 1-2X$ = probability that any NCO group is attached to single-endedly reacted diol
 $P_2 = (P_1)^2 = (1-2X)^2$ = probability that both NCO groups on a single TMXDI molecule are attached to single-endedly reacted diol
 $M_2 = P_2$ = mole fraction of 2/1 (diol/TMXDI) adduct
 $M_3 = P_1^2 (1 - P_1^2)/2$ = mole fraction of a 3/2 adduct
 $M_4 = P_1^2 (1 - P_1^2)^2/3$ = mole fraction of a 4/3 adduct
 $M_5 \dots \dots \dots$

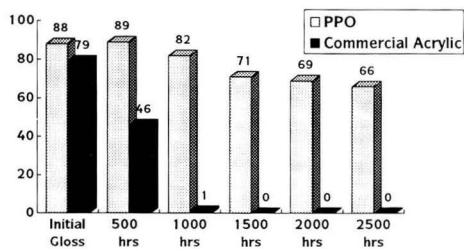


Figure 8—White monocoat QUV exposure

Table 7 — Frequency Distribution of Adducts and Corresponding Weight Distribution Calculated by the Model of Table 6 from the GPC Data of Figure 2

| EHDO/TMXDI Adduct Ratio | Molecular Weight | Calculated Mole - % | Experimental Mole - % |
|--------------------------------|------------------|---------------------|-----------------------|
| 2:1 | 536 | 84.74 | 85.62 |
| 3:2 | 926 | 12.24 | 12.39 |
| 4:3 | 1316 | 2.36 | 1.78 |
| 5:4 | 1706 | 0.51 | 0.21 |
| 6:5 | 2096 | 0.12 | — |
| 7:6 | 2484 | 0.03 | — |
| | | Calculated | Experimental |
| Mn | 611 | 642 | |
| M _w /M _n | 1.103 | 1.120 | |

Table 8 — Properties of Spray Applicable Coatings Prepared from a PPO and Cymel 303

| Wet Paint Properties | Clearcoat | Black Monocoat |
|----------------------|-----------|----------------|
| VOC | 3.50 | 3.90 |
| % NV | 58.00 | 53.00 |
| Weight/gallon, lb. | 8.31 | 8.32 |
| Dry Film Properties | Clearcoat | Black Monocoat |
| DOI | 94 | 99 |
| 20° Gloss | 95 | 93 |
| Tukon hardness (KHN) | 12.0 | 12.3 |
| MEK double rubs | 200+ | 200+ |
| Gravelometer | 5A | 5A |
| Kesternich | Pass | Pass |

Table 9 — QUV Exposure Results Obtained with Acrylic Basecoat Overcoated Either with an Acrylic or with a PPO Based Clearcoat

| | Standard Bake: 17 Min at 265°F | | | | Overbake: 30 Min at 265°F | | | |
|--------------|--------------------------------|-----------------|---------|-----------------|---------------------------|------------------|---------|------------------|
| | 20° Gloss | | DOI | | 20° Gloss | | DOI | |
| | Initial | 4500 Hr | Initial | 4500 Hr | Initial | 4500 Hr | Initial | 4500 Hr |
| Acrylic..... | 99 | 83 ^a | 91 | 88 ^a | 99 | 3.3 ^b | 94 | 1.5 ^b |
| PPO..... | 94 | 91.7 | 94 | 93 | 94 | 91 | 94 | 93 |

(a) Some cracking.
(b) Severe cracking.

SO₂ atmosphere. Commercial automotive coatings tend to show cracking in this test. The PPO/melamine coatings are completely stable. The gravelometer test (SAE J-400) rated the PPO coatings to be slightly better than current commercial systems.

Black PPO/melamine mono coats have outstanding gloss retention in artificial weathering tests with or without stabilizing antioxidant/UV absorber additives, and are in this respect far superior to the commercial acrylic controls, which are formulated with stabilizing additives (cf. Sections 2.6 and 2.7). These results are shown in Figures 5-7.

The photooxidation resistance of additive free PPO/melamine coating was tested by a method developed at Ford Research Laboratories.^{13,14} Hydroperoxide concentration was followed iodometrically as a function of xenon arc "light only" exposure time. In this method a low sustained hydroperoxide concentration predicts better outdoor weatherability. According to private communication from Dr. Gerlock, PPO/melamine hydroperoxide concentration remained near the lower detection limit of the iodometric technique for the duration of the exposure, substantially lower than the hydroperoxide concentration profiles observed for conventional acrylic/melamine coatings.

The data of Figures 7 and 8 and of Table 9 are based on coatings containing stabilizing additives. The white PPO/melamine coating (cf. Figure 8) is not quite as good as the black coating in its resistance to accelerated weathering. The catalytic effect of TiO₂ in UV degradation was not completely overcome by the PPO/melamine. The commercial white acrylic coating lost gloss almost completely after 1,000 hr QUV (B-lamp) exposure, while the PPO/melamine coating retained 92% of its initial gloss. The gloss retention after 2,500 hr exposure was 74%.

A PPO-based clearcoat retained gloss and distinctness of image (DOI) very well after 4,500 hr QUV exposure, much better than the commercial thermoset acrylic, according to the data of Table 9. It is noteworthy that overbaking caused severe deterioration in the weathering resistance of the acrylics, but not of the PPO-based coating.

The PPO/melamine coatings are being exposed in Florida. The black mono coat and the clearcoat show very little change to date (two years for the black mono coat, three years for the clearcoat). The exposure is continuing.

Successful production line application of PPO/melamine paints in Ford Motor Company's Atlanta, GA, facility involved Taurus cars. Three car bodies were painted with PPO/melamine black mono coats and about 5,000 fully assembled cars were produced using a PPO/mela-

mine clearcoat over a blue metallic thermoset acrylic basecoat. The PPO/melamine clearcoated cars showed no significant acid etch damage when stored outdoors without a temporary "transit coating," which is normally put over conventionally coated cars for protection against acid etch damage. None of these cars required repainting. Contrary to this, cars clearcoated during the same period of time with conventional acrylic/melamine paints sustained considerable acid rain damage, regardless whether protected by transit coating or not, and many of them had to be repainted.

ACKNOWLEDGMENTS

Dr. Fritz Walker, Peter Uhlianuk, and Scott Loper are coinventors of the patents covering the new PPO technology.¹⁵⁻¹⁷ Dr. Fritz Walker, Alex Yahkind, and Dr. Ian Wagstaff made key contributions to the systematic understanding of structure/property relationships of the PPO resins. Dr. Hank J.W. van den Haak contributed to the data of Figures 3 and 4. Practical paint formulations were developed by groups headed by Kim Scarlet, Tim Fisher, Bruce Williams, and Deborah Reiner.

References

- (1) Odian, G., *Principles of Polymerization*, John Wiley and Sons, New York, pp 88-92, and 279-281, 1970.
- (2) Anonymous, *Paint and Coatings Industry*, pp 22 and 24 (April 22, 1992).
- (3) Keebler, J., *Automotive News*, 16 (August 19, 1991).
- (4) Wolff, G.T., Collins, D.C., Rodgers, W.R., Verma, M.H., and Wong, C.A., *J. Air Waste Management Association*, 1638 (1990).
- (5) Schrantz, J., *Industrial Finishing*, 14 (July 1990).
- (6) Gawrouski, F.J. and Jackson, I.L., *Automotive News*, 61 (April 1990).
- (7) Bauer, D.R., *J. Applied Polymer Sci.*, 27, 2651 (1982).
- (8) Bauer, D.R., *Chemtech*, 616 (October 1991).
- (9) Ambrose, R.R., Chang, W., McKeough, D.R., and Peffer, D.R. (to PPG Industries, Inc.), U.S. Patent 4,543,405 (September 24, 1985).
- (10) Blank, W.J., "Polyurethanes as Reactive Cosolvents in Waterborne Coatings," *JOURNAL OF COATINGS TECHNOLOGY*, 61, No. 777, 119 (1989).
- (11) Parekh, G.G. and Blank, W.J. (to American Cyanamid Company), U.S. Patent 4,631,320 (December 23, 1986).
- (12) Blank, W.J., *Progr. Org. Coat.*, 20, 235 (1992).
- (13) Mielewski, D.F., Bauer, R.D., and Gerlock, J.L., *Polymer Degradation and Stability*, 33, 93 (1991).
- (14) Bauer, D.R., Gerlock, J.L., and Dickie R.A., *Progr. Org. Coat.*, 15, 209 (1987).
- (15) Gardon, J.L., Loper, S.W., and Uhlianuk, P.W., (a) E.P. Patent Application 0,409,301 A2 (January 3, 1991), and (b) USP 5,175,227 (December 29, 1992).
- (16) Walker, F.W. and Gardon, J.L., (a) USP 5,130,405 (July 14, 1992), and (b) E.P. Patent Application 0,455,291 A1 (November 6, 1991).
- (17) Gardon, J.L., Loper, S.W., Uhlianuk, P.W., and Walker, F.H., (a) E.P. Patent Application 0,409,300 A2 (January 23, 1991), and (b) USP 5,155,201 (October 13, 1992).

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Infrared Microscopic Analysis of Multiple Layers of Automotive Paints

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General Motors Corporation
NAO Research and Development Center

A five-layer paint system for sheet molding compound (SMC), consisting of molded coating, conductive primer, primer surfacer, basecoat, and clearcoat, was analyzed by infrared microscopy. The results of three sample preparation methods were compared: polishing the paint-SMC at 5° and 90° to the top surface, and microtoming a paint chip. The quickest and easiest method was taking reflection spectra of the individual paint layers polished at 5° to the top surface. The best infrared spectra were obtained by the difficult procedure of microtoming a cross section of the paint and analyzing the individual layers by transmission spectroscopy. Experience has shown that the 5° reflection method is the preferred method and the one we most frequently use.

INTRODUCTION

Automotive paint systems are composed of multiple layers having diverse compositions and functions. The primers are applied to protect the substrate and provide adhesion for the topcoat layers. The topcoat layers provide appearance and protect the substrate and primer layers. Substrates in automotive use are metals, thermoplastics, and thermoset composites.

In the present work, a thermoset composite called sheet molding compound (SMC) was used as the substrate. SMC consists primarily of glass fibers and calcium carbonate in a polyester matrix. The five coatings on the SMC are: (1) a molded coating applied *in-situ* during compression molding of the SMC that provides a smooth surface for the paint system and limits solvent migration into the SMC substrate; (2) a conductive primer that also limits solvent migration and

aids in electrostatic application of subsequent layers; (3) a primer surfacer that can be sanded if necessary for a smoother contaminant-free surface; (4) a basecoat for appearance; and (5) a clearcoat for high gloss and smoothness. An important part in the quality control of a paint system is having suitable methods for analyzing the individual layers and determining their composition.

Infrared methods for analyzing the exposed paint surface are well developed.¹ However, surface characterization alone is often not adequate because defects arise in any of the layers or interfaces.² Prior to the advent of infrared microscopy, the analysis of multiple paint layers required abrading away each successive layer and analyzing the resulting dust or exposed layer of interest.³⁻⁶

Infrared microscopy has now permitted the direct analysis of cross-sectioned paint layers, each of which vary in thickness from about 15 to 50 micrometers. The standard procedure is to cross section the paint into thin films with a microtome, and examine each layer by infrared transmittance microscopy.^{7,8} To enlarge the exposure of the paint layers fivefold, Stoecklein and Gloger⁹ microtomed paint chips at an angle of 10° to the top surface. They obtained good infrared transmittance spectra of each layer, but microtoming is an exacting and time-consuming procedure.

In the present study, we have extended the analysis of paint layers to include infrared reflectance. The paint sample was polished at an angle of 5° to the top surface to enlarge the dimensions of the exposed layers tenfold, and then a reflectance spectrum was taken of each paint layer. However, reflectance spectra of strongly infrared absorbing materials are not as well-defined or as sensitive as transmittance spectra. They need to be adjusted for refractive index changes with a Kramers-Kronig algorithm, and calibrated for infrared band shifts relative to the more customary transmittance spectra. But once the adjustments and calibrations have been made, reflectance spectra can be as useful as transmittance

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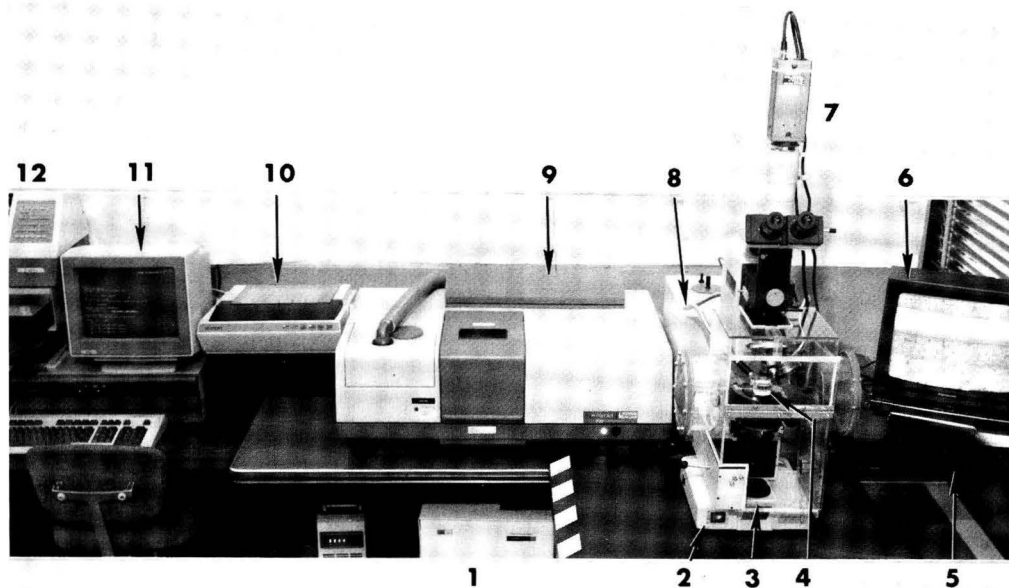


Figure 1—Photograph of infrared microscope and spectrometer: (1) Perkin-Elmer 186-0421 air dryer; (2) Spectra-Tech 0044-005D infrared microscope; (3) Microscope atmosphere chamber; (4) SMC specimen embedded at 90° in epoxy; (5) Panasonic AG-EP70 video printer; (6) Panasonic CT-1381Y video monitor; (7) Panasonic WVCL300 video camera; (8) Fiberoptic Specialties LS86-110-2 light; (9) Nicolet 740 FTIR spectrometer; (10) C. Itoh C310 printer; (11) Nicolet computer and monitor for 740 FTIR; and (12) Zeta Graphics 912 plotter

spectra and much easier to obtain. In this report, the reflectance method is demonstrated and compared to the transmittance method with the analysis of a five-layer SMC paint system.

EXPERIMENTAL

SMC and Paint System

The description of the SMC substrate and paint system is given in *Table 1*.

Paint-SMC Preparation for Analysis

Four methods were used to prepare the paint and paint layers on the SMC for analysis.

MICROREFLECTION, 5°: The painted SMC was glued with beeswax to a 5° bevel mount (Solid State Measurements, Inc., Model 1-55-15) and polished at 5° to the top surface with 1000-mesh carborundum paper.¹⁰ The bevel mount had an actual angle of 5.72°, so the paint layers were exposed ten times wider than their normal thicknesses.

MICROREFLECTION, 90°: The painted SMC was cast in epoxy (Fisher 12-270-2) and polished at 90° to the top surface with Linde A polishing compound. This procedure exposed the paint layers at their normal thicknesses.

MICROTRANSMITTANCE: A paint chip removed from the SMC was mounted on the end of a slit dowel and immersed in epoxy in a polyethylene cup (Ernest Fullam 54080). After the epoxy hardened, the polyethylene cup was cut away, and the chip-in-epoxy was microtomed to 3-micrometer thickness with a Reichert-Jung model FC4E microtome. The resulting paint slivers were straightened and flattened by pressing them between two 0.3 mm thick KBr windows in a pellet press. We tried to cut the chip at a large angle, but only achieved cuts at about 50° to the top surface, so the exposed paint layers were about 1/3 wider than the normal paint layer thicknesses.

MACROTRANSMITTANCE: Individual uncured coatings were smeared on KBr or ZnSe windows and cured at 120°C for 30 min. The sampling was done before and after stirring the coatings to mix the settled fillers, so that spectra were obtained of the polymers without and with the fillers.

Instrumentation

The infrared spectra were obtained with a Spectra-Tech IR-PLAN microscope fitted with 4X and 10X glass objectives for the visible region, and with a 15X Cassegrain-type objective for the infrared/visible region. The 32X objective was also used to examine the microtomed paint slivers. The examination of the paint layers was greatly facilitated with a

Table 1—Description of SMC and Paint System

| Material | Composition | Bake | |
|----------------------|---|------------|-----|
| | | min | °F |
| SMC | Styrene crosslinked polyester resin, glass fibers and calcium carbonate | — | — |
| Molded coating | Epoxy-acrylic resin, talc and carbon black | — | — |
| Conductive primer | Melamine-formaldehyde resin, barium sulfate and carbon black | 30 | 300 |
| Primer surfacer | Melamine crosslinked polyester resin, barium sulfate and titanium dioxide | 30 | 250 |
| Water-based basecoat | Melamine-formaldehyde resin and aluminum flake | wet-on-wet | |
| Clearcoat | Melamine crosslinked polyester and epoxy-acrylic resin | 30 | 250 |

color video camera and monitor. The microscope was connected to a Nicolet model 740 Fourier-transform infrared spectrometer (FTIR), as shown in *Figure 1*. The spectrometer was operated under conditions outlined in *Table 2*.

For the microreflectance studies, the spectra were distorted because the weak reflectance signal from the strongly infrared absorbing paint layers is dependent on the infrared absorption coefficient and the refractive index of the paint. A Nicolet algorithm called Kramers-Kronig was used to mathematically separate the two functions, so the spectra primarily represent the absorption coefficient. Also for the 90° microreflectance study, the detector was operated at such a high gain that the signal was quite noisy. Consequently, the spectra were smoothed with a 25-data point smoothing algorithm.

RESULTS

Photomicrographs of Paint Layers

Photomicrographs of the five paint layers plus SMC and potting epoxy are shown in *Figure 2*. *Figures 2A* and *2B* represent the surface of the paint samples that were polished at angles of 5 and 90° to the top surface, respectively. (The photograph for *Figure 2A* was reduced 10 times to match *Figure 2B*.) Because of the small polishing angle of 5°, the boundaries of the paint layers are not as clear cut in *Figure 2A* as they are in *Figure 2B*. These paint surfaces were used in the microscope reflection studies. The layers exposed after a 5° polish were sufficiently wide to avoid any spectral contamination from adjacent layers, but for the sample polished at 90° there was spectral contamination for layers thinner than about 25 micrometers when a 15X microscope objective was used.

Figure 2C shows the paint layers exposed by microtoming a paint chip held in an epoxy matrix. This sample was used in the microscope transmission studies. The paint was cut at 50° to the top surface, exposing the paint layers about 1/3 wider than normal at 90°. (The photograph for *Figure 2C* was

reduced by 1/3 to match the dimensions of *Figure 2B*.) The microtoming of the paint caused striations and wrinkling of the cut paint sliver. Even after pressing the sliver between thin KBr windows, the striations and wrinkles are still visible in *Figure 2C*. The boundary between the clearcoat and epoxy is almost indistinguishable, because the refractive indices of the clearcoat and potting epoxy are similar.

Infrared Analysis Molded Coating

The first coating that is applied to the SMC is an epoxy-acrylic resin with talc and carbon black. It is added and cured in the mold with the SMC, hence the name molded coating. Six spectra are shown in *Figure 3* that compare the results of the various sample preparation methods for infrared analyzing the molded coating. The top two are reflectance spectra of the molded coating polished at 5 and 90° to the top surface, the middle two spectra are transmittance spectra of a thin microtomed sliver, and the bottom two are transmittance spectra of cured smears of reference paints.

In the spectra of *Figure 3*, the main bands that represent the epoxy-acrylic resin are 1725, 1509, 1247, and 1183 cm⁻¹, and 1020 cm⁻¹ for talc (Spectrum #824¹¹). Other bands are listed in the legend of *Figure 3*. In addition, the molded coating on the SMC has some polystyrene (1494, 760, and 700 cm⁻¹, *Figures 3A-3D*), which was not found in the refer-

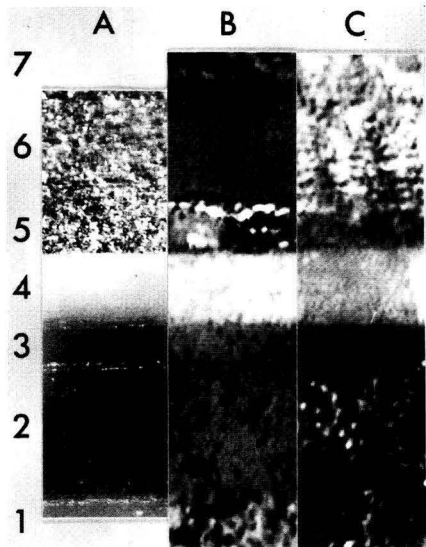


Figure 2—Photomicrographs of cross-sectioned paint layers. (A) 5° and (B) 90° polished cross sections used for infrared reflectance studies. (C) 50° cross section microtomed to 3 micrometer thickness and pressed between two 0.3 mm thick KBr windows, used for infrared transmittance studies. The various layers and thicknesses in micrometers are: (1) SMC; (2) molded coating—54; (3) conductive primer—17; (4) primer surfacer—29; (5) basecoat—22; (6) clearcoat—39; and (7) potting epoxy

ence material (Figures 3E and 3F). The reference spectrum that was used for polystyrene was Spectrum #380.¹¹

In comparing the spectra in Figure 3, the band maxima are considered to be at the same wavenumber if they are within a range of $\pm 5 \text{ cm}^{-1}$, since this study was done at a resolution of 4 cm^{-1} . The band wavenumbers of the transmittance spectra (Figures 3C to 3F) are all within this range, but the corresponding bands of the reflectance spectra (Figures 3A and 3B) are at a higher wavenumber. For example, the main talc bands are at 1020 cm^{-1} for transmittance and at 1050 cm^{-1} for reflectance. This 30 cm^{-1} difference was due to the reflectance spectral distortion and subsequent Kramers-Kronig adjustment. Weaker bands have smaller wavenumber differences between transmittance and reflectance spectra. Knowing the extent of the wavenumber differences, plus the overall appearance of the spectra, allows one to spectrally com-

pare reflectance and transmittance spectra for coating identification.

CONDUCTIVE PRIMER: Five spectra were obtained of the conductive primer: one reflectance spectrum for the 5° sample, and four transmittance spectra (Figure 4). A reflectance spectrum of the 90° polished sample is not shown because the conductive primer layer was too thin (17 micrometers) to get a reflectance spectrum that was free of infrared bands for adjacent paint layers when a 15X objective was used. The band shift in the reflectance spectrum after adjustment with the Kramers-Kronig algorithm (Figure 4A) was 20 cm^{-1} higher for the 1292 cm^{-1} band, while the other bands were only shifted $5\text{-}7 \text{ cm}^{-1}$ higher than the corresponding bands in the transmittance spectra.

The transmittance spectrum obtained with the 15X objective (Figure 4C) shows a slight contamination from the

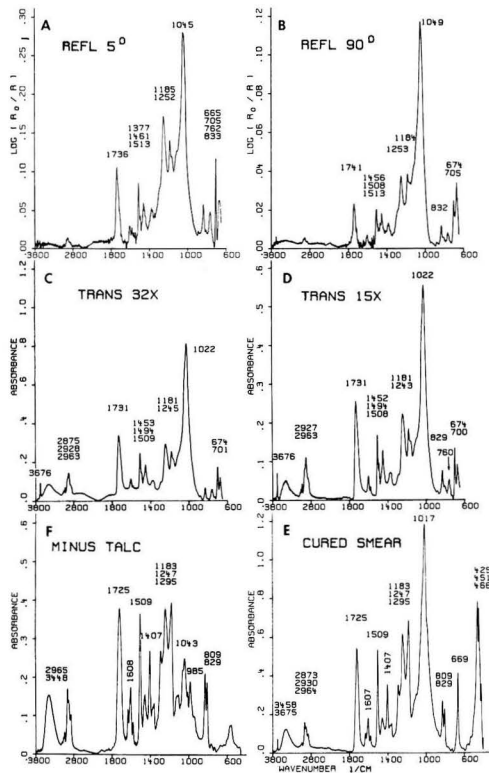


Figure 3—Infrared spectra of molded coating. Microscope reflectance with a 15x objective of a 54-micrometer layer, cross sectioned at (A) 5° and (B) 90° . Spectra adjusted with a Kramers-Kronig algorithm. Microscope transmittance with (C) 32x and (D) 15x objectives of a 54-micrometer layer microtomed at 50° to 3 micrometer thickness. Regular beam transmittance of smears with (E) and without (F) carbon black and talc, and cured on ZnSe windows at 120°C for 30 min. Polystyrene: 1494, 760, 700 cm^{-1} . Talc: 3676, 1020, 670, 466, 451, 425 cm^{-1} . Epoxy-acrylic: 1725, 1608, 1509, 1407, 1295, 1247, 1183, 1043, 985, 829, 809 cm^{-1}

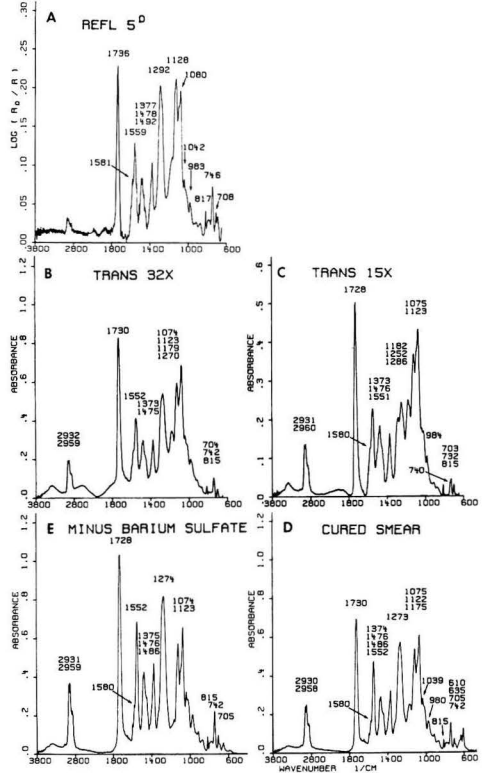


Figure 4—Infrared spectra of conductive primer. (A) Microscope reflectance with a 15x objective of a 17-micrometer layer cross sectioned at 5° . Spectrum adjusted with a Kramers-Kronig algorithm. Microscope transmittance with (B) 32x and (C) 15x objectives of a 17-micrometer layer microtomed at 50° to 3 micrometer thickness. Regular beam transmittance of smears with (D) and without (E) carbon black and barium sulfate, and cured on ZnSe windows at 120°C for 30 min. Melamine resin: 1552, 1486, 1175, 1123, 1074, 815 cm^{-1} . Ester: 1728, 1273 cm^{-1} . Barium sulfate: 1175, 1122, 1075, 980, 635, 610 cm^{-1}

primer surfacer: the 1270 cm^{-1} band has a shoulder at 1252 cm^{-1} , and the 1075 and 1123 cm^{-1} bands for barium sulfate are somewhat higher relative to the 1270 cm^{-1} band (Spectrum #792¹¹). The 32X objective was more suitable than the 15X objective for analyzing this thin layer as shown in the transmittance spectrum of Figure 4B. Here there is no discernible spectral contamination from infrared bands for components of adjacent layers.

Figure 4D represents the clear liquid phase of the conductive primer before stirring the carbon black and barium sulfate that had settled to the bottom of the container. Figure 4E represents the whole sample after stirring the contents. All the spectra have the same overall appearance, so it is relatively easy to identify the conductive primer from any one spectrum, including the reflectance spectrum, as a melamine-formaldehyde resin with carbon black and barium sulfate.

PRIMER SURFACER: The spectra for the primer surfacer are shown in Figure 5. The primer surfacer was thick enough (29 micrometers) to give useful reflectance spectra for samples polished at about 5 and 90°. As with the other coating layers, the band wavenumbers for the reflectance spectra were shifted to higher wavenumbers compared to the transmittance spectra. One of the bands for the strongly absorbing barium sulfate (1102 cm^{-1} , Figures 5A and 5B) was shifted 26 cm^{-1} higher than the same band for the transmittance spectra (1076 cm^{-1} , Figures 5C and 5D). Figures 5E and 5D, respectively, represent the clear and mixed samples before and after stirring the contents to mix the settled barium sulfate and titanium dioxide. The spectra indicate the primer surfacer to be a melamine-crosslinked polyester with barium sulfate and titanium dioxide fillers.

BASECOAT: The spectra for the basecoat are shown in Figure 6, which represent a methylated melamine-formaldehyde resin with aluminum flake. The transmittance spectra are well-defined (Figures 6C and 6F), but the reflectance spectra are distorted (Figures 6A and 6B). The bands in the reflectance spectra are broad and not well separated, probably a result of a Kramers-Kronig adjustment of a spectrum for a highly reflecting surface due to the presence of aluminum flake.

The basecoat layer was too thin (22 micrometers) to be examined with the 15X microscope objective without getting some spectral contamination from bands for barium sulfate in the primer surfacer (Figures 3B and 3D). The most prominent barium sulfate bands were 1097 and 1185 cm^{-1} . The absence of these bands in Figure 3C indicates that the 32X microscope objective was suitable for measuring a 22-micrometer layer, but the 15X objective was not (Figures 3B and

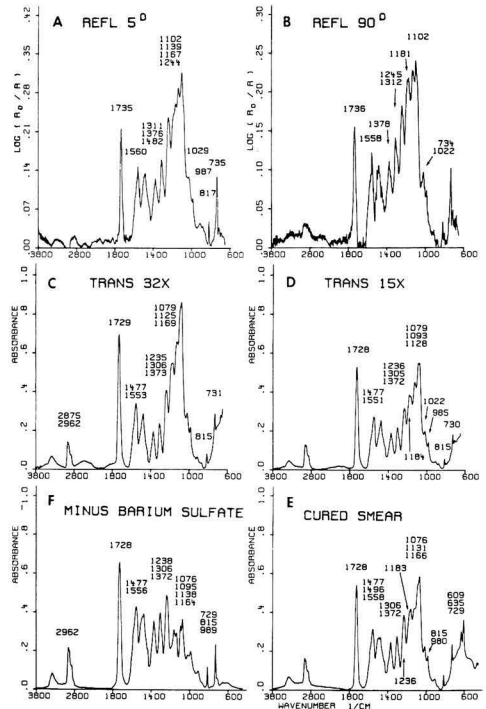


Figure 5—Infrared spectra of primer surfacer. Microscope reflectance with a 15x objective of a 29-micrometer layer cross sectioned at (A) 5° and (B) 90°. Spectra adjusted with a Kramers-Kronig algorithm. Microscope transmittance with (C) 32x and (D) 15x objectives of a 29-micrometer layer microtomed at 5° to 3 micrometer thickness. Regular beam transmittance of smears with (E) and without (F) barium sulfate, and cured on KBr windows at 120°C for 30 min. Melamine resin: 1556, 1180, 1130, 1076, 815 cm^{-1} . Ester: 1728, 1236, 1165 cm^{-1} . Barium sulfate: 1180, 1130, 1076, 980, 630, 610 cm^{-1} . Titanium dioxide: 650-550 cm^{-1}

3D). The bottom two spectra (Figures 6E and 6F), respectively, represent the basecoat resin before and after removing the aluminum flake by centrifuging.

CLEARCOAT: The spectra for the clearcoat (Figure 7) represent melamine-crosslinked polyester and epoxy-acrylic resins. The transmittance spectra are well-defined and agree well with each other. Even the reflectance spectrum for the

Table 2—Infrared Spectrometer Operating Conditions

| | 5° Microreflectance | 90° Microreflectance | Microtransmittance | Macrotransmittance |
|------------------------------------|---------------------|----------------------|--------------------|--------------------|
| Detector | MCT | MCT | MCT | DTGS |
| Detector gain | 32X | 64X | 8X | 2X |
| Number of scans | 144 | 144 | 36 | 32 |
| Mirror velocity, mm/s | 6.4 | 6.4 | 6.4 | 3.2 |
| Smoothing, data points | none | 25 | none | none |
| Resolution, cm^{-1} | 4 | 4 | 4 | 4 |

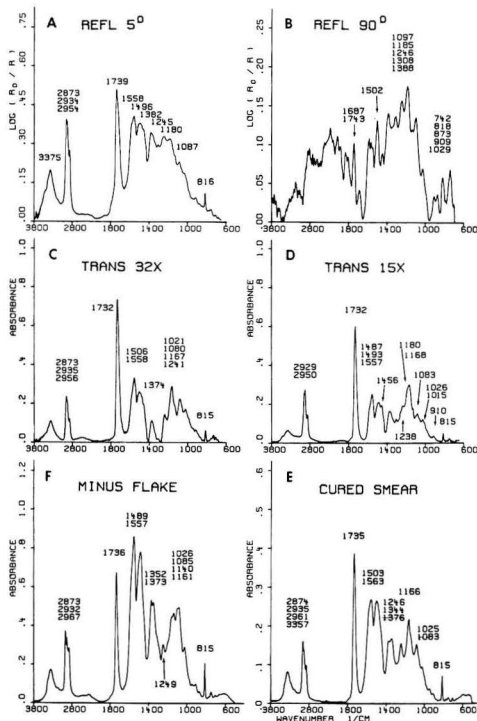


Figure 6—Infrared spectra of aqueous basecoat. Microscope reflectance with a 15x objective of a 22-micrometer layer cross sectioned at (A) 5° and (B) 90°. Spectra adjusted with a Kramers-Kronig algorithm. Microscope transmittance with (C) 32x and (D) 15x objectives of a 22-micrometer layer microtomed at 50° to 3 micrometer thickness. Regular beam transmittance of smears with (E) and without (F) metal flake, and cured on ZnSe windows at 120°C for 30 min. Melamine resin: 1557, 1489, 1140, 1085, 1026, 815 cm⁻¹. Ester: 1735, 1246, 1166 cm⁻¹

90° sample is similar to the transmittance spectra, although the baseline is noisier due to less signal. However, for unknown reasons, the reflectance spectrum of the 5° polished clearcoat had overlapping bands and was not sufficiently similar to the other five spectra in *Figure 7* to be useful in identifying the clearcoat. Fortunately, the clearcoat, being the top layer, can be easily identified by other infrared sampling procedures. For example, a transmittance spectrum was taken of the top surface scrapings (*Figure 7F*), so that we do not need to rely on a reflectance spectrum of the clearcoat for identification.

In summary, easily obtained reflectance spectra were suitable for identifying the most inaccessible coating layers, namely, molded coating, conductive primer, and primer surfacer. The quickest and easiest method was to polish the paint layers at 5° to the top surface, exposing tenfold wider paint layers to the infrared microscope. The reflectance spectra were adjusted with a Kramers-Kronig algorithm, resulting in infrared band shifts of less than 30 cm⁻¹ compared to

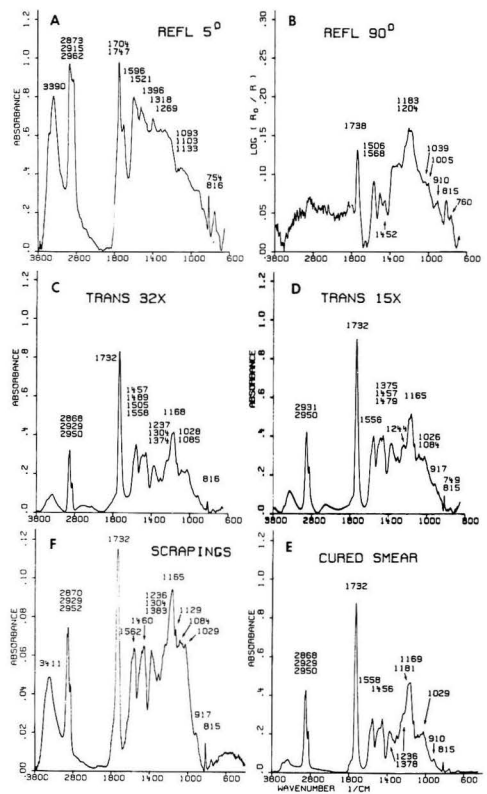


Figure 7—Infrared spectra of clearcoat. Microscope reflectance with 15x objective of 39-micrometer layer cross sectioned at (A) 5° and (B) 90°. Spectra adjusted with a Kramers-Kronig algorithm. Microscope transmittance with (C) 32x and (D) 15x objectives of a 39-micrometer layer microtomed at 50° to 3 micrometer thickness. Regular beam transmittance of (E) a smear cured at 120°C for 30 min on a KBr window and of (F) surface scrapings ground and pressed into a KBr pellet. Melamine resin: 1558, 1180, 1085, 1029, 815 cm⁻¹. Ester: 1732, 1240, 1167 cm⁻¹

normal transmittance spectra. Reflectance spectra of the basecoat with aluminum flake and of the clearcoat were poorer than their respective transmittance spectra. Although reflectance spectra of the basecoat and clearcoat were adequate, other sampling methods, such as transmission of top surface scrapings, were preferable.

SUMMARY

The purposes of this study were to develop a method for analyzing multiple paint layers by infrared microscopy, and to apply the method to the analysis of a paint system for SMC.

Three methods were studied for preparing the paint layers for infrared microscopic analysis:

(1) The quickest and easiest method was to polish the paint layers at a 5° angle to the top surface, which exposes the layers 10 times wider than their normal thicknesses, and then to examine the individual layers in the infrared microscope reflection mode. However, the reflection mode was not as sensitive as the transmission mode, and many of the reflection spectra had to be adjusted for refractive index changes (Kramers-Kronig adjustment).

(2) The best infrared spectra were obtained in the microscope transmission mode with cross-sectioned microtomed films of the paint layers. These spectra compared favorably with reference spectra of the individual paints. However, microtoming is a difficult and time-consuming procedure, and the 5° reflection method is usually used.

(3) We also tried a third method of preparing the paint-SMC sample by polishing an epoxy-embedded sample at 90° to expose the paint layers at their normal thicknesses. With a 15X microscope objective, spectral contamination from adjacent layers could be avoided with paint layers thicker than 25 micrometers. A few tests were made with a 32X microscope objective, which was satisfactory for analyzing the thinner paint layers without spectral contamination.

The paint system for SMC consisted of the following five layers of paint with thicknesses in micrometers: molded coating—54; conductive primer—17; primer surfacer—29; basecoat—22; and clearcoat—39. The molded coating contained epoxy-acrylic resin, talc, and carbon black; the conductive primer contained melamine-formaldehyde resin, barium sulfate, and carbon black; the primer surfacer contained melamine crosslinked polyester resin, barium sulfate, and titanium dioxide; the basecoat contained melamine-formaldehyde resin and aluminum flake; and the clearcoat

contained melamine crosslinked polyester and epoxy-acrylic resins.

References

- (1) McEwen, D.J., Verma, M.H., and Turner, R.O., "Accelerated Weathering of Automotive Paints Measured by Gloss and Infrared Spectroscopy," *JOURNAL OF COATINGS TECHNOLOGY*, 59, No. 755, 123 (1987).
- (2) Cheever, G.D., "Analysis of Defects Occurring at Interfaces in Multilayer Paint Systems on Polymeric Substrates," *JOURNAL OF COATINGS TECHNOLOGY*, 58, No. 742, 25 (1986).
- (3) Cheever, G.D., "Role of Surface Morphology and Composition in the Painting of Sheet Molding Compound (SMC) Plastics," *JOURNAL OF COATINGS TECHNOLOGY*, 50, No. 645, 36 (1978).
- (4) Cheever, G.D. and Wojtkowiak, J.J., "Instrumental Studies of the Surface and Internal Composition of Paint Films," *JOURNAL OF PAINT TECHNOLOGY*, 42, No. 546, 409 (1970).
- (5) Johnson, W.T.M., "Chemical Nature of Paint Film Surfaces," *OFFICIAL Digest*, 32, No. 427, 1067 (1960).
- (6) English, A.D. and Spinelli, H.J., "Degradation Chemistry of Primary Crosslinks in High Solids Enamel Finishes: Solar Assisted Hydrolysis," *JOURNAL OF COATINGS TECHNOLOGY*, 56, No. 711, 43 (1984).
- (7) Wilkinson, J.M., Locke, J., and Laing, D.K., "The Examination of Paints as Thin Sections Using Visible Microspectrophotometry and Fourier Transform Infrared Microscopy," *Forensic Sci. Intl.*, 38, 43 (1988).
- (8) Allen, T.J., "Paint Sample Presentation for Fourier Transform Infrared Microscopy," *Vib. Spectrosc.*, 3, 217, (1992). A condensed version was published in Allen, T.J., "Fourier Transform Infrared Microscopy in Forensic Paint Analysis," *Spectra-Tech Newsletter*, "SCAN TIME," #21, May 1991, Spectra-Tech, Inc., Stamford, CT.
- (9) Stoecklein, W. and Gloger, M., "FT-Infrared Spectroscopy of Automobile Paints Using Infrared Microscopy," *FT-IR Spectral Lines*, 9, [1] 2 (1988), Nicolet Instrument Corp., Madison, WI.
- (10) Jain, K.C., Electrical and Electronics Engineering Dept., General Motors NAO Research & Development, personal communication.
- (11) Federation of Societies for Coatings Technology, *An Infrared Spectroscopy Atlas for the Coatings Industry*, Philadelphia, PA, 1980.

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Low-Temperature Curing Higher-Solids Polyester Coatings with Melamine-Formaldehyde Resin Crosslinkers

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Eastern Michigan University*

Polyester (PE)/melamine-formaldehyde (MF) coatings that cure rapidly at low bakes (<80°C) and appreciably at ambient temperature are described. They are formulated from enhanced-reactivity MF resins having very low levels of >NH and >CH₂OH functional groups and from conventional higher-solids PE resins. Of the PE resins studied, those made from 1,4-cyclohexanedimethanol are the fastest curing. Coatings with 0.5 parts per hundred (phr) of

para-toluene sulfonic acid (p-TSA) catalyst develop hardness, solvent resistance, and impact resistance that would be acceptable for many commercial applications at bakes of 60-70°C for 30 min. With 1.5 to 2 phr of catalyst, ambient temperature curing PE/MF coatings for certain applications appear feasible. The rate of apparent cure was correlated with the rate of disappearance of -OCH₃ groups observed by FTIR.

INTRODUCTION

Polyester (PE) resin/melamine formaldehyde (MF) resin binders are widely used in higher-solids industrial enamels. Class I (fully formylated, fully alcoholated) MF resins provide excellent film properties but require catalysis by strong acid; in typical formulations 0.3 to 1.0 parts per hundred (phr) parts of coating solids of arylsulfonic acid catalyst are used.¹ Such formulations are commonly cured by baking at temperatures above 100°C for 10 to 30 min. Lower baking temperatures would be desirable to save energy and to permit coating of heat-sensitive substrates. Lower bakes are possible with higher levels of catalyst. However, high levels of residual catalyst in the film can accelerate deterioration, causing, for example, poor exterior durability. Thus, it would be desirable to find formulations with low levels of catalyst that could cure adequately below 100°C.

As a step towards this goal, the reactivity of different Class I MF resins was studied by measuring rates of their reactions with neopentyl alcohol in solution.^{2,3} A puri-

fied HMMM type resin (here designated HMMM-P) was found to react substantially faster than the HMMM resin from which it was purified. Enhanced reactivity was attributed to removal of -NH and -CH₂OH groups. A commercial resin with low levels of -NH and CH₂OH groups, here designated PMM(IOM)M, was also shown to be exceptionally reactive, although slightly less so than HMMM-P. Our observation that in solution HMMM-P equilibrates with neopentyl alcohol within three hours at 25°C suggests that it should be possible to formulate enamels that cure at temperatures well below 100°C, perhaps even at 25°C.

Having identified reactive MF resins, in this study we turned attention to the polyester coreactants, seeking structures that will cure at the lowest possible temperatures with a given catalyst level. Ideally we would like to find formulations that could cure without baking. For bake studies the catalyst level was arbitrarily fixed at 0.5 phr of p-toluenesulfonic acid (p-TSA); higher levels were tested in ambient temperature cure studies.

It should be pointed out that the chemistry of crosslinking by MF resins is a complex and only partly understood process. It is beyond the scope of this paper to discuss

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it in detail. The reader is referred to published review articles,^{4,8} and to a recent publication from this group.⁹

EXPERIMENTAL

Materials

Commercial grades of neopentyl glycol (NPG) and 1,4-cyclohexane dimethanol (CHDM) were contributed by Eastman Chemical Company. Trimethylol propane (TMP), 1,6-hexanediol (HG), phthalic anhydride (PA), hexahydrophthalic anhydride (HHPA), and p-toluene-sulfonic acid monohydrate (p-TSA) were purchased from Aldrich and were used without further purification. Methyl ethyl ketone (MEK) and methyl n-amyl ketone (MAK) were contributed by ChemCentral Company. Monsanto Chemical Company contributed MF resins Resimines 747 [HMMM] and RF-4518 [PMM(IOM)M] and styrene/allyl alcohol resins RJ-100 and RJ-101.

Purified resin HMMM-P was prepared from Resimine 747 as described.^{2,3} The procedure involves extracting R-747 with hexane, treating the solution with neutral alumina and removal of solvent. HMMM-P is a waxy solid, mp about 50°C, which is about 95% hexakis(methoxymethyl) melamine and about 5% higher oligomers; it is virtually free of >HN and >NCH₂OH groups as indicated by the near absence of infrared (IR) absorption in the 3400 cm⁻¹ region.

Synthesis of Polyester Resins

Seven polyester resins with the monomer ratios shown in Table 1 were prepared. Reactants (diacids and diols) were charged in a kettle equipped with a condenser system,¹⁰ an agitator, a thermometer, and an N₂ gas sparge. No esterification catalyst was employed. An overhead temperature of 98°C was maintained and the resin was processed at kettle temperature of 230°C until water stopped coming off and the acid number was less than 10 (5 to 8 hr). The viscous mass was cooled to 150°C, thinned with MAK, cooled to 80°C, and then thinned with an equal amount of MEK to about 70% solids. Resin PE-II was thinned entirely with MEK.

Characterization of Polyester Resins

Molecular weight was estimated by gel permeation chromatography (GPC) using tetrahydrofuran (THF) as eluting solvent. The instrument included a Waters Model 510 pump, a Waters Model R401 differential refractometer detector and four Phenogel columns—one 500Å and three 100Å. Molecular weight was calibrated with polystyrene standards. Glass transition temperature (T_g) was measured using a Du Pont 2000 Thermal Analyzer with a DSC module scanning from -60 to 150°C at 20°C/min; sample size was 5 mg; the temperature of maximum slope was taken as T_g ("midpoint T_g"). Hydroxyl number was determined by the method of Kingston et al.¹¹ Acid number, nonvolatile, and Gardner color were measured by ASTM D 1639-83, ASTM D 2369-87, and ASTM D 1544-80, respectively. Viscosity was measured at 25°C with a Brookfield rotational viscometer (ASTM D 2196-

86) and with Gardner-Holdt bubble tubes (ASTM D 1545-76).

Preparation of Coatings

Solutions of polyester and MF resins were prepared in MAK/MEK at 60 wt% using MEK as thinning solvent, and p-TSA was added to provide catalyst levels of 0.5-2.0 phr on total solids. The solutions were drawn down on phosphated steel panels (3 in. × 6 in., type R-36-P, Q-Panel Company) using a #36 wire-wound drawdown bar. The panels were kept at room temperature (normally 22-24°C) or were baked in a forced air oven. Dry films were about 25 μm thick as measured by an Elcometer Model 300 thickness gauge.

Characterization of Coating Films

Solvent rub resistance was measured by double rubbing with acetone saturated nonwoven paper ("Kim-Wipe"). Pencil hardness was measured by ASTM D 3363-74, and impact resistance was measured using a Gardner impact tester having a maximum impact of 160 in.-lb. IR spectra were recorded with an IBM FTIR Model IR44 using films cast on NaCl plates.

RESULTS AND DISCUSSION

Polyester Resins

Initially, four polyester resins (PE-I to PE-IV) with the compositions detailed in Table 1 were synthesized by conventional techniques. The equivalent ratios of diacid anhydrides (PA or HHPA) to diols (CHDM, NPG, or HG) were calculated to give a 40% excess of hydroxyl functionality, in line with contemporary practice for high solids coatings resins. In each case, 4 mol % of TMP was introduced to impart branching. After preliminary studies indicated that resins PE-I-1 and PE-II-1 provided the fastest apparent cure rates, three more resins (PE-I-2, PE-III-2, and PE-I-3) were prepared with the same monomers but with higher levels of TMP to increase branching and functionality.

Characteristics of the resins are provided in Table 1. Acid numbers, molecular weights, and molecular weight distributions are comparable. There is a clear-cut trend inversely relating flexibility of the diols to viscosity and T_g, although precise comparisons cannot be made because of differences in molecular weight. These trends are similar to those noted by Golob et al.¹²

MF Resins

It was previously demonstrated^{2,3} that the two MF resins studied are exceptionally reactive Class I MF resins. HMMM-P is obtained by purification of a standard HMMM type resin to essentially eliminate >NH and >CH₂OH groups, enhancing its reactivity presumably by removal of basic species. PMM(IOM)M was selected because it is a commercially available (as Resimine RF-4518) MF resin having an especially low content of >NH and >CH₂OH groups as noted by Cameron et al.¹³ PMM(IOM)M is a chemically complex mixture; its struc-

Table 1—Compositions and Properties of Polyester Resins

| Monomers | | PE-I-1 | PE-II | PE-III-1 | PE-IV | PE-I-2 | PE-III-2 | PE-I-3 |
|--|--------|---------|-------|----------|---------|---------|----------|---------|
| CHDM | (g) | 224 | | | | 224 | | 195 |
| | (mole) | 1.6 | | | | 1.6 | | 1.35 |
| NPG | (g) | | 191.6 | | | | | |
| | (mole) | | 1.8 | | | | | |
| HG | (g) | | | 204 | 200 | | 188.8 | |
| | (mole) | | | 1.73 | 1.69 | | 1.6 | |
| TMP | (g) | 15.6 | 18.4 | 17.6 | 17.2 | 26.8 | 26.8 | 33.5 |
| | (mole) | 0.12 | 0.14 | 0.13 | 0.13 | 0.2 | 0.2 | 0.25 |
| PA | (g) | 182 | 215.6 | 202.4 | | 182 | 182 | 182 |
| | (mole) | 1.2 | 1.46 | 1.36 | | 1.2 | 1.2 | 1.2 |
| HHPA | (g) | | | | 206.4 | | | |
| | (mole) | | | | 1.34 | | | |
| Nonvolatile (wt%) | | 69.0 | 68.8 | 68.9 | 69.4 | 71.1 | 70.8 | 69.8 |
| Acid number (on solids) | | 2.2 | 7.1 | 5.1 | 8.1 | 3.0 | 7.1 | 2.0 |
| Solvent | | MAK:MEK | MEK | MAK:MEK | MAK:MEK | MAK:MEK | MAK:MEK | MAK:MEK |
| | | 1:1 | | 1:1 | 1:1 | 1:1 | 1:1 | 1:1 |
| Viscosity (25°C) Brookf. (mPa s) (Spindle No. 2) | | 241 | 142 | 134 | 119 | 544 | 161 | 806 |
| Gardner color | | 1 | 1 | 1 | 1 | 1 | 1 | 1 |
| Hydroxyl number (on solids) | | 140 | 149 | 152 | 156 | 188 | 190 | 141 |
| Molecular weight (M _n ; GPC) | | 1100 | 1000 | 1100 | 1100 | 1000 | 900 | 1200 |
| M _w /M _n (PDI; GPC) | | 1.5 | 1.5 | 1.5 | 1.5 | 1.5 | 1.4 | 1.6 |
| T _g (°C) | | 9 | 0 | -29 | -34 | — | — | — |
| Equiv wt. (g/equiv) | | 401 | 377 | 369 | 360 | 308 | 295 | 398 |
| Number av. functionality (equiv/mol) | | 2.7 | 2.7 | 3.0 | 3.1 | 3.2 | 3.1 | 3.0 |

ture can be visualized as HMMM with about one-sixth of the -OCH₃ groups replaced by -iso-OC₈H₁₇ groups.

Low-Temperature Bake Enamels.

Initial experiments were effected with PE resins PE-I-1, II, III-1, and IV to investigate the effects of different monomers in the PE resins. In preliminary experiments, it was found that resins cured fastest with both crosslinkers when the polyester resin/MF resin weight ratio was about 3/1. We found this result surprising because this ratio provides a substantial stoichiometric excess (roughly 2:1) of melamine resin in all cases. Nonetheless, a 75/25 ratio was adopted as standard in this study. A level of 0.5 phr (on total solids) of p-TSA was used. This level is consistent with commercial practice for current bake enamels. Coatings were prepared by casting films and baking them for 30 min at various temperatures.

Because of the complexity of the crosslinking process, it would be quite difficult to measure the rates of the individual chemical reactions involved. In this study we adopted the practical, but much less rigorous, method of measuring "apparent cure rates" by measuring the pencil hardness, impact resistance, and acetone rub resistance of the coatings after baking. It must be emphasized that none of these properties can be expected to provide a quantitative index of the chemical reaction rates involved in crosslinking; they are used for convenience and because they relate to enamel properties. Of the three properties, acetone rub resistance is probably the best indicator of

crosslink density, although it is affected by T_g and probably by other variables. The results are summarized in Table 2. Impact resistance proved of little use for assessing the progress of cure; while the 2H hardness films generally had good (160/160 in.-lb direct/reverse) impact resistance, the results with low and intermediate cures did not fit a clear pattern.

The results in Table 2 show that enamels formulated with HMMM-P have slightly faster apparent cure rates than those formulated with PMM(IOM)M, and polyesters PE-I-1 and PE-II have much faster apparent cure rates

Table 2—Acetone Rub Resistance and (Pencil Hardness) of Enamels (Polyester/MF = 75/25 w/w; p-TSA = 0.5 phr)

| Bake T, °C | PE-I-1 | PE-II | PE-III-1 | PE-IV |
|----------------------------------|----------|----------|----------|----------|
| (a) HMMM-P Crosslinker | | | | |
| 40 | | 24(H) | | |
| 50 | | 52(H) | | 18(HB) |
| 60 | | 106(2H) | | 50(F) |
| 70 | | >200(2H) | | 98(H) |
| 80 | | >200(2H) | 123(2H) | 74(H) |
| 100 | | | >200(2H) | 104(H) |
| 120 | | | >200(2H) | 87(H) |
| | | | | 160(H) |
| | | | | 134(H) |
| | | | | >200(2H) |
| | | | | >200(2H) |
| (b) PMM(IOM)M Crosslinker | | | | |
| 50 | 10(H) | | | 8(HB) |
| 60 | 35(H) | | | 31(H) |
| 70 | 98(2H) | | | 80(2H) |
| 80 | >200(2H) | | | 130(2H) |
| 100 | | | | 97(H) |
| 120 | | | | 135(H) |
| | | | | 98(H) |
| | | | | >200(2H) |
| | | | | >200(2H) |

Table 3—Properties of Polyester/MF Enamels Cured at Ambient Temperature (Polyester/MF = 75/25 w/w; p-TSA = 0.5 phr)

| Polyester Crosslinker | [-----PE-I-1-----] | | | | [-----PE-II-----] | | | | | |
|---------------------------------|--------------------|----|----|----|--------------------|----|----|----|----|----|
| | [-PMM(IOM)M-] | | | | [-----HMMM-P-----] | | | | | |
| Cure time (days) | 3 | 7 | 10 | 3 | 7 | 10 | 30 | 3 | 7 | 10 |
| Acetone rub resistance | 15 | 30 | 38 | 18 | 24 | 34 | 52 | 12 | 12 | 13 |
| Pencil hardness | B | H | H | H | H | H | H | 4B | 4B | 4B |
| Impact Dir. | 20 | 30 | 30 | 30 | 40 | 60 | 60 | 10 | 10 | 10 |
| Impact resistance (in.-lb) Rev. | 10 | 20 | 30 | 20 | 20 | 40 | 40 | 6 | 6 | 6 |

than polyesters PE-III-1 and PE-IV. PE-I-1 is the fastest, with PE-II a close second. Pencil hardness generally followed the same trend as acetone rub resistance. PE-I-1 and PE-II formulations reached a hardness of 2H (a level that satisfies the majority of end use requirements) at 70°C while PE-III-1 and PE-IV formulations required 120°C to reach 2H hardness. This observation can be attributed to T_g as well as crosslink density effects; perhaps the low T_g coreactants PE-III-1 and -IV can reach 2H only when co-condensation is substantially supplemented by MF resin self-condensation.

These results indicate that bake temperatures of 60-80°C are realistic targets for commercial development. They suggest that high T_g polyesters with primary OH groups combined with MF resins with low NH (or OH) content are a good starting point. Polyesters made with CHDM provide the fastest apparent cure rates, while those made with NPG provide an attractive combination of fast apparent cure and low viscosity.

Ambient Temperature Cure with 0.5 phr of Catalyst

Evaluation of ambient temperature curing focused on the fastest curing resins, PE-I-1 and PE-II, with the results summarized in Table 3. Again, resin PE-I-1 formulations cured fastest, and only minor differences between formulations with HMMM-P and PMM(IOM)M were noted.

At the 0.5 phr catalyst level, these formulations develop properties in 7 to 10 days that are inferior to those of baked coatings but that may be comparable to those of ambient-temperature cure alkyds. However, alkyds harden in 0.5 to 8 hr, and cure of these formulations is too slow for commercial use.

Ambient Temperature Cure with Higher Levels of Catalyst

Higher catalyst levels were tested with the results shown in Table 4. As expected, cure rates proved very sensitive to catalyst levels.

As shown in Table 4, PE-I-1/HMMM-P (75/25) provides reasonable balance of film properties within three days with 1.5 phr catalyst—2H hardness, 160/160 impact resistance, and 65-rub solvent resistance. Unsurprisingly, crosslinking continues at a decreasing rate for four months as evidenced by the increase in solvent rub resistance. The good impact resistance after four months was encouraging, suggesting that the film would not become excessively brittle for many months, if ever.

It is concluded that ambient temperature cure high-solids polyester resin/MF resin coatings are feasible in applications where relatively slow development of film properties and high levels of acid catalyst can be tolerated. Optimization of the resin and coating formulation should further accelerate cure.

Effect of Polyesters with Higher TMP Level

Polyester resins PE-I-2, PE-III-2, and PE-I-3 were synthesized to investigate the effects of increased branching on cure behavior in comparison with PE-I-1. The compositions and characteristics of these resins are presented in Table 1. Resins PE-I-2 and PE-III-2 have higher TMP and higher excess hydroxyl levels; resin PE-I-3 has still higher TMP but the same excess hydroxyl level as PE-I-1.

Coatings catalyzed with 0.5 phr p-TSA were cured at ambient temperature as previously described. However, results were disappointing. Fastest apparent cure rates were observed with the most branched resin, PE-I-3, but within 10 days the acetone rub resistance was only 71 (with HMMM-P) and hardness was only H. Impact resistance of these enamels was generally inferior to that of the 4% TMP resins studied initially. Thus, at least with these particular resins and formulations, increasing TMP content did little to improve apparent cure rate or properties. It should be noted, however, that the average functionality of these high TMP resins was only modestly increased over that of the 4% TMP resins.

Another effort to accelerate cure was made by blending 10 and 20% of styrene-allyl alcohol resins, RJ-100 and RJ-101 (known to have functionality about 5-6), into PE-I formulations with 0.5 phr p-TSA. A substantial increase in the rate of development of impact resistance was noted, but the effect on the rate at which hardness and solvent resistance develop at ambient temperature was negligible.

Volatile Acid Catalysts

Volatile acid catalysts were examined for their potential utility in room-temperature curing. The motivation for this part of the study was the concern that essentially nonvolatile catalysts would remain in the film indefinitely and could, with highly reactive coreactants, cause over-

Table 4—Effect of Different p-TSA Catalyst Levels (PE-I-1/HMMM-P = 75/25)

| p-TSA, phr | [-----0.5-----] | | | | [-----1.0-----] | | | | [-----1.5-----] | | | | [-----2.0-----] | | | |
|---------------------------------|-----------------|----|----|-----|-----------------|-----|-----|-----|-----------------|-----|-----|-----|-----------------|-----|-----|------|
| | 3 | 10 | 30 | 120 | 3 | 10 | 30 | 120 | 3 | 10 | 30 | 120 | 3 | 10 | 30 | 120 |
| Acetone rub resistance | 18 | 34 | 52 | 56 | 58 | 73 | 97 | 120 | 65 | 130 | 134 | 185 | 71 | 150 | 183 | 200+ |
| Pencil hardness | H | H | H | H | H | 2H | 2H | 2H | 2H | 2H | 2H | 2H | 2H | 3H | 2H | 3H |
| Impact resistance (in.-lb) Dir. | 30 | 60 | 55 | 50 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 |
| (in.-lb) Rev. | 20 | 40 | 35 | 40 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 |

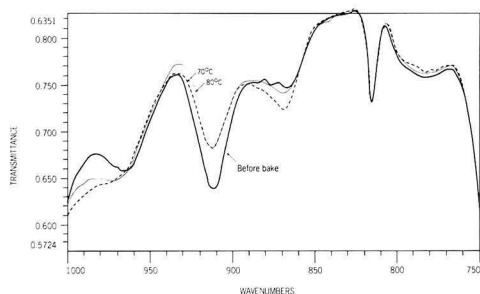


Figure 1—Changes in the FTIR spectra as a result of bake. PE-III-2/HMMM-P (75/25); 0.5% p-TSA

cure at ambient temperature, probably resulting in embrittlement. However, if a catalyst could be found that would evaporate from the film at a rate such that catalyst concentration falls to low levels fairly soon after coating properties have reached optimum levels, this problem could be overcome.

Four volatile acids were studied: formic acid (bp 101°C, pKa = 3.74), trifluoroacetic acid (bp 72°C, pKa = 0.23), trichloroacetic acid, (bp 196°C, pKa 0.64), and methanesulfonic acid (bp 167°C at 10 torr). [Data from reference 14.]

Formic acid seemed to have no catalytic effect. Trifluoroacetic and trichloroacetic acids had minimal catalytic effect and caused film yellowing. Apparently, these acids are either too weak, too volatile, or both.

Methane sulfonic acid (MSA) proved to be an excellent catalyst, more effective than p-TSA on a weight basis and probably about comparable on a mol basis. (See Table 5.) A drawback was that higher levels of methane sulfonic acid caused pronounced yellowing of the films on steel panels but not on glass panels. Reasons for yellowing are unknown; contamination of the catalyst with sulfuric acid is suspected.

As with p-TSA, solvent resistance of MSA catalyzed films increased for several months when the crosslinker was HMMM-P but not when it was HMMM-M. This suggests that MSA is retained in the films to some extent for at least several months. If it volatilizes appreciably within a year at 25°C, it appears to be a good candidate as a fugitive catalyst. Its water solubility may be a positive feature as well as its volatility since it could be leached from the film by rain water.

Transmission FTIR Studies

FTIR was used to observe chemical changes during cure more directly. Thin films of a given formulation were cast on NaCl plates and spectra were recorded after varying time intervals. Films of the same formulation were cast on panels and evaluated at the same time. Representative results are shown in Figures 1 and 2, for baking and ambient temperature cure coatings, respectively.

Comparison of the IR spectral peak at 915 cm^{-1} ($-\text{OCH}_3$ group) with the peak at 815 cm^{-1} (triazine ring) provides an indication of the chemical rate of crosslinking which is independent of T_g and other physical

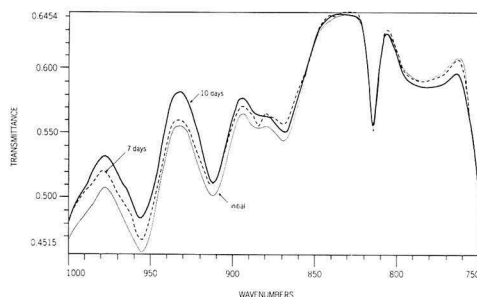


Figure 2—Changes in the FTIR spectra during ambient temperature cure. PE-I-2/HMMM-P (75/25); 0.5% p-TSA

effects. The height of the former peak decreases during cure while the latter is assumed to remain constant; our experience and that of others^{7,8} indicates that this assumption is warranted. The rate of decrease in the 915 cm^{-1} /815 cm^{-1} peak height ratio provides a way to compare effects on cure rates of changes in formulation and conditions. Additional, less precise, indications of the progress of cure are provided by other spectral features, such as the broad peak at about 3400 cm^{-1} (primarily OH). Efforts to use these spectral features to measure reaction rates did not yield satisfying results, but the following qualitative observations were made:

(1) Polyester resin PE-I-1 reacts substantially faster than resin PE-III-1 with model MF resin HMMM-P. With PE-I-1 the 915 cm^{-1} /815 cm^{-1} peak height ratio drops by about 20% in three days at ambient temperature, while with PE-III the change is barely discernable.

(2) Good film properties are attained when the 915 cm^{-1} /815 cm^{-1} peak height ratio has dropped by 30 to 40%.

(3) Peak height ratios indicate that 10 days curing at ambient temperature is about equivalent to 30 min at 70°C.

(4) The broad peak at about 3400 cm^{-1} gets smaller during crosslinking but never disappears, suggesting that a significant fraction of the OH groups are unconverted at 70°C with 0.5 phr catalyst.

The first observation establishes a key point: chemical reactivity measured by FTIR correlates qualitatively with apparent cure rate measured by solvent resistance and pencil hardness. Thus, while factors such as T_g of the polyester also probably play a role in apparent cure rate, chemical reactivity of the hydroxyl groups is a major factor, quite possibly the largest.

Observations two to four clearly show that reasonable properties are attained when the crosslinking reaction is chemically incomplete. This is an attractive situation from the standpoint of attaining rapid cure, but it suggests a risk that curing may continue, eventually leading to deterioration of film properties over a period of years, although we have not observed the problem yet. Our work with potentially fugitive catalysts suggests a possible remedy.

Table 5—Properties of PE-I-1/HMMM-P (75/25wt) Catalyzed by MSA at Ambient Temperature

| MSA level (phr) | 0.5 | | | 1.0 | | | 1.5 | | | 2.0 | | |
|----------------------------|-----|-----|-----|-----|-----|-----|-----|-----|------|------|------|------|
| | 3 | 10 | 100 | 3 | 10 | 100 | 3 | 10 | 100 | 3 | 10 | 100 |
| Cure time (days) | | | | | | | | | | | | |
| Acetone | | | | | | | | | | | | |
| resistance | 32 | 57 | 121 | 45 | 80 | 180 | 134 | 200 | 200+ | 200+ | 200+ | 200+ |
| Pencil hardness | H | H | 2H | H | H | 2H | H | 2H | 2H | H | 3H | 3H |
| Impact resistance Dir. | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 |
| (in.-lb) Rev. | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 | 160 |

The chemical reactivity imparted by the diols studied is in the rank order CHDM > TMP >> HG. Based on its low steric hindrance, it might predict that HG would be the most reactive, not the least. We can only speculate as to the reasons why. Perhaps the fact that the crosslinking reactions are reversible plays a role—could the high overall reactivity of CHDM polyesters be due to an unusually slow reverse reaction? (The S_N1 mechanism predicts that overall crosslinking rates depend on the relative rates of both the forward and the reverse reactions.^{2,5}) Perhaps physical factors play a significant role. For example, subtle differences in compatibility of different polyester resins with a given MF resin might influence rates of the forward reactions by causing subtle variations in the accessibility of hydroxyl groups, and differences in rigidity of the polyester segment near the crosslink might influence the rates of reverse reactions.

A number of questions are left unanswered or at least only partly answered by these results: How do T_g , functionality, and hydroxyl group environment affect apparent cure rates? Does crosslinking rate drop as the film T_g increases to the cure temperature? Are even faster curing formulations possible with acrylic coreactants? These questions will be addressed in future studies.

SUMMARY AND CONCLUSIONS

Our results provide rough guidelines for formulating polyester/MF resin coatings that cure rapidly at low bakes and slowly at ambient temperature. Polyesters made from CHDM are fastest reacting of those studied, and yield hardness, solvent resistance, and impact resistance that would be acceptable for many commercial applications at bakes of 65–80°C for 30 min with 0.5 phr of p-TSA catalyst. With higher levels of catalyst, ambient temperature curing PE/MF coatings might be feasible for applica-

tions where film property requirements are not demanding, although there is a risk of eventual overcure. FTIR studies indicated good qualitative correlation between the rate of disappearance of $-OCH_3$ groups and the rate of apparent cure.

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References

- (1) Jones, F.N., *Polymer Mater. Sci. Eng.*, 55 (1986).
- (2) Samaraweera, U., Teng, G., Gan, S., and Jones, F.N., *Polymer Mater. Sci. Eng.*, 64, 385 (1991).
- (3) Samaraweera, U., Gan, S., and Jones, F.N., *J. Appl. Polymer Sci.*, in press.
- (4) Blank, W.S., "Reaction Mechanism of Melamine Resins," *JOURNAL OF COATINGS TECHNOLOGY*, 51, No. 656, 61 (1979).
- (5) Santer, J.O., *Progr. Org. Coat.*, 12, 309 (1984).
- (6) Nakamichi, T., *Progr. Org. Coat.*, 14, 23 (1986).
- (7) Bauer, D.R., *Progr. Org. Coat.*, 14, 45 (1986).
- (8) Bauer, D.R., *Progr. Org. Coat.*, 14, 193 (1986).
- (9) Samaraweera, U. and Jones, F.N., "Possible Reaction Pathways for Self-Condensation of Melamine Resins Reversibility of Methylene Bridge Formations," *JOURNAL OF COATINGS TECHNOLOGY*, 64, No. 804, 69 (1992).
- (10) Shoemaker, S.H., "Two-Component Isopolyester Urethane Coatings for Plastics," *JOURNAL OF COATINGS TECHNOLOGY*, 62, No. 787, 8 (1992).
- (11) Kingston, B.H.M., Garey, J.J., and Hellwig, W.B., *Anal. Chem.*, 41(1), 86 (1969).
- (12) Golob, D.J., Odom, T.A., and Whitson, R.L., *Polymer Mater. Sci. Eng.*, 63, 826 (1990).
- (13) Cameron, J.M., Stanton, T.P., Tye, A.J., and December, T., U.S. Patent 4 837 278 (1989).
- (14) Rappoport, Z., *Handbook of Tables for Organic Compound Identification*, 3rd Ed., Chemical Rubber Co., p 429, 1972.

Recent Advances in UV-Curing Chemistry

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The efficiency of newly developed photoinitiators and acrylic monomers has been evaluated in UV-curable resins by using real-time spectroscopy techniques. The kinetic profiles of these ultrafast photopolymerizations have been directly recorded by following either the monomer disappearance by infrared spectroscopy, or the photoinitiator loss by ultraviolet spectroscopy. The best performance was obtained with formulations based on a morpholino-type photoinitiator and on cyclic-carbonate monoacrylates. One of the great advantages of these new monomers lies in their high reactivity, which leads to fast and extensive cure upon exposure to UV-radiation or laser beams. Chain transfer reactions play an important role in the formation of such strongly crosslinked polymers, which exhibit remarkable mechanical properties, such as hardness, scratch resistance, flexibility, and impact resistance.

INTRODUCTION

Radiation curing is known to be one of the most efficient methods for producing quasi-instantly highly crosslinked polymer materials. Owing to its distinct advantages, this technology has found a large number of industrial applications, in particular for the surface protection of materials by fast-drying varnishes or inks, the production of UV-curable adhesives and composites, and the patterning of electronic components and printing plates by light-induced insolubilization of photoresists.¹⁻⁵

In the past few years, most of the research efforts in formulating UV-curable resins have been directed towards the development of more efficient photoinitiators and highly reactive, nonirritating monomers, with the

objective of increasing both the cure speed and the extent of the polymerization, as well as improving the final properties of the cured material. In coating applications, it is indeed important to reduce as much as possible the amount of unreacted monomer, which is known to badly affect the long-term properties of UV-cured polymers. In addition, a large variety of functionalized oligomers, mainly acrylics, recently have been put on the market by several companies in the U.S., Europe, and Japan, in order to enable production of polymeric materials with tailor-made properties, well suited for specialized applications.

In this paper, the outstanding performance of some newly developed photoinitiators and acrylic monomers is described. When used in UV-curable formulations, these compounds were found to be highly efficient for achieving fast and complete cure. They also markedly improve the mechanical properties by imparting both hardness and flexibility to the UV-cured polymers.

A new analytical method based on real-time ultraviolet (RTUV) or real-time infrared (RTIR) spectroscopy has been developed in order to monitor continuously and quantitatively the curing process. This method proved particularly appropriate to study the kinetics of ultrafast photopolymerization processes, since it has the distinct advantage of allowing the disappearance of either the photoinitiator or the monomer to be directly recorded, for reactions occurring within less than one second.

HIGH-PERFORMANCE PHOTOINITIATORS

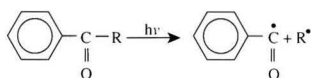
UV-Curing of Acrylic Resins

Photoinitiators which generate free radicals upon UV-exposure can be classified in two main categories, depending on their photolysis mechanism⁶:

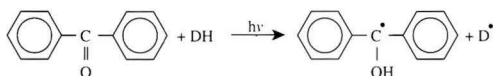
(1) Photocleavage (aryl ketones)—The photoinitiators

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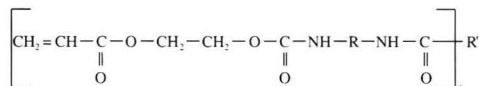
excited states undergo a homolytical scission that leads to the formation of two radical fragments:



(2) Hydrogen abstraction (benzophenone, thioxanthone)—By interaction with a hydrogen donor molecule, the photoinitiators' excited state undergoes a hydrogen transfer, with formation of an inactive ketyl radical and an initiating donor radical:

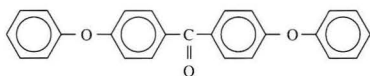


The performance of two recently developed compounds, which are representative of these two main classes of photoinitiators, was examined. The acrylic resin used in this study was made of a 1/1 mixture of hexanedioldiacrylate (HDDA) and a polyurethane acrylate [Actilane 20 from the Société Nationale des Poudres et Explosifs, (SNPE)]. Actilane 20 consists of a short polyurethane chain end-capped at each extremity by an acrylate function. It was obtained by reaction of a polyester polyol with a saturated diisocyanate, followed by acrylation, and can be represented by the typical formula of this class of functionalized oligomers:



The UV-curable resin was applied on an NaCl salt disc as a uniform layer of typically 25 μm thickness by means of a calibrated wire-wound applicator. Samples were exposed, in the presence of air and at room temperature, to the radiation of a medium pressure mercury lamp (80 W/cm) for a given time selected by a camera shutter. This type of light source, which is the most widely used in UV-curing applications, has its strongest UV emission lines at 254 and 303 nm.

DIPHENOXY-BENZOPHENONE (DPB):

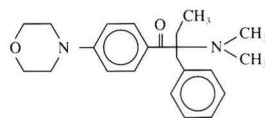


DPB, which is an intermediate product in the fabrication of thermoplastic polyether-etherketones (PEEK), was synthesized by SNPE, by phosgenation at 90°C of diphenylether in the presence of AlCl_3 . When associated with a hydrogen donor molecule, as methyl-diethanol-amine (MDEA), DPB was found to be a very efficient photoinitiator in UV-curable resins.⁷ At a DPB concentration of 2% in an aliphatic polyurethane-acrylate resin, the light-induced crosslinking-polymerization developed eight times faster than with benzophenone, as shown by Figure 1, where the acrylate conversion, measured by IR spectroscopy, has been plotted as a function of the exposure time.

Such a high-cure rate is resulting from both a greater light absorption of DPB in the UV region, and a higher efficiency in producing initiating radicals. Indeed, the polymerization quantum yield was found to be five times larger with DPB than with benzophenone.⁷

Another advantage of this new photoinitiator is to provide a more complete cure of the irradiated sample, thus reducing the amount of unreacted acrylate functionality in the final product. This is clearly illustrated by Figure 2, where the residual unsaturation content of the tack-free coating has been plotted as a function of the film thickness. While benzophenone ensures a better surface cure, DPB is providing both surface and deep through-cure, which is of particular interest for thick coatings. The enhanced polymerization of the deep-lying layers has two important consequences: first, it improves markedly the adhesion of the polymer film onto the support, and second, it increases substantially the hardness of the UV-cured material (Figure 3). As a nontoxic and low-cost compound, DPB should prove to be a most valuable photoinitiator in UV-curing applications where high speed and extensive cure are required, as well as in thiol-polyene polymerizations,⁸ which need H-donor type photoinitiators.

MORPHOLINO-KETONE:



(2-Benzyl-2-N-Dimethylamino-1-(4-Morpholinophenyl)-1-Butanone)

This photoinitiator has been recently developed by CIBA-GEIGY under the trade name Irgacure® 369, and was shown to be very efficient in UV-curable formulations, particularly in pigmented systems and in imaging applications.⁹ The exposure time needed to reach surface cure, body cure, scratch resistance, and hardness was found to be markedly reduced,¹⁰ compared to the commonly used photoinitiators.

To evaluate the cure performance of Irgacure 369 in acrylic resins, we have studied the kinetics of the light-induced polymerization, by using RTIR spectroscopy.¹¹⁻¹² This technique has the unique advantage of allowing conversion versus time profiles to be directly recorded for curing reactions occurring within a fraction of a second, simply by following continuously the disappearance of the IR absorption of the reactive group, for example, at 812 cm^{-1} for the acrylate double bond.

The cure profiles recorded for various photoinitiators in a polyurethane-acrylate formulation (Figure 4) clearly show the superior performance of Irgacure 369. The induction period, due to O_2 -inhibition, was sharply reduced, whereas both the rate of polymerization and the maximum conversion were found to be substantially higher than with any of the other photoinitiators tested so far. This is mainly due to the large absorption of Irgacure 369 in the 300-350 nm region, and to an effective photolysis process which generates large amounts of initiating radicals.¹³ Such a photoinitiator should prove particularly

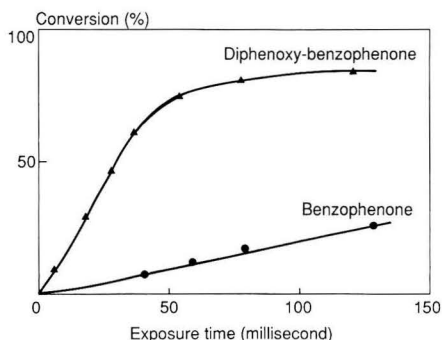


Figure 1—Influence of the photoinitiator on the polymerization profile of a polyurethane-acrylate/hexanediol diacrylate resin exposed to UV radiation in the presence of air. Photoinitiator = 2%; MDEA = 5%; and film thickness = 25 μm

useful in photoimaging applications where high sensitivity is required, and for the UV-curing of pigmented systems (inks, lacquers, composites), where deep through-cure is often difficult to achieve. It is less appropriate for the curing of clear varnishes or coatings used in outdoor applications, because of the formation of colored photo-products, which may have a detrimental effect on the aspect and long-term properties of these materials.

Photolysis of the Initiator

The rate of initiation of light-induced polymerizations depends primarily on the photolysis rate of the initiator. While the mechanism of photoinitiation has been thoroughly investigated during the past decade,⁶ it is rather surprising to see that very little is known about the value of this important quantity, especially when the photoinitiators' photolysis is carried out under conditions similar to those employed in UV-curing applications, that is, thin

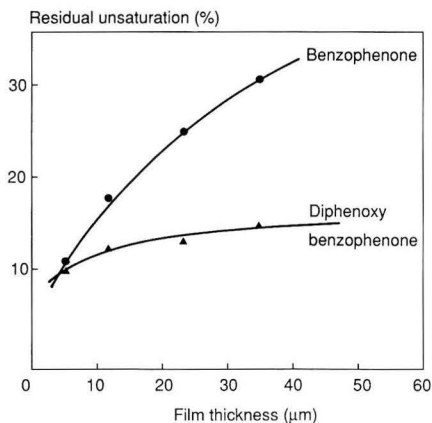


Figure 2—Influence of the photoinitiator on the amount of residual unsaturation in a polyurethane-acrylate coating UV cured in air

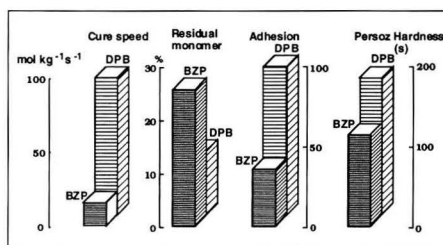


Figure 3—Performance analysis of benzophenone (BZP) and diphenoxy benzophenone (DPB) in UV-curable polyurethane-acrylate coatings. Film thickness = 36 μm

monomer films exposed to intense UV-radiation in the presence of air. By using real-time UV spectroscopy, we have been able to monitor continuously the disappearance of radical and cationic-type photoinitiators in acrylic and epoxy systems, respectively, and thus evaluate both the photolysis rate of the photoinitiator and its residual content in the UV-cured polymer.

MORPHOLINO-KETONE: When a UV-curable resin, consisting of Irgacure 369 in tripropylene glycol diacrylate (TPGDA), was exposed to the radiation of a medium pressure mercury lamp, polymerization was found to develop extensively within a few seconds, while the photoinitiator content dropped progressively. Figure 5 shows some typical kinetic profiles, which were recorded by RTIR (curing) and RTUV (photoinitiator photolysis) spectroscopy, with the detection wavelength set at 12.3 μm and 322 nm, respectively. The disappearance of the photoinitiator was found to follow a single exponential decay, as one would expect for a direct photolysis process, where the reaction rate is supposed to be proportional at any time to the chromophore concentration:

$$-d[\text{PI}] / dt = k[\text{PI}]$$

and

$$[\text{PI}]_t = [\text{PI}]_0 \exp(-kt)$$

The decay rate constant k was calculated from the slope of the linear semi-log plot ($\log [\text{PI}]_t / [\text{PI}]_0 = f(t)$), and its value was used to determine the quantum yield of the photolysis of the initiator:

$$\Phi_{-PI} = \frac{\text{number of PI molecules consumed}}{\text{number of photons absorbed}} = \frac{k[\text{PI}]}{I_a}$$

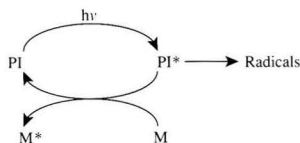
where I_a is the absorbed light-intensity. The Φ_{-PI} value, 0.3 for Irgacure 369 in TPGDA, was found to be independent from the photoinitiators' concentration, the film thickness, and the light intensity.

The less than unity value of Φ_{-PI} indicates that a large fraction (70%) of the photoinitiators' excited states are not undergoing cleavage, but are returning unaffected to the ground state. A quenching reaction by the acrylic monomer may account for this low efficiency of the photolysis:



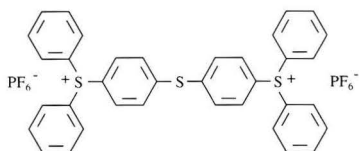
To test this explanation, Irgacure 369 was dispersed in a poly(methyl methacrylate) (PMMA) matrix and ex-

posed to UV light. Under those conditions, the photoinitiator disappeared three times faster than previously (Figure 6), with a quantum yield close to one. When a triacrylate monomer, like pentaerythritol triacrylate (PETIA), was introduced in the PMMA matrix, Irgacure 369 was found to disappear at a lower speed (Figure 6), with a rate decrease factor of up to seven for bulk PETIA compared to PMMA, thus clearly demonstrating the strong quenching effect of acrylate monomers which can be represented schematically as follows:



The kinetic data obtained by RTUV and RTIR spectroscopy for the various UV-curable acrylic resins are summarized in Table 1. The general trend observed is that, as the acrylate concentration is increased, the rate of photoinitiator photolysis, and thus of initiation, decreases, whereas the rate of polymerization increases. By taking the ratio R_p/R_{-PI} , it was possible to show that each photoinitiator molecule destroyed can induce the polymerization of up to 8000 acrylate groups, and that UV-curing of these acrylic resins is thus proceeding with long kinetic chains.

TRIARYLSULFONIUM SALT: A similar kinetic study has been carried out on a UV-curable cationic system, which consisted of a cycloaliphatic difunctional epoxide (Cyracure™ UVR 6110 from Union Carbide) and an arylsulfonium salt, $S(\text{O}_3\text{S} + \text{PF}_6^-)_2$ (Degacure® KI 85 from Degussa).



When a 20 μm thick film was exposed to UV-radiation at room temperature, the photoinitiator was found to disappear rapidly, while polymerization developed at a relatively low rate (Figure 7), in marked contrast with what we observed with acrylic resins (Figure 5). At a photoinitiator concentration of 5%, the polymerization was found to level off after 1 s of irradiation and a degree of conversion of only 40%. This early slowing down of the curing process is actually due to the fast consumption of the photoinitiator, which has almost disappeared after 2 s of exposure. Indeed, by increasing the photoinitiator concentration up to 10%, larger amounts of initiator remain available in the later stages of the reaction, thus allowing higher conversion to be reached (Figure 7).

As for the radical type initiator, the photolysis rate of KI-85 was found to be proportional to the light-intensity (Figure 8). It can be extrapolated from this linear relationship that, by operating at the high intensities used in

Table 1—Photolysis and Polymerization Kinetic Data for Various UV-Curable Systems

| Irgacure 369 ($1.6 \times 10^{-2} \text{ mol L}^{-1}$) | RTUV | | RTIR | | Conversion % |
|---|----------------------------------|--|---|---------------|--------------|
| | $[M]_0^a$ mol L^{-1} | R_{-PI}^b $\text{mmol L}^{-1} \text{ s}^{-1}$ | R_p^c $\text{mol L}^{-1} \text{ s}^{-1}$ | R_p/R_{-PI} | |
| TPDGA (laminate) | 6.8 | 7 | 21 | 3000 | 85 |
| Actilane 20 + TPGDA | 4.3 | 6 | 20 | 3300 | 80 |
| PETIA | 12 | 3 | 24 | 8000 | 50 |
| PMMA + PETIA | 6 | 6 | 10 | 1700 | 50 |
| PMMA | 0 | 20 | — | — | — |
| Degacure KI-85 ($2.3 \times 10^{-2} \text{ mol L}^{-1}$) | | | | | |
| Cycloaliphatic diepoxy | 9 | 70 | 8 | 110 | 40 |

(a) Initial concentration in acrylate or epoxy groups.
 (b) Initial loss rate of the photoinitiator.
 (c) Maximum rate of polymerization.

RTUV — Real-time ultraviolet spectroscopy.
 RTIR — Real-time infrared spectroscopy.
 TPGDA — Tripropyleneglycol diacrylate.
 PETIA — Pentaerythritol triacrylate.
 PMMA — Poly(methylmethacrylate).

most UV-curing applications ($> 500 \text{ mW cm}^{-2}$), almost all of the photoinitiators will have disappeared within the first 0.1 s of irradiation.

Despite the very fast photolysis of the sulfonium salt and the related high rate of initiation, the cationic polymerization of the epoxy monomer was shown to develop at a slower pace than in acrylic systems. This is due to a much shorter kinetic chain length, as indicated by the relatively low value of the ratio R_p/R_{-PI} (Table 1), a result in good agreement with our previous evaluation of the polymerization quantum yield of this system.¹⁴ It confirms previous observations which showed cationic epoxy systems to cure significantly slower than radical acrylate-

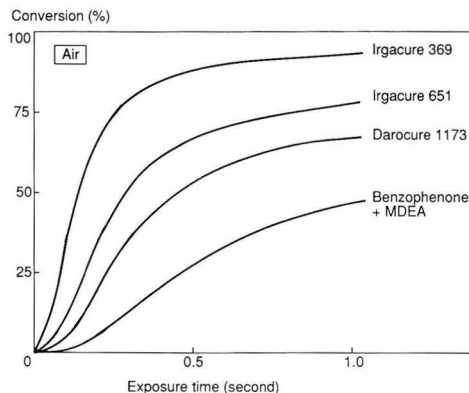


Figure 4—Cure profiles of polyurethane-acrylate resins recorded by real-time infrared spectroscopy. Atmosphere: air; Photoinitiator = 5%; light-intensity: 200 mW cm^{-2} MDEA: methyl diethanol amine = 5%

based varnishes, but to perform quite well regarding the properties of the final product.¹⁵ Yet, it should be mentioned that a cationic epoxy resin was recently found to cure faster than an acrylate-based varnish when a prototype Fusion Systems high powered UV-light source was used.¹⁶ In that study, the degree of cure was determined by methylketone rub testing, a method which indicates the solvent resistance of the cured coating, but does not necessarily correlate with the speed of cure.

Besides providing a continuous monitoring of the cure process, RTIR and RTUV spectroscopy have the distinct advantages of allowing a fast and precise evaluation of both the amount of unreacted monomer and the amount of residual photoinitiator, at any stage of the polymerization. Therefore, these techniques should prove quite useful in the coating industry for analyzing UV-cured polymers and determining how much unreacted monomer and photoinitiator remains in the final product, two quantities, which are known to strongly affect the long-term properties of UV-cured materials.

HIGH-PERFORMANCE ACRYLIC MONOMERS

The monomer used as reactive diluent in UV-curable resins plays a key role, for it affects both the cure speed and the polymerization extent, as well as the properties of the final product. An increase of the monomer functionality was shown to accelerate the curing process, but at the expenses of the overall monomer conversion, thus leading to a crosslinked polymer which contained a substantial amount of residual unsaturation. As a result of the increased crosslink density, UV-cured coatings become harder, but less flexible.

| Increase of the Monomer Functionality | | | | |
|---------------------------------------|-------------|-------------------|----------|-------------|
| Cure speed | Cure extent | Crosslink density | Hardness | Flexibility |
| ↗ | ↘ | ↗ | ↗ | ↘ |

Light-Induced Homo-Polymerization

The chemical structure of the monomer has also a strong influence on the cure kinetics and on the physical characteristics of the polymer formed. By employing, as reactive diluents, monomers that contain, in their structural unit, one acrylate function and either a carbamate or an oxazolidone group (Figure 9), we recently succeeded in achieving a fast and extensive polymerization of UV-curable polyurethane-acrylates and epoxy-acrylates.¹⁷ These new monomers (Acticryl® CL-959 and Acticryl® CL-960 from SNPE) have a low vapor pressure and a mild skin and eye irritation effect. Another of their advantages, besides their high reactivity, is to impart both hardness and flexibility to the UV-cured polymer.

Even better results were obtained by introducing a cyclic carbonate function into the monomer unit¹⁸ (Acticryl® CL-1042 from SNPE). This compound, whose formula is given in Figure 9, showed an unexpectedly high reactivity when it was exposed to UV-radiation in the presence of a photoinitiator (5% Irgacure 651). The UV-curing of a 1-mil thick coating was found to proceed 100 times faster for CL-1042 than for conventional monoacry-

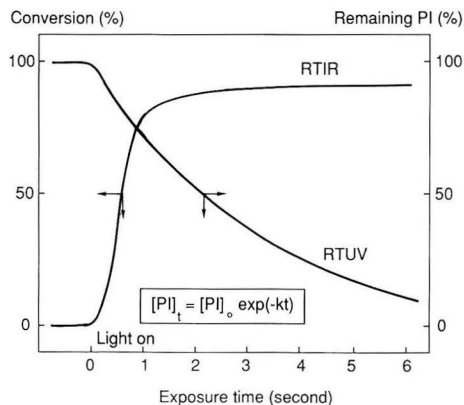


Figure 5—Kinetic profiles recorded by real-time infrared and real-time ultraviolet spectroscopy for a tripropyleneglycol diacrylate photoresist exposed to UV radiation as a laminate. Photoinitiator: Irgacure 369 = 1%; light-intensity: 50 mW cm⁻²

lates, like ethyldiethyleneglycolacrylate (EDGA), and still faster than for triacrylates, such as trimethylolpropanetriacrylate (TMPTA), as shown by Figure 10. Like with the other Acticryls, the extremely fast cure of CL-1042 does not prevent the chain reaction to develop extensively, so that the tack-free coating contains little unreacted monomer (4% of its original amount, compared to 50% for TMPTA), as would be expected for a monoacrylate (Figure 11).

A striking feature observed with these new monomers containing only one acrylate function is that they become insoluble upon UV exposure, very much as a di- or trifunctional monomer would, as shown in Figure 12. After 30 ms of irradiation, Acticryl CL-1042 was found to become totally insoluble in organic solvents like acetone, chloroform, or methyl ethyl ketone, compared to a 50%

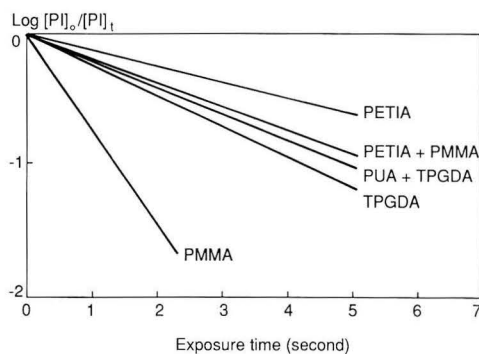


Figure 6—Photoinitiator PI decay profiles in various UV-curable systems exposed to UV radiation in air. Photoinitiator: Irgacure 369 = 1%. PETIA—pentaerythritoltriacrylate; PMMA—poly(methylmethacrylate) TPGDA—tripropylene glycol diacrylate; and PUA—polyurethane acrylate (Actilane 20)

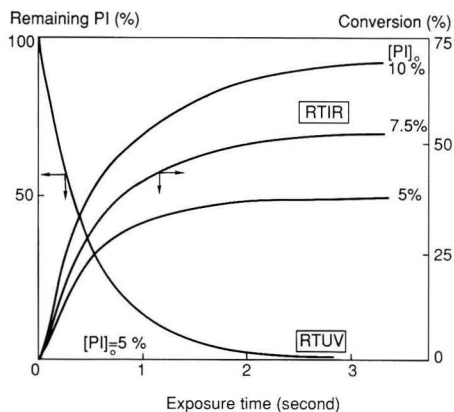


Figure 7—Photoinitiator decay and polymerization profiles for a cycloaliphatic diepoxy monomer exposed to UV radiation in the presence of a triarylsulphonium salt (KI-85). Light-intensity: 55 mW cm^{-2}

insolubilization for TMPTA and only 10% for HDDA. Except for EDGA, further exposure leads to complete insolubilization of all these acrylic monomers, in particular the Acticryl CL-959 and CL-960, which indicates that an efficient crosslinking process has taken place. Further evidence of a crosslinking reaction was obtained from hardness measurements, which showed the cyclic-carbonate monoacrylate to yield hard (Persoz: 200 s) and scratch-resistant coatings, instead of the soft (Persoz: 50 s) and elastomeric material formed by using conventional monoacrylates, like EDGA. The nature of the chemical bonds that connect the polymer chains in these UV-cured monoacrylates is presently under investigation.

Light-Induced Copolymerization

One of the great interests of these new monomers is to provide fast and extensive cure when they are used as

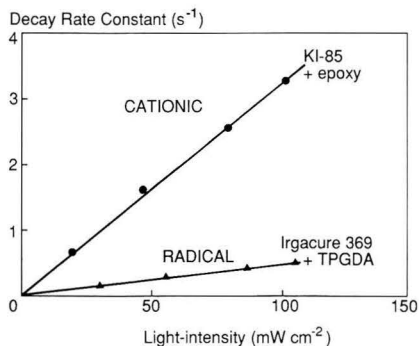


Figure 8—Influence of the light-intensity on the photolysis rate of radical and cationic-type initiators exposed to UV radiation in the presence of air. TPGDA—tripropylene glycol diacrylate

reactive diluents in acrylic resins.¹⁹ Some typical kinetic curves are shown in *Figure 13* for polyurethane-acrylate formulations containing different types of monomers, in a 1 to 1 weight ratio, upon exposure to UV radiation in the presence of air. The higher performance of Acticryl CL-1042 compared to usual reactive diluents is clearly apparent from these polymerization profiles, with respect to both the cure speed and the overall conversion. As a consequence, the tack-free coating contained only a few percent residual unsaturation, compared to 16% and 36% when using HDDA and TMPTA, respectively, as reactive diluent. It can be noticed in *Figure 13* that the polymerization of the CL-1042 based formulation starts without detectable induction period, thus showing the great capacity of this monomer to overcome the oxygen inhibition effect.

Very similar results were obtained in UV-curable epoxy-acrylate resins (Actilane 72 from SNPE). Replacing HDDA or TPGDA with Acticryl CL-1042 led to a threefold increase of the speed of the curing line. For all the UV-cured epoxy-acrylate coatings examined, the polymerization was found to stop at an earlier stage than in the elastomeric polyurethane-acrylate, as expected when considering the severe mobility restrictions of the reactive sites in such stiff and glassy polymer materials. There remains thus a relatively large amount of residual unsaturation, 18 and 23%, in the tack-free UV-cured epoxy-acrylate coatings based on CL-1042 and HDDA, respectively. By pursuing the irradiation for up to 2 s, this level was further reduced down to 9 and 12%, respectively.

An important quantity which can be evaluated from the recorded cure profiles is the polymerization quantum yield, Φ_p , which expresses the photochemical efficiency of this chain reaction:

$$\Phi_p = \frac{\text{number of acrylate groups polymerized}}{\text{number of photons absorbed}}$$

It can be calculated simply by taking the ratio of the maximum rate of polymerization to the absorbed light-intensity.²⁰ The Φ_p values obtained for the various systems examined are reported in *Table 2*. The high reactivity of Acticryl monomers clearly appears from such a quantitative comparison, each photon absorbed being capable to induce the polymerization of over 3000 acrylate double bonds in the CL-1042 based resins. With the photoinitiator used here, Irgacure 651, this would correspond to a kinetic chain length on the order of 10^4 mol per initiating radical.

Properties of UV-Cured Polymers

Both the polyurethane-acrylate and the epoxy-acrylate copolymers based on Acticryl CL-960 and CL-1042 were found to be completely insoluble in the organic solvents, which makes these photoresists well suited for imaging applications. Sensitivity values as low as 0.5 mJ cm^{-2} have been obtained for CL-1042 based photoresists exposed to UV radiation or to lasers in the presence of air.²¹ Such UV-cured coatings also exhibit a good resistance to moisture, strong acids, alkaline treatment, and weathering.

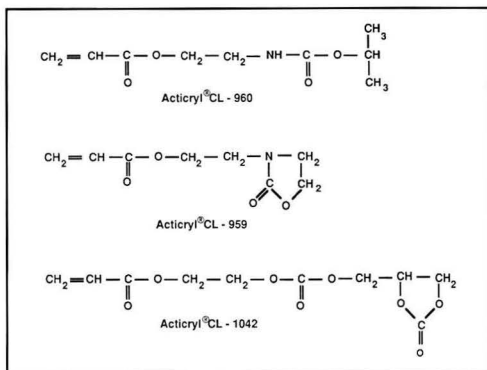


Figure 9—Formulas and trade names of new acrylate monomers

Table 2 — Polymerization Quantum Yield of UV-Curable Acrylic Resins Photoinitiator: Irgacure 651 = 5%; Oligomer/Monomer = 1/1; Film Thickness = 25 μm; and Atmosphere: Air

| Q _p (Molecule / Photon) | Diluent | | | |
|------------------------------------|---------|------|-----------------|------------------|
| | EDGA | HDDA | Acticryl CL-960 | Acticryl CL-1042 |
| Polyurethane-acrylate | 200 | 700 | 1700 | 3000 |
| Epoxy-acrylate | 230 | 800 | 2000 | 3200 |

EDGA — Ethyl-diethyleneglycol acrylate.
 HDDA — Hexanediol diacrylate.
 Polyurethane-acrylate — Actilane 20 from SNPE.
 Epoxy-acrylate — Ebecryl 605 from UCB.

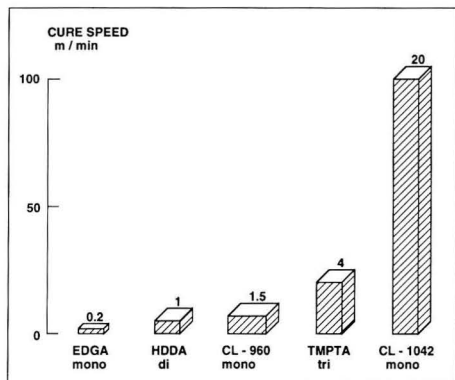


Figure 10—Performance analysis of various acrylic monomers exposed to UV radiation in the presence of 5% Irgacure 651. Film thickness = 25 μm; atmosphere: air. EDGA—ethyl-diethyleneglycol acrylate; HDDA—hexanediol diacrylate; and TMPTA—trimethylolpropane triacrylate

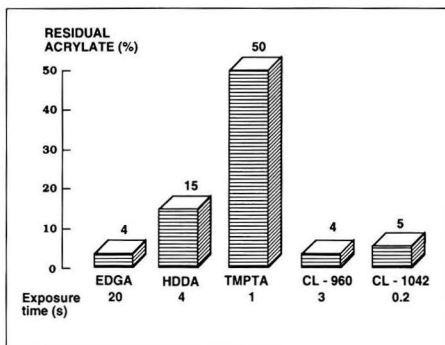


Figure 11—Unsaturation content of tack-free acrylic monomer films in the presence of air. Irgacure 651 = 5%. EDGA—ethyl-diethyleneglycol acrylate; HDDA—hexanediol diacrylate; and TMPTA—trimethylolpropane triacrylate

Table 3 — Influence of the Diluent on the Hardness and Flexibility of UV-Cured Acrylic Coatings

| | Diluent | | | | |
|-----------------------------------|--|-----------------|------------------|------|-------|
| | Diacrylate oligomer/monomer = 1/1 Photoinitiator: Irgacure 651 = 5% | | | | |
| | EDGA | Acticryl CL-960 | Acticryl CL-1042 | HDDA | TMPTA |
| Polyurethane-acrylate | | | | | |
| Perso hardness | 30 | 80 | 100 | 130 | 270 |
| Mandel flexibility (mm) | 0 | 0 | 0 | 2 | 5 |
| Epoxy-acrylate | | | | | |
| Perso hardness(s) | 60 | 250 | 320 | 300 | 360 |
| Mandel flexibility (mm) | 0 | 1 | 1 | 12 | 30 |

Polyurethane-acrylate — Actilane 20 from SNPE.
 Epoxy-acrylate — Ebecryl 605 from UCB.
 EDGA — Ethyl-diethyleneglycol acrylate.
 HDDA — Hexanediol diacrylate.
 TMPTA — Trimethylolpropane triacrylate.

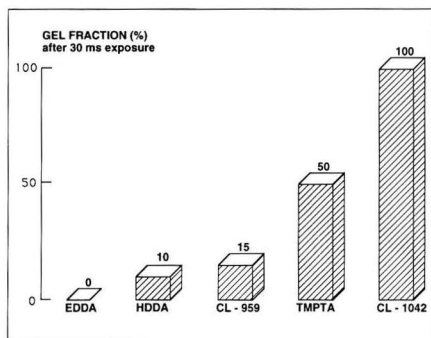


Figure 12—Amount of insoluble polymer formed after 30 ms of irradiation of various acrylic monomers, in the presence of air. Irgacure 651 = 5%. EDGA—ethyl-diethyleneglycol acrylate; HDDA—hexanediol diacrylate; and TMPTA—trimethylolpropane triacrylate

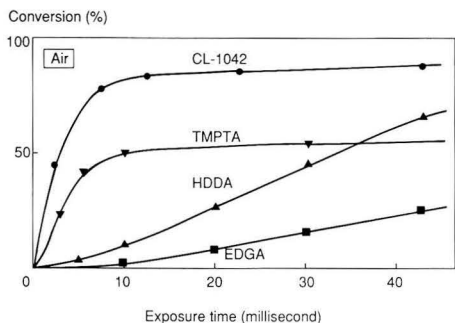


Figure 13—Influence of the reactive diluent on the polymerization profile of a polyurethane-acrylate resin exposed to UV radiation in the presence of air. Irgacure 651 = 5%; diluent/oligomer = 1. EDGA—ethylthioleneglycol acrylate; HDDA—hexanediol diacrylate; and TMPTA—trimethylolpropane triacrylate

POLYURETHANE-ACRYLATE COATINGS: The mechanical properties of these highly crosslinked polymers depend primarily on the functionality and chemical structure of the monomers and oligomers used. Aliphatic polyurethane chains provide elasticity and impact resistance, while the polyphenoxy structures give hard and stiff materials.

For some UV-curing applications, like adhesives or laminates, it is required to have low-modulus elastomers which show high elongation at break. This is generally achieved by taking a polyurethane-acrylate as oligomer and a monoacrylate as diluent. However, such UV-curable formulations proved to be poorly reactive, thus requiring relatively long exposure times. One of the main interests of using monoacrylates having carbamate or cyclic carbonate structures is that the curing occurs much faster, thus allowing a substantial increase of the line speed, and leads to the production of soft, impact resis-

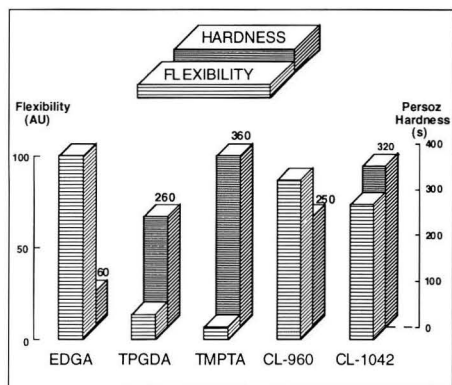


Figure 14—Influence of the reactive diluent on the mechanical properties of an epoxy-acrylate coating UV cured. EDGA—ethylthioleneglycol acrylate; HDDA—hexanediol diacrylate; and TMPTA—trimethylolpropane triacrylate

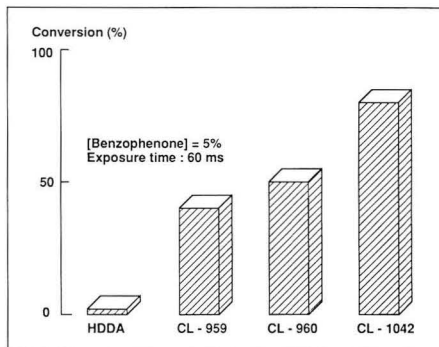


Figure 15—Photopolymerization of various acrylic monomers in the presence of benzophenone. Atmosphere: air; HDDA—hexanediol diacrylate

tant polymer materials (Table 3). All the monoacrylate/polyurethane-acrylate copolymers were found to pass the severe zero T-bend test at room temperature (25°), no cracks appearing when the polymer film was bent onto itself and a 10 N cm⁻² pressure applied.

EPOXY-ACRYLATE COATINGS: With epoxy-acrylate oligomers, hard and glassy polymers were obtained upon UV exposure, except when conventional monoacrylates like EDGA were used as reactive diluent. UV-cured coatings based on monomer CL-960 or CL-1042 present the distinct advantage of being very hard and scratch resistant, while they proved at the same time to be highly flexible, with a mandrel flexibility of 1 mm at room temperature, that is, a break elongation value above 50% (Table 3). The drastic effect of the diluent on the hardness and flexibility of UV-cured epoxy-acrylate coatings is illustrated by Figure 14. Very similar results have been obtained with some other monoacrylates that contained either a carbamate or a cyclic carbonate structure,^{18,19} thus showing that these functional groups are indeed responsible for the improved performance of these new monomers.

Mechanism of the Polymerization

The basic reasons which make monoacrylates bearing carbamate, oxazolidone, or cyclic carbonate groups so reactive are still unknown. Two sets of experimental results are yet pointing to the fact that an efficient chain transfer reaction is taking place during UV-curing, a process which may account, at least partly, for the observed increase of reactivity.

CROSSLINKING AGENT: Despite the fact that Acticryls contain a single acrylate function, these monomers actually play the role of difunctional crosslinking agents, as shown by the formation of a totally insoluble material during the light-induced homopolymerization. The higher hardness value of the cured polymer, compared to conventional UV-cured monoacrylates, provides further evidence of such a crosslinking process.

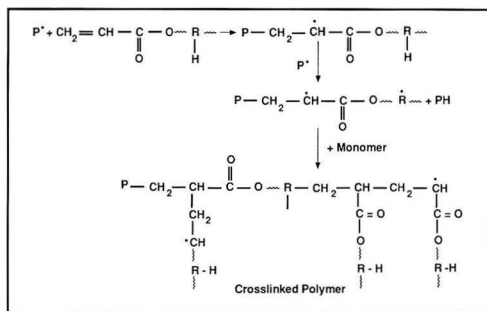


Figure 16—Chain transfer reaction in UV curing of some new acrylic monomers

HYDROGEN DONOR CHARACTER: The three Acticryls studied exhibit a strong hydrogen donor character, as shown by the UV-curing experiments carried out using benzophenone as the photoinitiator, a compound which needs a hydrogen donor molecule to produce radicals upon UV irradiation. As expected, polymerization was not taking place in HDDA, even after prolonged exposure. By contrast, Acticryl CL-959, CL-960, and CL-1042 were found to polymerize rapidly under those conditions (Figure 15), thus demonstrating the H donor character of these monomers. As a consequence, it is not necessary to add tertiary amines when hydrogen abstraction-type photoinitiators, such as thioxanthenes, are used to polymerize such monomers. Another fact which emphasizes the important role of hydrogen abstraction is that the polymerization rate dropped by a factor of five when the NH group of the carbamate-acrylate (CL-960) was replaced by an N-CH₃ group.¹⁴

The reaction scheme of Figure 16, which involves a chain transfer reaction by abstraction of a labile hydrogen from the functional group introduced, appears to best account for our experimental results. It should be mentioned that the viscosity increase, due to the building up of a tridimensional polymer network, is also likely to contribute to the cure speed increase, essentially by acting on the competition between propagation and termination reactions.

CONCLUSION

The recent advances in UV-curing chemistry presented here emphasize the remarkable performance of some new photoinitiators and monomers, which proved highly efficient in both accelerating the cure process and improving the properties of the final product. UV and IR spectroscopy appear today as the best analytical techniques for quantitatively monitoring in real-time polymerization reactions which occur in a fraction of a second. The most important kinetic parameters, such as cure rates, quantum yields, sensitivity, and kinetic chain length, have thus

been determined accurately for different types of UV-curable systems.^{22,23}

The reactivity of monoacrylates, often used as reactive diluents, can be greatly enhanced by introducing into the structural unit a carbamate, oxazolidone, or cyclic carbonate group, all of which being likely to favor chain transfer reactions. In such monomers, the photopolymerization was shown to develop as fast as in triacrylates, and as extensively as in monoacrylates, thus leading within milliseconds to highly crosslinked polymers that contain little residual unsaturation. A most remarkable feature is that this new class of monomers impart both hardness and flexibility to the UV-cured polymers, which in addition exhibit a good resistance to solvents, chemicals, and weathering. Such highly reactive monomers are expected to find their main openings as diluents in acrylic-based resins, which are widely used in today's UV-curing applications, especially those where cure speed and product quality are a major concern.

References

- (1) Roffey, C.C., *Photopolymerization of Surface Coatings*, Wiley Interscience, Chichester, 1982.
- (2) Pappas, S.P. (Ed.), *UV-Curing-Science and Technology*, Vols. 1 and 2, Technology Marketing Corp., Stamford, CT, 1978 and 1985.
- (3) Decker, C., "UV-Curing Chemistry: Past, Present, and Future," *JOURNAL OF COATINGS TECHNOLOGY*, 59, No. 751, 97 (1987).
- (4) Hoyle, C.E. and Kinstle, J.F. (Eds.), "Radiation Curing of Polymeric Materials," *ACS Symp. Ser.*, 417 (1990).
- (5) Oldring, P.K.T. (Ed.), *Chemistry and Technology of UV and EB Formulation for Coatings, Inks and Paints*, Vol. 2., SITA (Selective Industrial Training Associates Ltd.) Technology, London, 1991.
- (6) Dietliker, K.K., *Chemistry and Technology of UV and EB Formulation for Coatings, Inks and Paint*, Vol. 3., SITA Technology, London, 1991.
- (7) Decker, C. and Moussa, K., *J. Polymer Sci., Polymer Lett. Ed.*, 27, 347 (1989).
- (8) Jacobine, A.F., Glasser, D.M., and Nakos, S.T., in ref. (4), p. 160.
- (9) Desobry, V., Dietliker, K., Hüslér, R., Misev, L., Rembold, M., Rist, G., and Rutsch, W., in ref. (4), p. 92.
- (10) Gatechair, L.R. and Tiefenthaler, A.M., in ref. (4), p. 27.
- (11) Decker, C., and Moussa, K., *Makromol. Chem.*, 189, 2381 (1989).
- (12) Decker C. and Moussa, K., "Real-Time Monitoring of Ultrafast Curing by UV-Radiation and Laser Beams," *JOURNAL OF COATINGS TECHNOLOGY*, 67, No. 786, 55 (1990).
- (13) Decker, C. and Moussa, K., *Makromol. Chem.*, 191, 963 (1990).
- (14) Decker, C. and Moussa, K., *J. Polymer Sci., Polymer Chem. Ed.*, 28, 3429 (1990).
- (15) Wolinski, L.E., *Proc. RadTech 90 Conference*, Vol. 1, Chicago, IL, 1990, p. 41.
- (16) Schaeffer, W.R., *Proc. RadTech 90 Conference*, Vol. 1, Chicago, IL, 1990, p. 29.
- (17) Decker, C. and Moussa, K., *Europ. Polymer J.*, 27, 403 and 881 (1991).
- (18) Decker, C. and Moussa, K., *Makromol. Chem., Rapid Commun.*, 11, 159 (1990).
- (19) Decker, C. and Moussa, K., *Makromol. Chem.*, 192, 507 (1991).
- (20) Decker, C., *Macromolecules*, 23, 5217 (1990).
- (21) Decker, C., *Proc. RadTech 91 Conference*, Edinburgh, 1991, p. 536.
- (22) Decker, C. and Moussa, K., *Macromolecules*, 22, 4455 (1989).
- (23) Decker, C. and Moussa, K., *Europ. Polymer J.*, 26, 393 (1990).

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Effect of Polyethyleneimine on Phosphate Coatings on Mild Steel

U.B. Nair and M. Subbaiyan
University of Madras*

The interposition of a phosphate layer between a metal substrate and its paint finish has become a well known method of improving adhesion between them. This paper describes efforts to improve the protective and paint-base properties of phosphate coatings, through the incorporation of polymeric compounds as additives in phosphating compositions. In the present study, a high molecular weight, water-soluble polymer, polyethyleneimine (PEI), was evaluated as an additive in an optimized Ca-Zn cold phosphating formulation. The incorporation of PEI in the bath resulted in the formation of coatings having desirable properties and good corrosion resistance.

INTRODUCTION

Phosphate conversion coatings are one of the most widely used pretreatments for ferrous metals. These coatings enhance the corrosion resistance of the substrate metal and improve its paint-base properties and workability in drawing operations.¹

Among the most recent methods of improving the properties of phosphate coatings, modification of conventional phosphating formulations through the use of special additives has gained prominence.^{2,3} These additives are often added to improve one or more characteristics of the phosphate coatings, thereby improving their performance under service conditions. Refinement of phosphate grain size by addition of certain metal ions,^{4,5} decreased sludge formation by use of organic compounds,⁶ etc., are among the numerous improvements in phosphating that have been achieved through the use of additives.

More recently, polymeric compounds such as polyacrylamide and polyacrylic acid⁷ have been used successfully in phosphating baths to improve certain properties of phosphate coatings including crystal dimensions,⁸ mechanical properties, and ductility.⁹ It has also been suggested that incorporation of polymers into the phosphating bath would improve its paint-base properties, due to their ability to enhance interaction at the pretreatment/topcoat interface.

The present study is a preliminary investigation into the use of polyethyleneimine (PEI) as an additive in a calcium-modified cold zinc phosphating formulation. A combination of desirable properties which PEI possesses made it an ideal choice as an additive to be evaluated in the formulated bath. High water solubility of PEI allowed its easy incorporation into the aqueous phosphating bath. Besides being a heteropolar high molecular weight compound, PEI possessed other potentially useful properties such as chelating property, flocculating property, good thermal stability, and low oral toxicity.¹⁰ PEI has also been successfully used as a corrosion inhibitor for ferrous metals¹¹ and as a filming agent in adhesives and primer formulations,¹⁰ suggesting that its incorporation in the phosphating bath would enhance the quality and corrosion resistance of coatings obtained in its presence.

EXPERIMENTAL

Hot-rolled mild steel panels of composition conforming to IS:1079 specifications,¹² of dimensions 8 cm x 6 cm x 0.2 cm, were used in this study. The panels were solvent-degreased before being pickled in 10% sulfuric acid at 70-80°C (158-176°F) to remove rust and millscale. The cleaned panels were phosphated at room temperature (27°C, 80.6°F) for a period of 30 min by an immersion process. The phosphating composition used is shown in *Table 1*.

Following the phosphating step, a chromic acid postrinse [using 0.0125% CrO₃ solution maintained at 70-80°C, (158-176°F)] was performed on panels coated in a reference bath

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Table 1—Composition of the Phosphating Bath

| | |
|--|--------------|
| Zinc oxide | 9 g/L |
| o-Phosphoric acid (85%) | 20 mL/L |
| Calcium carbonate | 1 g/L |
| Sodium nitrite | 2 g/L |
| Polyethyleneimine (PEI) ^a | 50-2000 mg/L |
| pH | 2.33 |

(a) Molecular weight of 600,000—1,000,000. (Fluka)

(containing no additive). This step was avoided in case of panels processed in baths containing PEI, in order to evaluate the efficiency of this filming additive as a suitable substitute for the chrome rinse.

Studies Carried Out

Phosphated panels were visually evaluated for physical properties such as appearance and uniformity. The coating weight and the weight of iron dissolved during phosphating were recorded at various concentrations of PEI in the bath, in the concentration range of 50-2000 mg/L. From among the concentrations studied, the optimum was fixed, at which variation of accelerator concentration (0-4 g/L of NaNO₂) and pH (2-2.66) were carried out in order to ascertain the effect of these bath parameters on coating weight.

Other properties such as absorption value and hygroscopicity¹³ were evaluated in comparison with those of the reference bath. The gain in weight of coated steel panels after immersion in diacetone alcohol for two minutes followed by draining for three minutes was recorded as the absorption value. The hygroscopicity value was determined as the gain in weight of coated steel panels placed two inches above water for six hours in a closed chamber and is expressed as a percentage of the coating weight.

Corrosion performance of the coatings obtained from the reference bath and PEI-containing baths was assessed using the salt spray test,¹⁴ weight loss after 24 hr of immersion in 3% NaCl and the humidity test.¹⁵ Wet adhesion measurements were made by performing the crosshatch test after 240 hr of immersion of the phosphated and painted panels in distilled water maintained at 45°C (109°F). Ratings were made against ASTM D 3359-87¹⁶ to compare the adhesion properties of panels coated with and without PEI. The microtopography of the coatings obtained in the reference

Table 2—Variation of Coating Weight with PEI Concentration

| Concentration of PEI (mg/L) | Coating Weight ^a (g/m ²) | Weight ^a of Iron Dissolved During Phosphating (g/m ²) |
|-----------------------------|---|--|
| 0 | 9.26 ± 0.26 | 7.35 ± 0.31 |
| 50 | 7.90 ± 0.32 | 6.01 ± 0.15 |
| 100 | 7.31 ± 0.14 | 5.77 ± 0.12 |
| 250 | 6.87 ± 0.23 | 5.27 ± 0.27 |
| 500 | 6.46 ± 0.16 | 4.91 ± 0.17 |
| 1000 | 6.51 ± 0.22 | 4.86 ± 0.28 |
| 1500 | 6.48 ± 0.19 | 4.88 ± 0.37 |
| 2000 | 6.23 ± 0.36 | 4.61 ± 0.09 |

(a) Average of five determinations and standard deviations.

bath and in the presence of PEI were examined using a Cambridge Stereoscan 180 scanning electron microscope.

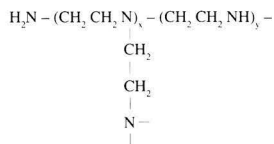
RESULTS AND DISCUSSION

Variation of Coating Weight with PEI Concentration

Representative concentrations of PEI, dissolved in water, were added to the formulated phosphating bath. The coating weight and weight of iron dissolved during phosphating were determined at each concentration of PEI in the bath. These data are presented in *Table 2*. An overview of the data shows that PEI profoundly inhibits coating formation at all concentrations. The decrease in coating weight of PEI-containing baths as related to the reference bath is more significant at concentrations between 50 and 500 mg/L, thereafter no marked decrease in coating weight occurred with the increase of PEI concentrations. The weight of iron dissolved during phosphating also showed a similar trend.

The decrease in coating weight and weight of iron dissolved during phosphating in PEI-containing baths suggest that PEI hinders the phosphate deposition process. Its participation in the coating deposition process is envisaged through its adsorption onto the steel substrate being phosphated.

PEI is a highly branched polymeric amine having primary, secondary and tertiary nitrogens in the ratio 1:2:1,¹⁰ having the structure



where x, y = 1, 2, 3 Due to its ability to behave as a monoacidic base, this polymer is converted into a cationic polyelectrolyte in the acidic phosphating solution (pH = 2.33) by protonation at the amino groups, preferably at the primary amine positions. It may be considered that one-half of the nitrogens in the molecule obtain a charge at the low pH of the phosphating bath.¹⁰ The cationic polyelectrolyte thus formed undergoes preferential adsorption at the cathodic sites of the steel panel being coated. Adsorption to the substrate occurs through the numerous charged nitrogen atoms present on the branched carbon chain of the polymer. Adsorption occurs at more than one cathodic site for every molecule of PEI adsorbed, due to the presence of multiple protonated nitrogen atoms along the carbon backbone. This leads to a strong adsorption of PEI on the exposed steel surface immersed in the phosphating solution. However, adsorption at multiple cathodic points hinders the process of coating deposition, as cathodic sites are also the sites at which phosphate coating deposition occurs. This phenomenon of preferential multipoint adsorption at cathodic sites of the steel specimen being coated results in decreased coating weight when PEI is added to the phosphating bath.

As the concentration of the polymer in the bath is increased from 50-500 mg/L, coating weight decreases due to

Table 3—Variation of Coating Weight with NaNO_2 Concentration

| Concentration of NaNO_2 (g/L) | Reference Bath | | PEI-Containing Bath | |
|--|---|--|---|--|
| | Coating Weight ^a (g/m ²) | Weight ^a of Iron Dissolved During Phosphating (g/m ²) | Coating Weight ^a (g/m ²) | Weight ^a of Iron Dissolved During Phosphating (g/m ²) |
| 0 | 0.89 ± 0.21 | 1.56 ± 0.18 | 0.59 ± 0.27 | 1.01 ± 0.11 |
| 1 | 6.85 ± 0.45 | 10.91 ± 0.49 | 3.59 ± 0.51 | 7.23 ± 0.28 |
| 2 | 9.26 ± 0.26 | 7.35 ± 0.31 | 7.90 ± 0.32 | 6.01 ± 0.15 |
| 3 | 10.72 ± 0.39 | 7.98 ± 0.25 | 9.44 ± 0.61 | 6.37 ± 0.21 |
| 4 | 13.49 ± 0.46 | 9.36 ± 0.10 | 13.12 ± 0.48 | 8.16 ± 0.33 |

(a) Average of five determinations and standard deviations.

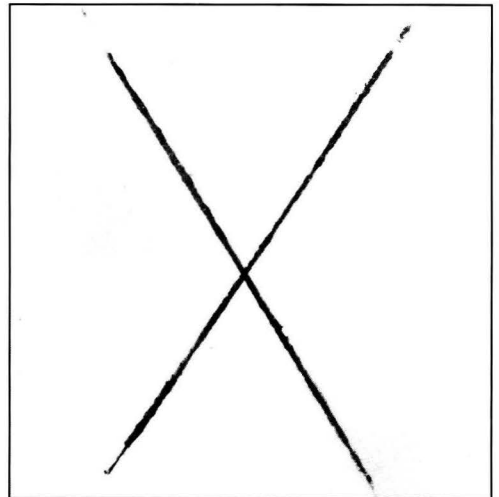
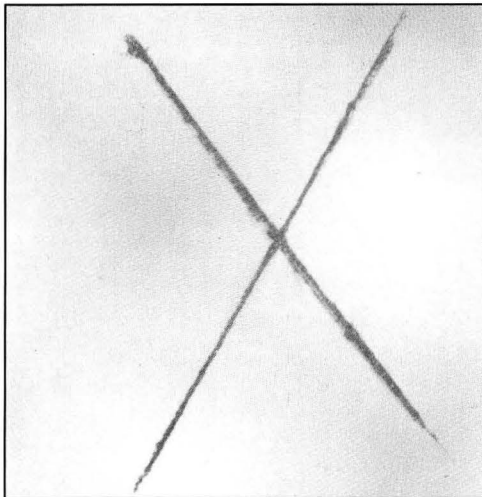


Figure 1—Extent of lateral creepage of rust from scribe after 96 hr of salt spray test, for panels coated in: a—reference bath; b—PEI-containing bath

Table 4—Variation of Coating Weight with Bath pH

| pH of the Bath | Reference Bath | | PEI-Containing Bath | |
|----------------|---|--|---|--|
| | Coating Weight ^a (g/m ²) | Weight ^a of Iron Dissolved During Phosphating (g/m ²) | Coating Weight ^a (g/m ²) | Weight ^a of iron Dissolved During Phosphating (g/m ²) |
| 2.00 | 7.52 ± 0.39 | 10.50 ± 0.41 | 6.78 ± 0.37 | 7.42 ± 0.44 |
| 2.33 | 9.26 ± 0.26 | 7.35 ± 0.31 | 7.90 ± 0.32 | 6.01 ± 0.15 |
| 2.66 | 7.99 ± 0.31 | 5.07 ± 0.54 | 7.31 ± 0.41 | 4.25 ± 0.32 |

(a) Average of five determinations and standard deviations.

Table 5—Physical Properties

| Bath Used | Appearance | Absorption Value* (g/m ²) | Hygroscopicity* (as% of Coating Weight) |
|---|---|---------------------------------------|---|
| Reference bath | Uniform, adherent, grayish-white in color | 11.77 ± 0.08 | 0.11 ± 0.006 |
| Reference bath containing 50 mg/L of PEI | Uniform, adherent, grayish-white in color | 8.60 ± 0.11 | 0.08 ± 0.002 |

(a) Average of six determinations and standard deviations.

increased surface coverage through increased adsorption by the polymer, leading to greater suppression of coating formation. When the concentration of PEI in the bath is increased beyond 500 mg/L, no significant changes in coating weight or weight of iron dissolved during phosphating occurred. This may be regarded as a consequence of saturation of adsorption, due to the limited accessible surface area available for the numerous pendant groups capable of adsorbing even at low concentrations of the additive. It may also be the result of significant repulsive forces due to "nearest neighbor interaction"¹⁷ arising out of the closely situated charged amino groups or significant repulsive forces operating between the highly charged adsorbed PEI and the molecules approaching the interface, at the prevailing low pH of the phosphating bath. The variation of iron dissolved during phosphating is supportive of the proposed behavior of PEI additive in the phosphating bath.

Since uniform coatings of maximum coating weight were obtained at the concentration of 50 mg/L of PEI in the bath, this concentration was chosen as the optimum concentration at which further studies were carried out.

Effect of Variation of Other Bath Parameters on Coating Weight

Within limits of practical operability of the formulated composition, significant bath parameters like accelerator (NaNO₂) content and pH of the bath were varied, at the optimum concentration of PEI. The coating weight and weight of iron dissolved during phosphating were measured at various concentrations of NaNO₂ ranging from 0-4 g/L (Table 3) and in a pH range of 2-2.66 (Table 4).

It is evident from these data that PEI significantly suppressed coating deposition, irrespective of the concentration of accelerator in the bath or its pH (as compared to the reference bath). An expected increase in coating weight and weight of iron dissolved during phosphating occurred as NaNO₂ content in the bath was increased. The inhibitory effect due to adsorbed PEI, however, became less prominent at higher accelerator concentrations. This is because better coating formation, aided by higher concentrations of accelerator in the bath, overrides the less significant effect from adsorption of PEI during phosphating.

It is also seen that both an increase and decrease in pH over that of the optimum caused decreased coating formation. While decreased coating weight at low pH may be related to delayed onset of hydrolytically induced precipitation of tertiary phosphates as a result of higher acid content in the bath, decreased metal attack may be ascribed as the

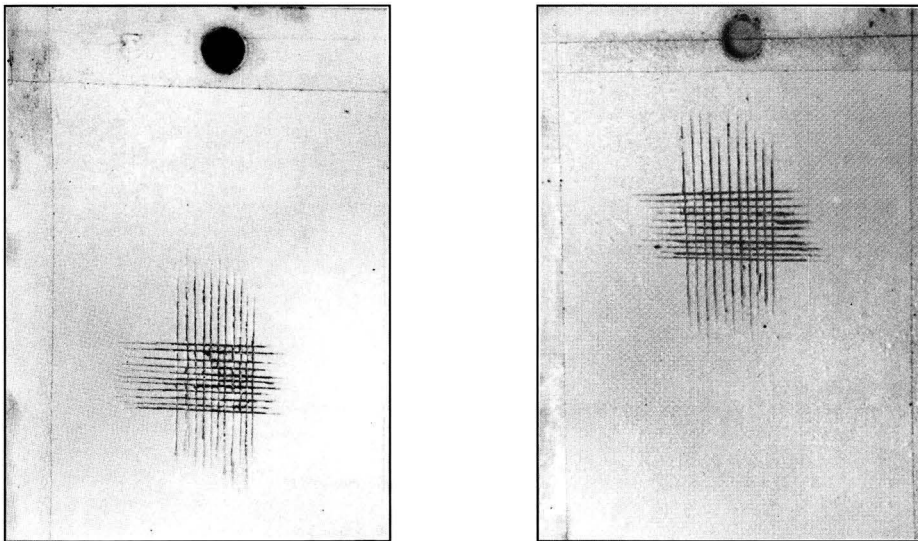


Figure 2—Wet adhesion after 240 hr of immersion in distilled water at 45°C (109°F) for panels coated using: a—reference bath; b—PEI-containing bath

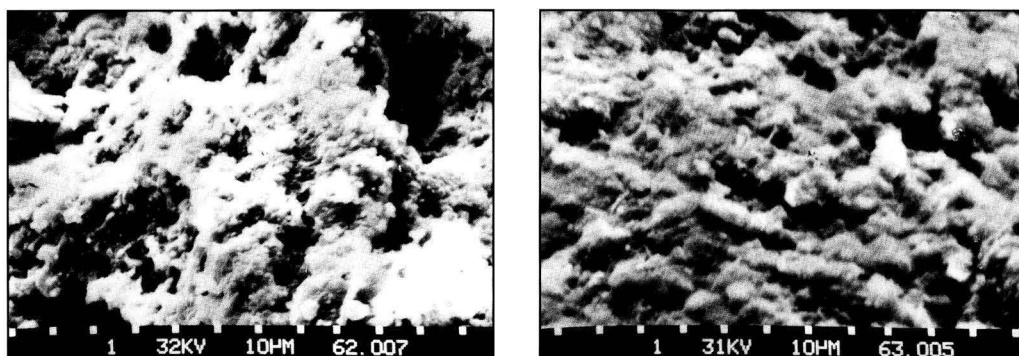


Figure 3—Scanning electron micrographs of coatings obtained in: a—reference bath; b—PEI-containing bath

cause for lower coating weight obtained at high pH. However, in the latter case, earlier attainment of the point of incipient precipitation largely compensates for decreased metal attack, thereby yielding coating weight similar to that obtained at the optimum pH. The values of weight of iron dissolved during phosphating are supportive of these facts.

Significantly high values of the weight of iron dissolved during phosphating are obtained at a concentration of 1 g/L of NaNO_2 (Table 3) and at pH 2 (Table 4) in the formulated baths. This is the result of the fact that at a concentration of accelerator below the optimum, incomplete utilization of NaNO_2 occurs due to its decomposition to form nitrous acid. This in turn increases the acidity of the phosphating bath, prompting further metal dissolution without significantly enhancing coating deposition. Similarly, at low pH, (pH = 2), the excess acidity in the bath favors metal dissolution to coating deposition. In both cases, this results in the formation of a dark brown coloration of the phosphating solution during the processing of steel panels. The poor quality of the coatings and the low conversion ratios obtained under these conditions support these views.

EVALUATION OF PROPERTIES OF THE COATING

The coatings obtained in the presence of the optimum concentration of the PEI were grayish-white in color, adher-

ent, and uniform. The absorption value and hygroscopicity for the reference bath subjected to the chrome rinse and the bath containing PEI are shown in Table 5. The data indicate that despite a decrease in coating weight obtained in the presence of PEI, there is a reduction in porosity and water permeability of these coatings, as compared to the reference bath.

The low porosity associated with PEI-containing baths is correlated to the ability of PEI to form surface films which complement the protective property of the phosphate coating formed on the steel surface, even without a further post rinse. The coatings containing PEI are essentially water repellent due to the long carbon skeletons which project away from the metal surface after the PEI molecule has adsorbed through its charged amine moieties. This reduces the moisture permeability of these coatings and is reflected in the reduced hygroscopicity of panels phosphated in presence of PEI, as compared to the reference bath.

Corrosion Performance and Adhesion

Corrosion performance of panels phosphated in baths with and without PEI were assessed by measuring the weight loss after 24 hr of immersion in 3% NaCl. The weight loss due to corrosion (Table 6) in the panels coated in the presence of PEI were considerably lower than that of the reference bath. Also, it was observed that the NaCl solution showed a red-orange coloration at the end of the test period

Table 6—Corrosion Performance

| Bath Used | Weight Loss ^a in 3% NaCl after 24 hr of Immersion (g/m ²) | Observation after 96 hr of Salt Spray Test | Observation after 168 hr in Humidity Chamber | Rating ^b after Wet Adhesion Test |
|--|--|--|--|---|
| Reference bath | 8.13 ± 0.24 | Minimal lateral rust creepage | No rust spots seen | 3B |
| Reference bath containing 50 mg/L of PEI | 6.56 ± 0.66 | Minimal lateral rust creepage | No rust spots seen | 4B |

(a) Average of 10 determinations and standard deviations.

(b) As per ASTM D.3359-87.

in the case of the reference bath, while no discoloration was observed in the case of panels coated in the presence of PEI, thus indicating the improved performance in the latter case.

Exposure of the panels processed in the reference and PEI-containing baths to 100% relative humidity in a humidity chamber for 168 hr, showed no rust spots (Table 6). There was only minimal lateral creepage of rust from the scribes made on panels phosphated both in the presence and absence of PEI, in a 96 hr salt-spray test (Figures 1a and 1b), indicating good corrosion resistance despite the fact that the lower coating weight was obtained in the case of panels coated in the presence of PEI.

The ratings obtained in the crosshatch test performed on panels coated in the reference and PEI-containing baths (Figures 2a and 2b, Table 6), indicate better adhesion in the latter case. This is explained to be the result of better interaction of the polymeric groups of adsorbed PEI present in the phosphated layer with the paint applied over it; thereby improving the adhesive forces that operate at the phosphate/paint interface. The reported ability of certain polyelectrolytes to retard crystal growth,¹⁸ leading to the formation of fine-grained phosphate coatings is envisaged as an associated factor contributing to improved adhesion at the pretreatment/topcoat interface. This is confirmed from the photomicrographs obtained in the scanning electron microscopic examination of coatings obtained from the reference and PEI-containing baths (Figures 3a and 3b). It is observed that nodular congregations of fine crystallites characterize coatings obtained in the presence of PEI. The coatings obtained from the PEI baths are also less porous and more uniform than those obtained from the reference bath.

SUMMARY

Polyethyleneimine (PEI) inhibits coating formation by adsorption onto the steel panel being subjected to phosphating. Although coating weight is reduced in the presence of PEI as compared to the reference, the coatings obtained were of good quality and performed well under simulated corrosive conditions. Although the conventional chrome post-rinse was avoided, the coatings obtained in the presence of the additive possessed low moisture permeability and were of low porosity, both features resulting from the pore-filling and water-repellent film of PEI formed on phosphate coatings obtained in these baths. This polymeric additive also markedly improved the adhesion of organic topcoats to the pretreated metals.

ACKNOWLEDGMENT

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References

- (1) Freeman, D.B. *Phosphating and Metal Pretreatment*. Woodhead-Faulkner, London, 1986.
- (2) Sankara Narayanan, T.S.N. and Subbaiyan, M., "Influence of Detergent Type Amines on Phosphate Coatings," *Metal Finishing*, 89 (9), 39 (1991).
- (3) Nair, U.B. and Subbaiyan, M., "Influence of 1-Octadecane Thiol on Phosphate Conversion Coatings on Mild Steel," *Trans. Metal Finishers Assoc. India*, 1, 9 (1992).
- (4) Ong, H.W.K., Gan, L.M., and Tan, T.L., "Nickel Activated Phosphating of Cold-Rolled Steel," *J. Adhes.*, 20, 117 (1986).
- (5) Satoh, N. and Minami, T., "Relationship Between the Formation of Zinc Phosphate Crystals and Their Electrochemical Properties," *Surface Coat. Technol.*, 34, 331 (1988).
- (6) Lorin, G., *Phosphating of Metals*. Finishing Publications Ltd., London, 1974.
- (7) Sugama, T., Kukacka, L.E., and Carciello, N., "Nature of Interfacial Interaction Mechanisms Between Polyacrylic Acid Molecules and Oxide Metal Surfaces," *J. Mater. Sci.*, 19, 4045 (1984).
- (8) Sugama, T., Kukacka, L.E., Carciello, N., and Warren, J.B., "Polyacrylic Acid Macromolecule-Complexed Zinc Phosphate Crystal Conversion Coating," *J. Appl. Polymer Sci.*, 30, 4357 (1985).
- (9) Sugama, T., Kukacka, L.E., Carciello, N., and Warren, J.B., "Factors Affecting Improvement in the Flexural Modulus of Polyacrylic Acid-Modified Crystalline Films," *J. Appl. Polymer Sci.*, 32, 3469 (1986).
- (10) Davidson, R.L. and Sitting, M. (Eds.), *Water-Soluble Resins*. Van Nostrand Reinhold Co., New York, 1968.
- (11) Dermer, O.C. and Ham, G.E., *Ethyleneimines and Other Aziridines*. Academic Press Inc., New York, 1969.
- (12) IS:1079, "Hot-Rolled Carbon Steel Sheet and Strip Standard," (4th revision), Bureau of Indian Standards, New Delhi, 1988.
- (13) Preston, R. St.J., Settle, R.H., and Worthington, J.B.L., "Tentative Analytical Tests for Phosphate Coatings on Steel," *J. Iron Steel Inst.*, 170, 19 (1952).
- (14) ASTM B 117-85, "Standard Method of Salt Spray (Fog) Testing," *Annual Book of ASTM Standards*, Vol. 6.01, 19, 1989, American Society for Testing and Materials, Philadelphia, PA.
- (15) IS:101 (Part 6/Sec. 1), 1988, "Methods of Sampling and Test for Paints, Varnishes and Related Products, Part 6: Durability Tests, Section 1: Resistance to Humidity under Conditions of Condensation," Bureau of Indian Standards, New Delhi, 1989.
- (16) ASTM D 3359-87, "Standard Test Methods of Measuring Adhesion by Tape Test," *Annual Book of ASTM Standards*, Vol. 6.01, 507, 1989, American Society for Testing and Materials, Philadelphia, PA.
- (17) Katchalsky, A., Mazur, J., and Spitnik, P., "Polybase Properties of Polyvinylamine," *J. Polymer Sci.*, 23, 53 (1957).
- (18) Amjad, Z., "Constant Composition Study of Crystal Growth of Calcium Fluoride. Influence of Poly (Carboxylic Acids), Polyphosphates, Phosphonates and Phytate," *Langmuir*, 7, 600 (1991).

Society Meetings

BIRMINGHAM JAN.

"That Was 1992"

A moment of silence was observed in memory of R. Wragg, who died recently.

The meeting was highlighted by the presentation of the Kenneth Cooke Memorial Lecture, which was delivered by Moira McMillan, Director of the Paintmakers Association of Great Britain. Mrs. McMillan's topic was "THAT WAS 1992."

The speaker gave an overview of the paint and coatings industry as it exists presently. She stated that for 1992, sales volumes were down, prices were up 2.3%, and costs were up 1.9%. In addition, debtor days increased from 63 to 70, and profits increased by 8.1%. Mrs. McMillan explained that these statistics are typical of what is expected during recessionary times. She continued, stating that the general industrial and automotive refinishing market sectors continue their downward trends, down 10% p.a.; 13% p.a. since 1990. Also, exports have been down over the same period of time in 1991. However, the decorative products sector of the industry moved upward after having suffered through bad times during the summer months.

Mrs. McMillan stated that overall, prices in 1992 held fast despite the increases in costs. She noted that the larger companies recorded stable profits, while smaller companies had lower profits. It also was pointed out that there have not been many, if any, reports of paint companies going out of business.

The speaker talked about the major tasks undertaken by the Paintmakers Association in 1992: legislation, information, collaboration, and representation. Mrs. McMillan spoke on some of the lobbying efforts by the Association on behalf of the paint and coatings industry.

In conclusion, the speaker admitted to covering only a small portion of the Association's operations, and pointed out that they are heavily committed in the area of training.

DAVID C. MORRIS, *Secretary*

CHICAGO JAN.

"Measurement of Color"

Theodore J. Fuhs, of Tru-Test Manufacturing Company, and Chairman of the FSCT's 1992 Annual Meeting and Paint Industries' Show Host Committee, presented Certificates of Appreciation to each of the

Host Subcommittee Chairmen. In attendance to receive their Certificates were: Hospitality Suite Chairman Thomas P. Yates, of United Coatings, Inc.; Information Services Chairman Natu C. Patel, of Ace Hardware Corporation, Paint Division; Program Operations Chairman Karl E. Schmidt, of Premier Coatings; and Registration Area Chairman William W. Fotis, of The Valspar Corporation.

Two Subcommittee Chairmen who were not in attendance to receive their awards were: FSCT Exhibit Chairman Victor M. Willis, of Ace Hardware Corporation, Paint Division; and Spouses' Program Chairman Cynthia Fuhs.

Leo A. Dombrowski, of Gibraltar Chemical Company, announced that the "Course in Coatings Technology," scheduled for January 13-May 16, at DePaul University, was about to commence.

The meeting's technical presentation was given by Brian Teunis, of X-Rite, Inc. His topic was "MEASUREMENT OF COLOR AND APPEARANCE."

He explained the meaning of the designations L a b, L C H, and cmc; the term observer value; and the difference between illuminant and source. Mr. Teunis discussed where the values for color measurement originated, and how observers can use them in creating color tolerances.

In addition, he talked about the use of color measurement software and spectrophotometers. Mr. Teunis said these tools can be used in controlling color tolerances in paints, plastics, and ink applications.

CLIFFORD O. SCHWAHN, *Publicity*

CLEVELAND JAN.

Joint CPCA Meeting

This month was the Annual Joint Meeting of the Society and the Cleveland Paint and Coatings Association.

A moment of silence was observed in memory of Warren J. Bair, who died recently.

The recipient of the Joseph A. Vasta Memorial Scholarship Award of \$2,500, presented to a university on a rotating basis, was Kent State University (KSU). Carl J. Knauss, of KSU, presented the Scholarship to Keith Obermeier, a student in the cooperative program at Wright Air Force Base.

Two guest speakers highlighted the meeting's agenda: Robert F. Ziegler, Executive Vice President of the FSCT, and J. Andrew Doyle, Executive Director of the National Paint and Coatings Association (NPCA).

Mr. Ziegler explained the cooperative efforts between FSCT and NPCA, including the origin of their discussions and where these efforts will lead in the future. It was pointed out that there is some duplication of effort between the organizations. Mr. Ziegler explained what is presently being done by the two groups to eliminate the duplication, thereby fostering a closer working relationship between the two organizations.

In addition, Mr. Ziegler urged the Society to become involved in the Ohio Paint Council, and to set up a line of communication with NPCA.

Mr. Ziegler explained that the mission of the FSCT is the education of its membership and the coatings industry. He discussed some of the tools which have been made available by the FSCT for these purposes. The 1992 Annual Meeting and Paint Industries' Show, held October 21-23, in Chicago, IL, was reviewed.

Mr. Doyle reviewed the working relationship that has existed between FSCT and NPCA for the past few months. He discussed the factors responsible for pushing toward a joint venture, including: financial, a decreasing number of coatings companies, fewer Association members, and a growing budget.

Mr. Doyle talked about the formation of the State Affairs Program (hence the formation of the State Paint Councils), which began in 1989. These State Paint Councils deal with regulatory affairs and legislation.



JANUARY TECHNICAL SPEAKER—Brian Teunis addresses the Chicago Society membership on "Measurement of Color and Appearance"

Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Martins West, Baltimore, MD). HELENE J. RANFONE, Duron, Inc., 10460 Tucker St., Beltsville, MD 20705.

BIRMINGHAM (First Thursday—Strathallan Hotel, Birmingham, England). D.C. MORRIS, PPG Industries (UK) Ltd., P.O. Box 359, Birmingham, B16 0AD, England.

CDIC (Second Monday—Location alternates between Columbus, Cincinnati, Dayton, and Indianapolis). JEFFERY L. BUCHMAN, AKZO Coatings, Inc., P.O. Box 147, Columbus, OH 43216-0147.

CHICAGO (First Monday—Sharko's Restaurant, Villa Park, IL). NATU C. PATEL, Ace Hardware Corp., Paint Div., 21901 S. Central Ave., Matteson, IL 60443.

CLEVELAND (Third Tuesday—Brown Derby, Independence, OH in Nov., Mar., and Apr.; Cleveland Hilton, Cleveland, OH, in Feb.; Landerhaven, Mayfield Heights, OH, in May). CONSTANCE F. WILLIAMS, The Glidden Co., 801 Canterbury Rd., Westlake, OH 44145.

DALLAS (Thursday following second Wednesday—Holiday Inn Crowne Plaza, Dallas, TX). BENNY PUCKETT, Kelly-Moore Paint Co., Inc., 301 W. Hurst Blvd., Hurst, TX 76053.

DETROIT (Second Tuesday—meeting sites vary). JANE ALLEN, Reichhold Chemicals, Inc., 814 Commerce Dr., Oakbrook, IL 60521.

GOLDEN GATE (Monday before third Wednesday—alternates between Francesco's in Oakland, CA, and Holiday Inn in S. San Francisco). RICHARD COOPER, Synergistic Performance Corp., 5801 Christie Ave., #590, Emeryville, CA 94608.

HOUSTON (Second Wednesday—Hobby Airport Hilton, Houston, TX). TOM FITZGERALD, Monarch Paint Co., P.O. Box 55604, Houston, TX 77255.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). LAWRENCE J. MURPHY, Tnemec Co., Inc., 123 W. 23rd Ave., N. Kansas City, MO 64116.

LOS ANGELES (Second Wednesday—Steven's Steakhouse, Commerce, CA). JOHN C. KULNANE, Ameritone Paint Corp., 18414 S. Santa Fe Ave., P.O. Box 190, Long Beach, CA 90801.

LOUISVILLE (Third Wednesday—Executive West Motor Hotel, Louisville, KY). WILLIAM LEIGHTNER, C.L. McGuire & Co., 8134 Newlagrange Rd., Louisville, KY 40222.

MEXICO (Every fifteen days—Gabriel Mancera, Mexico City, Mexico). SERGIO ROJAS, Pinturas International, S.A. De C.V., Ganaderos 234, Col. Granjas Esmeralda, 09810 Mexico, D.F., Mexico.

MONTREAL (First Wednesday—Le Bifithèque Steakhouse, Ville St. Laurent, Quebec). ESTHER ROULEAU MCCARTHY, Stochem Inc., 1455 32nd Ave., Lachine, Que. H8T 3J1, Canada.

NEW ENGLAND (Third Thursday—Sheraton Lexington Hotel, Lexington, MA, and other locations in Massachusetts and Rhode Island). CHARLES SHEARER, ICI Resins US, 730 Main St., Wilmington, MA 01887.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). GEORGE M. AMRICH JR., Benjamin Moore & Co., 134 Lister Ave., Newark, NJ 07105.

NORTHWESTERN (Jax Cafe, Minneapolis, MN). MICHAEL GRIVNA, Hirshfield's Paint Mfg., Inc., 4450 Lyndale Ave. N., Minneapolis, MN 55412.

PACIFIC NORTHWEST (PORTLAND SECTION—Third Tuesday; PUGET SOUND SECTION—Third Wednesday; VANCOUVER SECTION—Third Thursday). JOHN WESTENDORF, Lipscomb Chemical Northwest, 2627 NW Nicolai, Portland, OR 97210.

PHILADELPHIA (Second Thursday—Williamson's Restaurant, GSB Bldg., Bala Cynwyd, PA). ROBERT D. THOMAS, M.A. Bruder & Sons, Inc., 52nd & Grays Ave., Philadelphia, PA 19143.

PIEDMONT (Third Wednesday—Ramada Inn Airport, Greensboro, NC). DALE BAKER, Kohl Marketing, Inc., 3859 Battleground Ave., Ste. 203, Greensboro, NC 27410.

PITTSBURGH (Second Monday—Montemurro's Restaurant, Sharpsburg, PA). MARK A. HARLEY JR., PPG Industries, Inc., 4325 Rosanna Dr., P.O. Box 9, Allison Park, PA 15101.

ROCKY MOUNTAIN (Monday following first Wednesday—Zangs Brewery, Denver, CO). CHRISTINE LES-CAMELA, Luzenac America, Inc., 8985 E. Nichols Ave., Englewood CO 80112.

ST. LOUIS (Third Tuesday—Salad Bowl Cafeteria, St. Louis, MO). CHUCK REITTER, American Paint Journal Co., 2911 Washington Ave., St. Louis, MO 63103.

SOUTHERN (GULF COAST SECTION—third Thursday; CENTRAL FLORIDA SECTION—third Thursday after first Monday; ATLANTA SECTION—third Thursday; MEMPHIS SECTION—bi-monthly on second Tuesday; and MIAMI SECTION—Tuesday prior to Central Florida Section). JEFF SHUBERT, Shubert Paints, Inc., 2157 Mountain Industrial Blvd., Tucker, GA 30084.

TORONTO (Second Monday—Cambridge Motor Hotel, Toronto). BOB C. NG, Hoechst Canada Inc., 100 Tempo Ave., Willowdale, Ont. M2H 2N8, Canada.

WESTERN NEW YORK (Third Tuesday—meeting sites vary). MARKO MARKOFF, 182 Farmingdale Rd., Cheektowaga, NY 14225.

and will, or have, contracted with lobbyists to represent the Councils.

The joint MSDS CD-ROM Technology project was discussed.

In conclusion, Mr. Doyle stated that the difference between FSCT and NPCA today versus 20 years ago is a willingness to listen to each other and to try to work together.

To summarize the cooperative efforts between the groups, Mr. Ziegler said that seats on the respected groups' Boards of Directors have been exchanged to ensure smooth relationships of the two organizations.

Q. What is the current membership in each organization?

A. FSCT is comprised of 7,200 members belonging to 26 Constituent Societies in the U.S., Canada, Great Britain, and Mexico. NPCA has 500 corporate members, including 350 manufacturers, 125 raw material suppliers, and 25 distributors.

Q. There are 70 small paint companies in the Cleveland area, some who cannot afford the NPCA dues. Does the NPCA Board plan to restructure its dues in the near future?

A. The NPCA constantly reviews its dues, but there are no plans to lower dues. The dues were increased a few years ago, from \$500-\$800-\$1,500. Dues currently are \$1,600+/- \$50 and it costs NPCA much more than \$1,600 to service a company, regardless of its size. J.P. Walton created a 1-2-3 Program, where a company that has never been a member, or has not belonged for at least five years, can join NPCA for 1/3 the price (\$500) for the first year, 2/3 the price (\$1,000) the second year, and the full amount (\$1,600) the third year. This gives a small company an opportunity to join the NPCA at a reduced cost so they can learn about all the NPCA has to offer a company.

CONSTANCE F. WILLIAMS, Secretary

HOUSTON JAN.

"Effects of Metal Sulfonates"

Guy Sullaway, of International Paint Company, was nominated for Society Treasurer for the 1993-94 year. No nominations were received from the floor, so the membership voted to close the nominations for that position.

The meeting's technical presentation was given by New York Society member Rudy Berndlmaier, of King Industries, Inc. His topic of discussion was "EFFECTS OF METAL SULFONATES ON CORROSION RESISTANCE AND OTHER PROPERTIES."

The speaker explained the essential elements for corrosion: anode, cathode, electrolyte, and conductor. Also, the mechanism of corrosion was examined.



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- GG Educational Institution/Library
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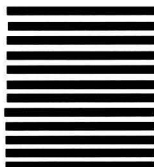
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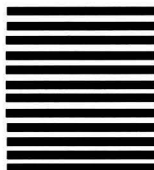
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In conclusion, Mr. Berndmaier stated that the use of metal sulfonates can enhance the corrosion resistance of coatings

Q. Metal sulfonates are used as corrosion inhibitors in grease and oil and have not been used much in coatings because of their tendency to soften the film. Did you notice any softening of the films with these?

A. No. The slides shown which presented the formulae tested also listed the hardness. The hardness was within acceptable levels. If one overloaded the coating with these products, it is possible that the film would be softened. Also, the type of metal used in the salt has an effect.

Q. Can these products be used in latex systems and are you giving guidance on such use?

A. The latex should contain amine and coalescent. Amine and coalescent should be added to the material (metal sulfonate) also. The pH of the finished product should be 9 max. The salts should be incorporated into the vortex of the mix. It is easiest to post-add these products.

THOMAS W. FITZGERALD, *Secretary*

KANSAS CITYJAN.

Federation Officer Visit

FSCT President Colin D. Penny, of Kapsulkote, Inc., and Executive Vice President Robert F. Ziegler, were the meeting's featured speakers.

Mr. Penny addressed the working relationship between FSCT and the National Paint and Coatings Association (NPCA).

Mr. Ziegler summarized the activities of FSCT, with particular attention to the upcoming 1993 Annual Meeting and Paint Industries' Show, October 27-29, in Atlanta, GA. Also discussed were: Spring Week 1993, on May 16-19, in Houston, TX; Professional Development Committee sponsored programs; Regulatory UPDATE insert in the JOURNAL OF COATINGS TECHNOLOGY; Coatings Industry Education Fund; and FSCT-NPCA areas of cooperation.

LAWRENCE J. MURPHY, *Secretary*

LOS ANGELESJAN.

"Weathering Tests"

Environmental Committee Chairman Dave Muggee, of E.T. Horn Company, reported on a number of regulatory issues.

The first item discussed was Proposition 65 and the new rules concerning toxicant listing and safe harbor provisions which are being considered for change again.

Also, the Department of Transportation is proposing the use of breath testing for alcohol. Mr. Muggee said that according to



HOST COMMITTEE CHAIRMEN—Theodore J. Fuhs (center), Chairman of the 1992 Host Committee, presents Certificates of Appreciation to the Subcommittee Chairmen for their efforts during last year's Annual Meeting and Paint Show held in Chicago. In attendance to receive their awards are (from left): Natu C. Patel, Karl E. Schmidt, Fuhs, Thomas P. Yates, and William W. Fotis

the proposed rules, workers tested for alcohol would be barred from performing safety sensitive tasks if test results showed a blood/alcohol level of 0.02% or greater. Also included in the proposal are provisions for pre-employment, post accident, reasonable suspicion, return to duty, and follow up testing.

The final topic was the Toxic Substances Control Act (TOSCA) Statute of Limitations. Mr. Muggee stated that a federal appeals court rejected a hazardous waste firm's request to review an administrative ruling that found there is no statute of limitations to govern when the EPA must file enforcement actions for alleged violations of TOSCA.

The technical speaker was Robert K. Lattie, of Atlas Electric Devices Company, who spoke on "WEATHERING TESTS AND COATINGS: HOW FAST AND HOW MEANINGFUL." Mr. Lattie is a member of the Chicago Society.

The speaker emphasized the need for accelerated testing in light of the need for shorter development time for products.

According to Mr. Lattie, the only meaningful environment for tests is the customer's environment, that is, the one that produced the coating failure. He said that often south Florida is used as a benchmark exposure site. However, Atlas operates sites in Florida, Arizona, Illinois (Chicago), New Jersey, Kentucky, the Netherlands, and south France. In addition to geographic location, it was pointed out that test panels are exposed at different angles to the sun, as well as, under glass or openly exposed.

The speaker compared UV spectral curves in an attempt to match actual Florida sunlight by the use of various UV lamps.

Various methods of tracking the sun were discussed.

Q. To speed up the xenon arc weathering, couldn't you merely heat up the chamber as hot as possible to accelerate reactivity?

A. Tests by General Electric found that 60-80 times the light was possible, but

without the thermal component. When the heat and light were applied, the results were found to correlate well with actual exposure. The chamber is heated to speed up reactivity. A weathering test for plastic for automotive application generally is heated up to 63°C for interior automotive parts, and 47°C for exterior parts.

JOHN C. KULNANE, *Secretary*

LOUISVILLENOV.

"Controlling Biological Contamination"

It was announced that Larry F. Pitchford, of Reynolds Metal Company, has been elected to serve as the Society Representative to the FSCT's Board of Directors.

FSCT Secretary-Treasurer John A. Lanning, of Courtaulds Coatings, Inc., discussed the Fall Meeting of the Board of Directors which took place October 20, 1992, in Chicago, IL. Mr. Lanning also talked about the working relationship between FSCT and the National Paint and Coatings Association.

Kris J. Grauer, of Ashland Chemical Company, reminded the membership about the April 21-23 Spring Meeting, to be held in conjunction with the Southern Society Annual Meeting, at the Opryland Hotel, in Nashville, TN. The theme of this year's symposium is "Water Based and Waterborne Technology of the 90s."

William Machemer presented a talk on "CONTROLLING BIOLOGICAL CONTAMINATION IN COATINGS MANUFACTURING PROCESSES."

The speaker spoke about microorganisms and how they can get into a plant. The problems they can cause were examined: viscosity loss, putrefaction, popping gas, and visible growth.

Mr. Machemer discussed how to evaluate in-can preservatives and the keys to an effective preservative program.

WILLIAM LEIGHTNER, *Secretary*

MONTREALJAN.

"Coatings for Wood Substrates"

A talk on "COATINGS FOR WOOD SUBSTRATES" was given by Dominique Janssens, of the Canadian Wood Council.

The speaker discussed the various properties of wood and the effect they have on choosing the ideal type of coating(s). Some of the important properties of wood include: dimensional stability, density, resin content, and moisture content.

Q. Is there a "moisture spec" for construction wood products?

A. Yes, 19% max, but it is difficult to enforce and control at job sites. Moisture pickup due to storage conditions often means higher moisture content. The best wood is exported. Sixty percent goes to the U.S. The wood is wrapped and must pass inspection by the customer.

Q. You said that latex is the best paint for exterior wood but that wood should be below 19% moisture to paint. Isn't this a contradiction?

A. No, it's still better to have a low moisture content before painting. In fact, in very humid climates, such as in the southern U.S., paint is not recommended. Opaque/preservative stains would be the preferred choice.

JASON G. HART

NEW YORKJAN.

"Opaque Polymer"

Technical Committee Chairman Larry Waelde, of Troy Corporation, announced that the Society symposium on "Recent Advances in Additives and Modifiers for Coatings," is scheduled for May 4-5, at the Holiday Inn, in Newark, NJ.

Also, the committee has completed its research on the paper "Silicon Additives for High Solids Coatings."

Environmental Committee Chairman Alfred A. Sarnotsky, of Spraylat Corporation, reported that the New Jersey Health Inspectors have not found anything major wrong with the paint plants that already have been inspected. He noted that most of the laboratory complaints were in peripheral areas. These areas included the boiler

room, laboratories, maintenance, and quality control areas.

Sidney J. Rubin, of Empire State Varnish Company, Inc., announced that if anyone is interested in attending the HM181 Seminar they should contact Mildred Leonard at the Society office.

A technical presentation on "OPAQUE POLYMER: THE ALL-PURPOSE PIGMENT" was delivered by Elmer Williams, of Rohm and Haas Company.

The speaker described the opaque polymer as an "all purpose pigment" because it scatters light, is not a film former, and, if used at high enough levels, flattens paint. He also noted that the opaque polymer is a synthetic pigment, which means that it can control the void diameters very closely, thus giving good quality control on the raw material.

Mr. Williams stated that by using the opaque polymer efficiently in high PVC paints, there is no loss of resistance properties. The opaque polymer can be used in semi-gloss paints, exterior paints, and flat paints.

In conclusion, the speaker noted that the most important thing that the opaque polymer does "is allow you to optimize hiding and cost performance of any paint formulation."

Q. Have you run burnishing tests on paints made with and without the opaque polymer?

A. Yes, tests have been run. In high PVC paints there might be a problem due to a lack of fine tuning in the formula. If the formula is optimized there should not be a problem with burnishing.

Q. How does UV affect the opaque polymer?

A. It is not affected by UV because it does not absorb UV.

GEORGE M. AMRICH JR., *Secretary*

NORTHWESTERNJAN.

Manufacturing Meeting

The meeting's first speaker was Becky Butler, of BYK-Gardner, Inc., who gave a talk on "FUNDAMENTALS OF THE DISPERSION PROCESS AND CHARACTERIZATION OF COATING MATERIALS USING DIFFERENT TYPES OF DISPERSION EQUIPMENT."

The speaker opened the presentation by defining dispersion as the complete wetting of pigments and their even distribution in the surrounding vehicle. She went on to say that the dispersion process involves the breakdown of associated particles into smaller particles and their distribution in a fluid, leading to a colloidal suspension. The object of dispersion is to produce a colloidal

system with pigment particles in the range of 0.05-0.5 microns.

Ms. Butler said that pigments can be divided into three categories: primary particles, aggregates, and agglomerates.

The speaker described the dispersion process, and the equipment used to create dispersions.

The second speaker on the agenda was Bob Borner, of the St. Croix Valley Sky Divers, who spoke about the sport of sky diving.

Mr. Borner talked about the history of sky diving, the equipment needed for this activity, the competition available for sky divers, and the training necessary to obtain a sky diving license.

MICHAEL GRIVNA, *Secretary*

PHILADELPHIA JAN.

Joint PPCA Meeting

This month was the Annual Joint Meeting with the Philadelphia Paint and Coatings Association.

The meeting featured Ian C. James, of Du Pont Company. Mr. James is responsible for monitoring economic and political developments and trends throughout the world.

The speaker stated that the past recession ended officially in March of 1991. However, he did note that the recovery has been "subpar." Mr. James compared the various aspects of the current recovery period with the recoveries from previous recessions. His personal feeling was that the media impact (both print and television) accounted for some of the erratic recovery.

According to the speaker, the inauguration of President Clinton will have "no impact whatsoever" on the economy during 1993. He said this is due primarily to the gestation period and processes of Washington, D.C.

Mr. James indicated that 1993 will be more positive than 1992, and that paints and coatings can expect a four to five percent volume growth this year. Also, it was pointed out that housing starts were up about two percent for 1992, and he predicted about three percent inflation for 1993 and 1994.

In conclusion, Mr. James commented that the U.S. is on the brink of becoming the major manufacturing nation in the world. He said that the return to average rates of growth for the 90s are expected.

Q. How do you feel about the deficit?

A. For the short term we are okay. However, some forecasters have shown that unless we begin to control spending by the government, there is disaster ahead in the next century.

ROBERT D. THOMAS, *Secretary*

Advertise in the JCT, and invest in the future of your company.

For more details, contact Samuel M. Amicone, Marketing Coordinator, FSCT, 492 Norristown Rd., Blue Bell, PA 19422; (215) 940-0777.

Future Society Meetings

Baltimore

(Apr. 15)—Educational Committee. Nominations.

(May 20)—Manufacturing Committee. Elections.

Birmingham

(May 6)—64th Annual General Meeting.

CDIC

(May 10)—Speaker to be announced, King Industries, Inc.

Chicago

(May 7)—Annual Awards Banquet.

Cleveland

(Apr. 20)—“CARBON BLACK MICRODISPERSION—EFFECT ON JETNESS AND UNDERTONE IN COATINGS”—Jerry Rogers, Columbian Chemicals.

(May 18)—To be announced—Richard Ressemeyer, Intermuseum Conservatory.

Dallas

(Apr. 15)—“COMPLYING WITH EMISSIONS REGULATIONS—A RAW MATERIAL SUPPLIERS’ VIEW”—Daniel N. King, Exxon Chemical Company.

(May 13)—“COLOR PERCEPTION AND MEASUREMENT”—Romesh Kumar, Hoechst Celanese Corporation.

Detroit

(Apr. 13)—“EFFECT OF ENVIRONMENTAL REGULATIONS ON PIGMENTATION OPTIONS FOR THE COATINGS INDUSTRY”—Jim King, Du Pont Company.

(Apr. 27)—“18th Annual FOCUS” Conference. University of Detroit/Mercy.

(May 11)—Joint DSCT/DPCA Meeting. “ENVIRONMENTAL ISSUES.”

Golden Gate

(Apr. 19)—“THE FOAM STORY”—Jay W. Adams, Tego Chemie.

(May 17)—“STATISTICAL DESIGN IN HIGH SOLIDS POLYURETHANE COATINGS”—Sherri L. Bassner, Air Products and Chemicals, Inc.

(June 14)—Manufacturing Committee Seminar.

Houston

(Apr. 14)—“COMPLYING WITH EMISSIONS REGULATIONS—A RAW MATERIAL SUPPLIERS’ VIEW”—Daniel N. King, Exxon Chemical Company.

(May 12)—“COLOR PERCEPTION AND MEASUREMENT”—Romesh Kumar, Hoechst Celanese Corporation.

Montreal

(May 5)—Past-Presidents’ Night. Manufacturing Committee Presentation—Gerard Paradis, BASF Canada.

New England

(May 25-26)—Tech Expo ’93. Sheraton Tara, Danvers, MA.

New York

(Apr. 13)—“MODERN TRENDS IN ORGANIC PIGMENT TECHNOLOGY”—Hugh M. Smith, Sun Chemical.

(May 11)—PaVaC Meeting. To be announced—Frank Jones, Eastern Michigan University.

Philadelphia

(Apr. 16)—Awards Night Dinner Dance.

(Mar. 11)—“FILTERING THOSE DIFFICULT HIGH SOLIDS PAINTS”—Pete Scovic, Ronnigen Petter.

(May 13)—Manufacturing Committee Presentation. “ISO 9000”—Speaker to be announced.

Pittsburgh

(Apr. 13)—Environmental Symposium. “AN ENVIRONMENT RESPONSIBLE 90s.” Airport Marriott, Pittsburgh, PA.

(May 10)—“PSYCHOLOGY OF COLOR”—Andrea Piontelc, PPG Industries, Inc.

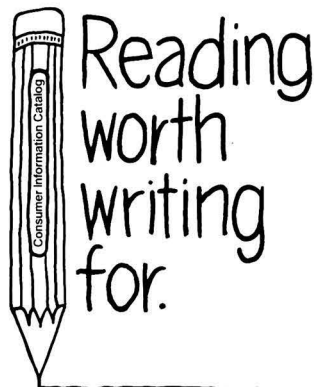
St. Louis

(May 18)—“PIGMENTS FOR HIGH SOLIDS AND WATER BORNE COATINGS”—Speaker from CIBA-GEIGY.

(June 4-5)—Joint Meeting with Kansas City Society. Holiday Inn, Lake of the Ozarks, MO.

Southern

(Apr. 21-23)—Annual Meeting. “WATERBORNE COATINGS—RIDING THE WAVE TO THE FUTURE.” Opryland Hotel, Nashville, TN.



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Elections

BIRMINGHAM

Associate

Robins, Michael L.—Ciba Polymers, Cambridge, Cams.

CHICAGO

Active

Ankele, Bruce E.—Tru-Test Manufacturing Co., Cary, IL.
Blast, Daniel B.—Moline Paint Manufacturing Co., Moline, IL.
Hubert, James F.—National Starch & Chemical Co., Oak Creek, WI.
McBee, James H.—Akzo Coatings Inc., Zion, IL.
Tikusis, Daniel J.—Morton International, Woodstock, IL.
Wille, Steven L.—Morton International, Woodstock.

Associate

Rodgers, Suzanne M.—BYK-Chemie USA, Roselle, IL.
Snedeker, Kathy B.—Sun Chemical Pigments, Chicago, IL.

CLEVELAND

Active

Aloye, James A.—The Glidden Co., Strongsville, OH.
Armstrong, Scott H.—Inorganic Coatings, Cleveland, OH.
Bulter, Kurt—Premix Inc., North Kingsville, OH.
Hahn, Lisa M.—Flexo Inc., Newbury, OH.
Hill, Mary L.—The Sherwin-Williams Co., Cleveland.
Ledvina, Edward A.—The Sherwin-Williams Co., Cleveland.
Patel, Sohini—The Sherwin-Williams Co., Cleveland.
Pizem, Catherine A.—The Sherwin-Williams Co., Cleveland.

Associate

Grayer, Gerren S.—Monsanto Co., Akron, OH.
Roether, Dan—North Pak, Macedonia, OH.
Solomon, John S.—B.F. Goodrich Co., Bay Village, OH.

Retired

Dreka, George B.—Cleveland Heights, OH.

DETROIT

Active

Cabell, Aloys III—Morton Automotive, Detroit, MI.
Kaczmarek, James P.—Akzo Coatings Inc., Troy, MI.
Kuhn, Kevin B.—Parker + Amchem, Madison Heights, MI.

Associate

Golota, Mary E.—Brooks & Kushman, Southfield, MI.

Schuld, Keith J.—Miles Inc., Farmington Hills, MI.

Educator/Student

Xiao, Han X.—University of Detroit-Mercy, Detroit, MI.

NORTHWESTERN

Active

Holtan, Ronald C.—Diamond Vogel Paints, Orange City, IA.
Kime, Daniel A.—Cargill, Inc., Wayzata, MN.
Puetz, Robert C.—Larson-Juhl, Ashland, WI.

Retired

Haering, Jim A.—Waconia, MN.
Olson, Morris R.—Minnetonka, MN.

PIEDMONT

Active

Davis, Randi M.—MAS, Raleigh, NC.
Dilldine, Timothy L.—Akzo Coatings Inc., High Point, NC.
Givens, Steven P.—Rhône-Poulenc Inc., Gastonia, NC.
Mohal, Brij R.—The Sherwin-Williams Co., Greensboro, NC.
Taylor, Bhupendra P.—NC Department of Correction, Smithfield, NC.

Richmond, Dale L.—Air Products & Chemicals Co., Allentown, PA.

Associate

Arkin, Kathryn P.—Union Carbide OSI, Charlotte, NC.
Velazquez, Marc S.—Kemet Electronics, Shelby, NC.

ST. LOUIS

Active

Kohlmiller, Randy—Kop-Coat, Inc., St. Louis, MO.

TORONTO

Active

Fisk, Ron G.—Owens Corning, Agincourt, Ont.
Ghali, Guirguis, Mary—Korzite Coatings Inc., Guelph, Ont.
Lum Shue Chan, Ronald F.—Korzite Coatings, Inc., Cambridge, Ont.
Madeira, Daryl J.—Madison Chemical, Milton, Ont.

Associate

Humby, Michael J.—Eastman Chemical Co., Markham, Ont.
Webber, Glenn R.—Anachemia Solvent Ltd., Mississauga, Ont.

Special Issue Schedule JOURNAL OF COATINGS TECHNOLOGY

September '93—Pre-Paint Show Issue

The first official listing of the Preliminary Program of Technical Sessions is featured along with the floor plan of show exhibitors, registration forms, hotel information, as well as general show information.

October '93—Paint Show Issue

This special Annual Meeting and Paint Show issue, which is distributed at the show in addition to our regular circulation, contains Abstracts of Papers to be presented; the final Program of Technical Sessions; information on all exhibitors, with emphasis on exhibitor products and special booth features; floor plan of show exhibitors; an alphabetical list of exhibitors and their booth number; a list of exhibitors classified by product/service categories; and general show/meeting information.

January '94—Annual Meeting and Paint Show Wrap-up Issue

The wrap-up issue features photo displays of award-winning booths, and a complete review of important Annual Meeting and Paint Show happenings.

For more information, contact
JOURNAL OF COATINGS TECHNOLOGY,
492 Norristown Rd., Blue Bell, PA 19422
Phone: (215) 940-0777 • FAX: (215) 940-0292



People

The position of Director of Marketing for Liquid Carbonic International, Chicago, IL, has been accepted by **Dennis Peavler**. In this position, Mr. Peavler will be responsible for developing industrial and medical gas sales programs for the company's overseas markets.

As part of The Dow Chemical Company's ongoing restructuring, **Enrique J. Sosa**, President, Dow North America, announced the formation of the Dow Plastics management group of Dow North America, consisting of six vice presidents. Four newly appointed vice presidents of Dow Plastics for Dow North America are: **J.L. (Jim) Borin**—Engineering Thermoplastics; **E.F. (Ed) Gambrell**—Olefins & Styrenics; **W.R. (Bill) Long**—Polyurethanes & Epoxies; and **E.W. (Ed) Rogers**—Fabricated Products.

The two additional members of the Dow Plastics management group with responsibilities for North America are: **R.E. (Dick) Sosville**—Vice President/Sales and Marketing for Dow Plastics and Chemicals & Performance Products; and **L.D. (Dennis) McKeever**—Vice President and Director of Research and Development.

Conrad Zhang has joined the Environmental Products Group of Johnson Matthey's Catalytic Systems Division, Wayne, PA, as a Senior Chemist. In this capacity, Mr. Zhang will be responsible for



C. Zhang

the development of new catalysts for controlling VOCs, air toxics, NOx, and CO emissions. He comes to Johnson Matthey after having worked for four years at Northwestern University's Catalysis Center in Evanston, IL.

Gerald W. Gruber has been named Director of Research and Development for PPG Industries' Chemicals Group, Monroeville, PA. He succeeds **Paritosh M. Chakrabarti**, who has been promoted to Corporate Vice President/Science and Technology. Having been with the company since 1971, Dr. Gruber most recently served as Director of Technology/Automotive Products, for PPG's Coatings & Resins Group, in Cleveland, OH.

SC Johnson Polymer, Racine, WI, has appointed **Wayne L. Franzen** as Senior District Accounts Manager/Coatings, for the eastern Michigan, northern Ohio, and western Pennsylvania regions. He will be located in the company's Cleveland, OH office and will be accountable for the direct sales coverage and technical assistance for the architectural and industrial coatings products. Mr. Franzen is a member of the Cleveland, Detroit, and Pittsburgh Societies.



W.L. Franzen

In addition, **David G. Solt** has been named District Accounts Manager, specializing in the technical support and sales of SC Johnson Polymer's coatings line in the western region. Mr. Solt will be located in Irvine, CA, and will provide sales coverage in the states of Arizona, southern California, Idaho, and Washington.



D.G. Solt

Degussa Corporation, Ridgefield Park, NJ, has announced that **John L. Medina** has accepted the position of Executive Vice President/Pigment Group. Mr. Medina joined Degussa in 1980 and has served in marketing and product management related positions in the feed additives, peroxygen chemicals, and cyanide derivatives product areas. Prior to this promotion he was Vice President and General Manager of the Industrial Chemicals Division within Degussa's Chemical Group.

Flint Ink Corporation has named **Leonard A. Walle** to the position of Director of Marketing. Mr. Walle will direct the overall marketing strategy for the corporation.

Ivan Garat has accepted the position of Area Sales Manager for Canada for Datacolor International, Lawrenceville, NJ. In his new position, Mr. Garat will oversee regional field sales representatives and coordinate in-depth customer applications and technical support services. He previously served as the company's Senior Technical Sales Representative in Canada.

Colorgen Industrial Group Inc., Newburyport, MA, has appointed **Michael A. Hammel** as Director of Sales with responsibilities for the company's markets in the U.S., Canada, and South America. Mr. Hammel bring 24 years of experience in various sales and marketing management positions in the electro-optical and testing instrumentation industries to this position.

Malcolm R. Proctor has joined the staff of the Research and Development Department of Sannor Industries, Inc., Leominster, MA. Mr. Proctor will work closely with **Jeffrey Blaisdell**, Assistant Director of Research and Development, in expanding the company's activities in the development and applications of urethane polymers as well as associated areas.

The National Decorating Products Association, St. Louis, MO, has elected **Bent Andersen**, owner of Andersen's Decorating Center, in Lomita, CA, President, and **Jim MacDonald**, owner of Ramey's, Inc., in Wanatchee, WA, Vice President of the Western Decorating Products Association.

Obituary

Herman W. Zeissler, retired from Cowman-Campbell Paint Company, died December 16, 1992. He was 89 years old.

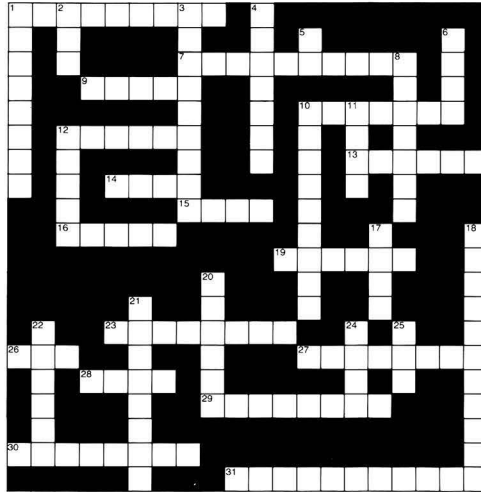
Mr. Zeissler graduated from the North Dakota State University School of Polymer Coatings in 1929. He then joined Du Pont in Chicago, IL. After 13 years with Du Pont, Mr. Zeissler joined the Cowman-Campbell Paint Company, in Seattle, WA, as Technical Director and Partner.

He was the first elected President of the Pacific Northwest Society, which he helped form, in 1947-48. Mr. Zeissler continued to be active in the Society until his retirement in 1968.

Mr. Zeissler is survived by two daughters, a daughter-in-law, seven grandchildren, and eight great-grandchildren.

CrossLinks

by Earl Hill



Solution
to be
Published in
May Issue

No. 53

ACROSS

1. Coating thixotropy (2 words) F_____
7. Kind of mixer blade (2 words)
9. Polymer cold flow (Rheol.)
10. Adhesive type (2 words)
12. One kind of roller on a rotary printing press
13. Word with spray
14. William Jay _____; "Father of Chemurgy," who patented processes for the manufacture of phenol, aniline, and other pigment-starting materials
15. What is the oxide of element no. 26 called?
16. A type of wear or abrasion test
19. Whirlpool; eddy (Syn.)
23. Wooden wall paneling; Dado (Syn.)

26. Carbon _____, tetrachloromethane for short
27. Follower of advertising
28. Which metal is used in the galvanization of iron?
29. A gloss category
30. Speed (Syn.)
31. What remains after you remove the volatile component of a paint? (2 words)

DOWN

1. Coating defect (2 words)
2. Math term; bump on a _____
3. Equipment used to disperse particles in a homogenous medium
4. A paint especially used for murals
5. Pound (Abr.)
6. What is the word for "undiluted" when referring to liquid chemicals?
8. A green color
10. Said of some chemical materials
11. A mistake made in the office
12. Short for turpentine
17. Government controls, for short
18. Materials used to reduce the quality of a standard
20. Yet another gloss category
21. Type of element no. 26 used in recording tape
22. Unit of color difference (2 words)
24. Paintbrush or screwdriver, e.g.
25. _noop _ardness _umber

Gordon Research Conference Releases Agenda For Coatings and Films Program, on August 2-6

The final program agenda for the biennial Gordon Research Conference on the "Chemistry and Physics of Coatings and Films," scheduled for August 2-6, 1993, at Colby-Sawyer College, in New London, NH, has been released.

The Gordon Research Conference offers an opportunity for coatings and films scientists to meet and discuss the current cutting edge topics in the science and technology of coatings and films.

Serving as the Chairman of the event is Anne K. St. Clair, of NASA Langley Research Center. Assisting Ms. St. Clair is Charles E. Hoyle, of the University of Southern Mississippi, Department of Polymer Science.

The schedule of presentations for the program includes:

"Rheological Properties of Different Viscoelastic Surfactant Solutions: Systems With and Without a Yield Stress Value"—Heinz Hoffman, of Universitat Bayreuth;

"Microstructures in Aqueous Solutions of Dimeric and Polymeric Amphiphiles"—Raoul Zana, of Institut Charles Sadron;

"Polyethylene Films for Long Duration Balloons"—Ian Harrison, of Pennsylvania State University;

"Transport in Stiff Chain Polymeric Films and Coatings: The Next Generation of Barrier Films and Ultraporous Membranes"—Hal Hopfenberg, of North Carolina State University;

"Orientation and Relaxation in Second Order Nonlinear Optical Polymers"—Dave Williams, of Eastman Kodak Company;

"Recent Developments in Nonlinear Optic and Electro-Optic Polymer Films"—Joe Perry, of Jet Propulsion Laboratory;

"Chemiluminescence Methods for Studying the Environmental Performance of Films and Coatings"—Graeme George, of The University of Queensland;

"Electrical Properties of Semicrystalline High Performance Polymers"—Peggy Cebe, of Massachusetts Institute of Technology;

"Theoretical Models for Polymer Films: Predictions for Controlling Interfacial Properties"—Anna Balazs, of University of Pittsburgh;

"Determination of Stress State and Adhesion in Polymeric Coatings"—Dick Farris, of University of Massachusetts;

"Characterization of the Molecular Structure of the Interphase in Thin Polymer Films and in Polymer Coatings on Metal

Substrates"—Jim Wightman, of Virginia Polytechnic Institute and State University;

"Electronic Transport in Polymer Films"—Martin Abkowitz, of Xerox Corporation;

"Electroactive Polymer Films—Ferroelectric, Piezoelectric, and Electrostrictive Properties"—Jerry Scheinbeim, of Rutgers University;

"Conductive Polymers as Anticorrosion Coatings"—Brian Benicewicz, of Los Alamos National Laboratory;

"Stealth Design of the F-117A Fighter"—Alan Brown, retired, Lockheed Corporation;

"High-Performance Water-Based, Anti-Stick Coating Systems"—Don Schmidt, of The Dow Chemical Company; and

"Numerical Simulation of Coatings Flows"—Richard Eley, of The Glidden Company.

In addition to the technical sessions, a Poster Session has been scheduled.

Admission is by application only, and attendance is limited to 135 attendees. To obtain an application form, contact Ms. St. Clair, Head, Advanced Aircraft Program Office, Materials Div., NASA Langley Research Center, Mail Stop 227, Hampton, VA 23681-0001.

New York Society to Host Symposium, May 4-5, On Advances in Additives and Modifiers

The New York Society for Coatings Technology will sponsor a symposium on "Recent Advances in Additives & Modifiers for Coatings," on May 4-5, 1993, at the Holiday Inn North, Newark Airport, Newark, NJ.

A total of 17 papers tentatively have been scheduled for presentation during the two-day conference. The topics and speakers slated for event are as follows:

"The Synergistic Effect of Metal Sulfonates on Anticorrosive Pigments in Coatings"—Robert Coughlin, of King Industries, Inc.;

"The Protection of Photosensitive Substrates by a New Class of UV Absorbers"—Mark Holt, of CIBA-GEIGY Corporation;

"The Use of Fine Particle Titanium Dioxide for UV Protection in Coatings"—John Clayton, of Tioxide Specialties Ltd.;

"The Improvement of Substrate Wetting of Waterborne Paint Systems"—Gene Franklin, of BYK-Chemie USA;

"Functional Polyethylene Additives: Reactive Polymers for a Changing Coatings Industry"—Arthur P. DeMonte, of Allied Signal Inc.;

"New Oxazolidine-Based Moisture Scavenger for Polyurethane Coating Systems"—Marina Hoffman, of ANGUS Chemical Company;

"The Dominant Role of Organic Peroxide Initiators in Acrylic HSC Resin Synthesis and Properties"—Peter Callais, of Elf Atochem North America, Inc.;

"The Importance of Low Dynamic Surface Tension in Waterborne Coatings"—Joel Schwartz, of Air Products and Chemicals, Inc.;

"Electrostatic Charge and Pigment Stabilization Properties of Fine Particle Sized Barium Sulfates"—Jochen Winkler, of Sachleben Chemie;

"Organic Corrosion Inhibitors in Direct-to-Metal Coatings"—I-Chyang Lin, of CIBA-GEIGY Corporation;

"Acetoacetate Functionalized Reactive Diluents for Solvent-Borne and Waterborne Coatings"—Delano R. Eslinger, of Cook Composites and Polymers;

"Silicone Microemulsions"—S. Lee Hertz, of Wacker Silicone Corporation;

"Organo Nitrite Corrosion Inhibitors for Coating Systems"—James Walther, of General Chemical Corporation; and

"How to Avoid a Catastrophe: The Selection of Additives; Their Use and Misuse"—Marc S. Hirsch, of Rhone-Poulenc Inc.

For more information on the two-day symposium, contact Mildred Leonard, 520 Westfield Ave., Room 208, Elizabeth, NJ 07208; (908) 354-3200.

Philadelphia Society Technical Committee to Sponsor Symposium on Defects in Waterborne Coatings, May 10

The Technical Committee of the Philadelphia Society for Coatings Technology will sponsor a seminar on "Surface Defects in Waterborne Coatings: Causes and Cures," on May 10, 1993, at the Philadelphia Court Hotel (formerly Airport Hilton Inn), in Philadelphia, PA.

The Program Chairman is Society Technical Committee Chairman Julio J. Aviles, of KRONOS, Inc. Assisting him are Technical Secretary Neil R. Shearer, of the 3E Group, and Registration Chairman Barry Fisher, of Van Horn, Metz & Company.

Highlighting the program will be eight technical presentations, including the following:

"Coating Additives: Use and Misuse—How to Avoid a Catastrophe"—Marc S. Hirsch, of Rhone-Poulenc, Inc.;

"The Importance of Low Dynamic Surface Tension in Waterborne Coatings"—Joel Schwartz, of Air Products and Chemicals, Inc.;

"The Improvement of Wetting Properties in Waterborne Systems"—Frederick M. Lawchik, of BYK-Chemie USA;

"Fluorochemical Additives for Paint and Coatings"—Jerome F. Colbert, of 3M Company;

"Exterior Architectural Coatings—Problems and Corrections"—Bernadette Corujo, of Rohm and Haas Company;

"Proper Defoaming of Waterborne Coatings"—Jay W. Adams, of Tego Chemie Service USA;

"Using Surfactants to Eliminate Surface Defects"—William H. McNamee, of ICI Surfactants; and

"Appearance Defects in Waterborne Coatings"—Gil Ericson, of Troy Corporation.

Registration fees for the one-day symposium are \$50 for Philadelphia Society members, and \$60 for nonmembers. The deadline for registering for the conference is May 3.

For further information, contact: Mr. Shearer, The 3E Group, 850 Glen Ave., P.O. Box 392, Moorestown, NJ 08057-0392; (609) 866-7600. Or, contact: Mr. Fisher, Van Horn, Metz & Co., Inc., 201 E. Elm St., Conshohocken, PA 19428; (215) 828-4500.

USM Department of Polymer Science Releases Slate of 1993 Coatings Science Short Courses

The Department of Polymer Science at the University of Southern Mississippi (USM), Hattiesburg, MS, has released its Coatings Science Short Course Series for 1993.

The schedule of courses and dates is as follows:

"Coatings Science for Coatings Technicians"—May 17-20;

"Coatings Science for Coatings Formulators"—June 7-10;

"Coatings Science for Coatings Chemists"—June 14-17; and

"Coatings Science of Powder Coatings"—August 9-12.

All courses will be conducted at the new state-of-the-art 86,000 square foot Polymer Science Research Center on the USM campus.

The format for all short courses is four days of laboratory and lecture activities. A

complete set of course notes also is provided.

The Coatings Science Series is under the direction of Dr. Shelby F. Thames, a Distinguished University Research Professor, the Southern Society for Coatings Technology Distinguished Professor, and a Professor of Polymer Science at USM.

The tuition for each course is \$875 which covers registration, instruction and lab, reference materials, morning and afternoon breaks, reception, and shuttle service from the hotel.

In addition, due to the limited registration for each course, participants will be selected by order of registration.

For further short course information, contact PSC Coatings Short Course, c/o Shelby F. Thames, Director, USM, Box 10076, Hattiesburg, MS 39406-0076; (601) 266-4080.

NDSU Announces Schedule of Coatings Science Short Courses

The Department of Polymers and Coatings at North Dakota State University (NDSU), Fargo, ND, has announced its Intensive Coatings Science Courses for June 1993.

The schedule is:

"Environmentally Compliant Coatings"—June 7-11; and

"Coatings Science"—June 14-25.

The course on "Compliant Coatings" is designed for personnel experienced in research or development in these or related fields. Recent developments in waterborne, latex, high solids, powder coatings, radiation curing, and analysis of coatings will be featured, with selected topics covered in more detail.

"Coatings Science" is designed for chemists relatively new to the field, and for more experienced chemists seeking a broader perspective and understanding of the fundamentals of coatings science.

Registration for both courses is limited to 40 participants.

The registration fee is \$750 for "Environmentally Compliant Coatings," and \$1,500 for "Coatings Science."

More information can be obtained from: Marek W. Urban, Program Director, or Debbie Shasky, at Dunbar Hall, Room 54, NDSU, Fargo, ND 58105; (701) 237-7633.

Paint Research Association to Host Conference On Powder Coatings, Nov. 15-17, in Brussels

"Powder Coatings" will be the focus of the Paint Research Association's (PRA) 13th International Conference, on November 15-17, 1993, in Brussels.

Papers are anticipated from raw material suppliers, powder manufacturers, spray gun and booth manufacturers, as well as powder coating users, on: mechanism of charging-tribo, corona, or hybrid; thin-layer powder coatings; low temperature powder coatings; clear powder coatings for furniture and automotive parts; outdoor durable powder coatings; textured, metallic, and low gloss powder coatings; powder coatings for non-

metal substrates; epoxy, epoxy/polyester (hybrid); polyurethane; TGIC polyester; acrylic; thermoplastic powder coatings; powder coatings for rebar, domestic appliances, automotive manufacture, and coil coatings applications; and additives to improve physical and flow properties and reduce curing temperature.

Additional information on the "Powder Coatings" Conference is available from: Conference Secretary, PRA, 8 Waldegrave Rd., Teddington, Middlesex TW11 8LD, United Kingdom.

Letters to the Editor

Article on "Service Life Prediction" in June 1992 JCT Opens Dialog

TO THE EDITOR:

In the Open Forum [JOURNAL OF COATINGS TECHNOLOGY, 64, No. 809, page 61 (June 1992)], "Toward a Unified Strategy of Service Life Prediction," Dr. Dickie lucidly outlines an approach to a coatings industry problem. Prediction of coating service life is a complex issue with no ready answers, and Dr. Dickie's "unified" strategy has merit, both scientifically and practically. While we support and applaud Ray Dickie's initiative, the paper also provides a springboard for broader questions. Can the coatings industry and its marketplace be motivated and organized, U.S. and abroad, to adopt a unified coating service life methodology? Taking the idea one step further, what can be done to develop improved accelerated tests that accurately predict service life? Is this

an opportunity to take substantive steps toward a more unified world of performance tests that can be carried out in hours and weeks, particularly corrosion and environmentally-induced deterioration; tests that safely predict how well a coated article will perform over real time in real environments?

The Corrosion Committee of the Federation of Societies for Coatings Technology (FSCT) previously recognized some of the problems cited above and established a project entitled "Survey of Accelerated Test Methods for Anti-Corrosive Coating Performance." A condensation of the final project report was published in the August 1990 issue of the JCT (Vol. 62, No. 787, page 57). Beyond the issues of test methods, a total overhaul of accelerated performance

tests may be an appropriate next step. These, and related ideas, are examined in more depth below.

What Are the Problems?

The "bilities" of the '90's rest heavy on the coated products industries—durability, credibility and liability. Quality is an all important issue for manufacturers of coated products worldwide. Extending service life of coated products makes good sense from business, economic, and environmental standpoints. There is a need to change and be assured that whatever changes are made are in the right direction. *The central problem has been that our ability to predict service both accurately and rapidly has not kept pace with other changes.*

Protective coatings technology has advanced markedly in the past decade. Significant changes in the chemistry of coatings, how the coatings are applied, the pre-treatments used, and the mix of substrates have occurred and are changing on a daily basis. Substantial R&D dollars have been expended to bring about these changes in a very short period of time. *However, the technology to assess the effect of these coating technology changes has not progressed at the same rate. Testing techniques have changed very little.* Few R&D dollars are being spent on improved testing techniques. Accelerated tests distinguish between very bad coatings and very good coating systems, but do not discriminate well among better coating systems. Beyond the test themselves, *there appears to be no organized approach to determine when, where and how all the tests should be applied or interpreted.* The appeal of a unified approach is that it would work for a large variety of applications where all could agree upon the best battery of tests for a given product situation.

What Directions Are Needed?

Three general areas need to be addressed:

- (1) Adoption of a unified approach to test methodology
- (2) Develop better, faster, *representative* performance assessment
- (3) Allow for upgrading the test methodology.

One proposed direction is to organize and involve all the different organizations

(Continued on page 79.)

TO THE EDITOR:

I could not agree more with the views expressed in the paper, "Toward a Unified Strategy of Service Life Prediction" [JOURNAL OF COATINGS TECHNOLOGY, 64, No. 809, page 61 (June 1992)]. The author has developed and explained opinions that I have struggled with for the more specific case of the contribution of TiO₂ pigments to the durability of paint film.^{1,2} For TiO₂ pigment, testing has become a bottleneck to progress toward more durable products. The injection of good science into testing technology is likely to revitalize product development.

I would like to add three points to the views expressed in the article. They apply to the weathering of coatings and possibly more broadly to many matters of service life.

Conventional exposures are not at all perfect simulations of real world service experiences. Because of impatience and business dictates conventional exposures contain many accelerating elements within: humid tropics rather than temperate climates, horizontal rather than vertical exposures, poor and often obsolete binders for the testing of pigments and poor, obsolete pigments for the testing of binders, etc. The total impact of these choices takes its toll on the relevance of the data.

Also the definition of service life involves considerable ambiguities beyond failure modes. Often service life is neither well understood nor defined. For life insurance, the end of service life is abrupt and obvious, for coatings it is gradual and very much subject to subtle requirements of the application. Architectural surfaces are flat and usually light, they can tolerate some chalk. Thus, service life of house paints ends toward the end of chalking. For automotive finishes, by contrast, service life may have ended when the coating begins to chalk and the car loses its shininess.

Finally, service life predictions of complex systems are not likely to be reliable unless statistics are made an integral part of the effort. We are far more likely to hear sweet music over the experimental noise of complex interactions if we use the statistical tools that mathematics and computer technology have put at our disposal. I consider it imperative for sound coatings development to use scientific statistics to design experiments, to reduce the data, and to evaluate the conclusions.

This said, it appears to me that progress is being made. We are on the way to translate good science into solutions of the testing problems of coatings technology.

—JUERGEN H. BRAUN
DuPont Chemicals
Wilmington, DE

(1) Braun, J.H., "Titanium Dioxide's Contribution to the Durability of Paint Films," *Progr. Org. Coatings*, 15, 249 (1987).

(2) Braun, J.H., "TiO₂'s Contribution to the Durability and Degradation of Paint Films—II. Prediction of Catalytic Activity," *JOURNAL OF COATINGS TECHNOLOGY*, 62, No. 785, 37 (1990).

Literature

Viscometry Software

Literature describes new software demonstration kits designed to enable workers in viscometry to experiment with PC-based data gathering and analysis. The kit consists of software diskettes, a brochure describing features and benefits of the programs, and an operator's manual. For further information on how to obtain demonstration kits on Rheocalc™ and DV GATHER+™ viscometry software, contact Brookfield Engineering Laboratories, Dept. NR-93, 240 Cushing St., Stoughton, MA 02072.

Circle No. 200 on the Reader Service Card

Dual Column Assembly

A single injection, dual capillary column system specially tested for pesticide, herbicide, PCB, and other applications is the subject of a product release. The dual columns are tested using a mixture of pesticides with tight specifications to assure resolution, calibration, and verification requirements. Write J&W Scientific, 91 Blue Ravine Rd., Folsom, CA 95630, for more information on DB™-17/1701 Dual Column Assembly.

Circle No. 201 on Reader Service Card

Cationic Polyurethane Aqueous Dispersion

The development of a cationic polyurethane aqueous dispersion suited for the formulation of specialty protective coatings has been announced through literature. The dispersion is recommended as a sealer for oak and concrete floors, and also has application in coatings for synthetic fiber and textiles that have cationic binder requirements. Information on Witcobond® W-213 dispersion is obtainable from the Polyurethane Specialties Group, Witco Corp., 2701 Lake St., Melrose Park, IL 60160-3041.

Circle No. 202 on Reader Service Card

Anticrease Lubricant

A product sheet detailing an anticrease lubricant has been released. The lubricant is designed to help eliminate several potential problems for textile dyers including rope marks, creasing, abrasion, and chafe marks. For more in-depth information on RAYCALUBE® ACA anticrease lubricant, contact ICI Surfactants, Wilmington, DE 19897.

Circle No. 203 on Reader Service Card

Thermal Analysis

A brochure highlighting a new thermal analysis technique has been printed. The technology reportedly provides unique insight into the structure and behavior of materials previously unavailable using conventional DSC methods. For a free copy of the brochure on Modulated DSC™, contact TA Instruments, 109 Lukens Dr., New Castle, DE 19720.

Circle No. 204 on Reader Service Card

Coatings Remover

Technical literature highlights a product specifically developed for the removal of high-strength, chemically-resistant coatings. This product is designed to remove coatings, including: epoxies, urethanes, chlorinated rubber, elastomeric, aluminum, vinyls, mastics, automobile paints, and most marine paints. For further details on Peel Away™, contact Dumond Chemicals, Inc., 1501 Broadway, New York, NY 10036.

Circle No. 205 on Reader Service Card

Acrylics

A line of acrylic polymers, which includes six products with glass transition temperatures ranging from -37 to +34°C, has been introduced. Films formed with the new acrylics are recommended for use in the textile, nonwoven, and paper industries for such applications as finishing, backcoating, bonding, and other related uses. More details on the Rohamere acrylic polymer line are obtainable from John Kolackovsky, Business Manager/Polymers, Rohm Tech Inc., 83 Authority Dr., Fitchburg, MA 01420.

Circle No. 206 on the Reader Service Card

Accelerated Weathering

A product bulletin details a new tabletop xenon exposure system for accelerated weathering. Applications include plastics, textiles, pharmaceuticals, inks, and other materials. For more details on the SunChex™ Tabletop Xenon Exposure Systems, contact Margaret MacBeth, Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60614.

Circle No. 207 on the Reader Service Card

Preservative for Aqueous Systems

The introduction of a new broad-spectrum preservative for aqueous systems has been made through a product sheet. Potential applications included: aqueous interior and exterior paints and coatings; latex stains; water-based wood preservatives and protectors; latex-, protein-, and starch-based adhesives; joint cements; printing inks; polymer emulsions; pigment dispersions; sealants and caulks; metalworking fluids; and leather and textile processing solutions. Write Troy Corp., 72 Eagle Rock Ave., E. Hanover, NJ 07936-0366, for more in-depth details on Troysan® 586.

Circle No. 208 on the Reader Service Card

Thermal Analyzer

A new six-page, color brochure describing a differential thermal analyzer has been printed. The instrument performs measurements in a broad temperature range with high sensitivity and rapid cooling. Contact The Perkin-Elmer Corp., 761 Main Ave., Norwalk, CT 06859-0012, for a free copy of the brochure on the DTA 7 Differential Thermal Analyzer.

Circle No. 209 on Reader Service Card

SITUATIONS WANTED

Coatings Chemist experienced in formulation of water and solvent systems. Experience in formulation and application of pigment dispersions and color for multi-product end use. Has hands-on plant and quality control management experience for large as well as small volume production sites. Environmental reporting for federal and state agencies including generation of MSDSs and other materials. Northern and central New Jersey loca-

tions preferred. Edward Baird, 160 Linden Ave., Verona, NJ 07044.

A Chemical Engineer with 24 years of experience in trade sales seeks a senior management position in plant, technical and/or quality assurance. Experience in formulation, process improvements, trouble shooting. Antoine Chaoui, 3481 Belcoud Rd., Longueuil, Quebec, J4M 2K6 Canada.

Supplies Catalog

A 50-page catalog featuring a full-range of marking, coding, and labeling systems has been printed. The publication also features a number of historical facts spotlighting the company's product offerings and highlights from the company's past. For a copy of the "1993 Industrial Marking & Shipping Systems & Supplies Catalog," write Diagraph Corp., Marketing Services, 3401 Rider Trail South, St. Louis/Earth City, MO 63045-1110.

Circle No. 210 on the Reader Service Card

Resins

Two new colorless and heat-stable hydrocarbon resins are highlighted in product sheets. These products are designed for use in: processing aids for vinyl, including flooring manufacture; gloss and film enhancers in overprint varnishes and coatings; curing compounds for concrete, and in traffic paint; and more. For copies of the data sheets or samples of Hercolite™-240 or Hercolite-290, contact Hercules Incorporated, Hercules Plaza, Wilmington, DE 19894.

Circle No. 211 on the Reader Service Card

Adhesion Promoters

A data sheet focusing on a new family of metal organic adhesion promoters has been released. The technology used is based upon stabilized metal centers in combination with reactive organic groups. For technical information on these coating adhesion promoters, write Lawrence B. Cohen, Chartwell International, Inc., 32 Condor Rd., Sharon, MA 02067.

Circle No. 212 on the Reader Service Card

Heating Coils

Heating coils for portable shipping and storage containers is the topic of literature. The heating coils reportedly enable faster emptying of heavier fluids which flow better when warm. Additional details on the new heating coils are available from Clawson Tank Co., 4545 Clawson Tank Dr., P.O. Box 350, Clarkston, MI 48346-0350.

Circle No. 213 on Reader Service Card

Letters to the Editor

Continued from page 77.

"Service Life Predictability" Article Opens Dialog

that might have a vested interest in the program. The list is long and includes:

- Coating Suppliers
- Accelerated Equipment Manufacturers
- Substrate Suppliers
- Pretreatment Suppliers
- Independent Performance Testing Services/Laboratories
- Academic Representatives
- Procedure Setting Agencies such as ASTM, AAMA, NACE
- Federal and State Agencies Involved in Performance Specifications
- Representative Coated Products Manufacturers
- Users

Although potentially unwieldy, the above groups would organize a core group to put a plan together and then put the plan in motion. Ideas on what could be done by the core group include the following:

- (1) Consider and promulgate a unified strategy
- (2) Fund research in defined areas
- (3) Organize round robin studies
- (4) Involve specification setting agencies in writing unified specifications
- (5) Invite technical societies in publishing papers and progress reports on the issues to keep industry informed
- (6) Motivate technical societies to sponsor meetings on the topic (or include as a section of annual meetings).

To get things moving, an international symposium on the subject could provide a rallying point for concerted action on a new

order for accelerated performance testing. Other issues include:

(1) Should the Corrosion Committee work toward detailing tests, test methodology, or service life predictions and what is state-of-the-art? The Corrosion Committee has supported research and published a report entitled, "Survey of Accelerated Test Methods for Anti-Corrosive Coating Performance," available from FSCT.

(2) How do we deal with the "Durability of Coatings" symposium backed by the ACS? Does this need to be referenced as a related step towards improvements in testing and test procedures?

(3) Who are the big players in testing from a procedure setting standpoint? Who must be engaged in the undertaking and can all interested parties be included?

(4) How can the Corrosion Committee approach all the different agencies for funding, if this is what is needed?

In summary, the FSCT Corrosion Committee supports the concept of a unified strategy as it applies to coated products performance testing. Dr. Dickie's concepts afford a framework upon which to build a broadly useful approach to performance testing. What we have outlined is a possible approach to how these concepts might be developed, organized and adopted by the coated products community. Your response to these issues is requested. Please forward your response to FSCT Corrosion Committee, c/o Mike Bell, 492 Norristown Road, Blue Bell, PA 19422-2350, or FAX 215-940-0292.

—FSCT CORROSION COMMITTEE

Silicone Emulsion

A VOC-compliant silicone emulsion is discussed in a product release. The emulsion is designed for use as a binder in outdoor architectural paints for masonry surfaces. Contact C&C Marketing Dept., Wacker Silicones Corp., 3301 Sutton Rd., Adrian, MI 49221-9397, for further information about silicone emulsion BS 43A.

Circle No. 214 on the Reader Service Card

Raw Materials

A four-page raw materials brochure featuring charts which list descriptions, commercial forms, physical properties, and application areas of various specialty raw material products for the coatings industry has been printed. To request a copy of the brochure, "Coating Raw Materials Products for Resins, Coatings, Sealants, Adhesives, and Elastomers," contact Hüls America Inc., CRM Group, 80 Centennial Ave., P.O. Box 456, Piscataway, NJ 08855-0456.

Circle No. 215 on the Reader Service Card

Atomic Force Microscope

An information sheet announcing a new atomic force microscope (AFM) system has been issued. The instrument may be placed on the sample to be analyzed; the system can reportedly be used for scans from atomic resolution to areas as large as 150 x 150 microns. For a copy of the data sheet on the TMX 1000 Explorer AFM system, contact Gary Aden, TopoMetrix, 1505 Wyatt Dr., Santa Clara, CA 95054.

Circle No. 216 on the Reader Service Card

Powder Coating

A 52-page powder coatings handbook has been published. Topics include: why powder coatings?; selecting coatings; quality and performance tests; metal pretreatment; selection of spray guns and automatic application; and much more. For information on how to order a copy of *Practical Guide to Powder Coatings*, contact Nigel Whitehouse, The Paint Research Association, 8 Waldegrave Rd., Teddington, Middlesex TW11 8LD, England.

Circle No. 217 on the Reader Service Card

Technical Oils

A full-color brochure detailing specifications on a full line of high-quality, technical vegetable oils has been released. The oils can be used for such applications as: paints, varnishes, stains, inks, hardboard binders, epoxidized oils, chemical intermediates, pharmaceuticals, pesticide adjuvants, brake linings, lubricants, and core oils. To obtain a copy of the brochure on technical oils, write Bill Reutz, Cargill Technical Oils, P.O. Box 9300, Minneapolis, MN 55440.

Circle No. 218 on the Reader Service Card

Grinding Equipment

A cryogenic grinding precooling system is highlighted in a data sheet. Features and product specifications are included in the literature. For more information on Model CO₂P-6FM (Form #6962), write Liquid Carbonic, Corporate Communications Dept., 800 Jorie Blvd., Oak Brook, IL 60522-7001.

Circle No. 219 on the Reader Service Card

Polymer Dispersions

A new data sheet discussing a line of aqueous urethane hybrid polymers for coating and adhesive applications has been published. The literature contains several tables which provide information on the product's dispersion and free film properties, formulating suggestions, and a starting point formulation for a water-based wood lacquer. For a copy of the publication, "Flexthane® Polymer Dispersion," contact Air Products and Chemicals, Inc., Polymer Chemicals Div., 7201 Hamilton Blvd., Allentown, PA 18195-1501.

Circle No. 220 on the Reader Service Card

Floor Coatings

A line of heavy duty floor coatings for industrial and commercial applications is the topic of a product release. The line includes a wide variety of topcoats, primers, sealers, and other coatings designed to meet specific application and performance needs for almost any industrial, commercial, or marine floor application. Contact The Sherwin-Williams Co., c/o HKM Direct, 5501 Cass Ave., Cleveland, OH 44102, for further details on ArmorSeal™ (SWS-3790).

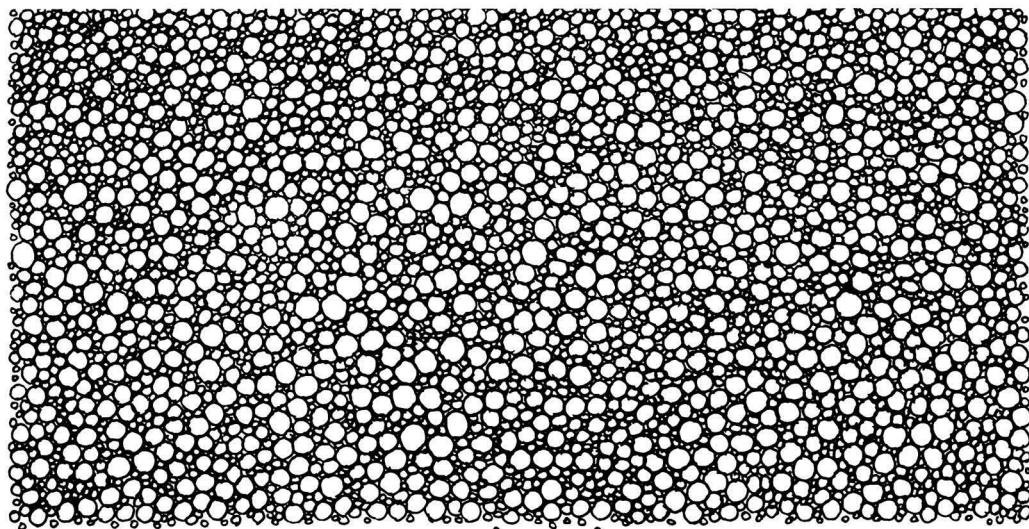
Circle No. 221 on the Reader Service Card

Mark October 27-29, 1993
on your Calendar!!



71st Annual
Meeting
&
58th Paint
Industries' Show

Georgia World Congress
Center, Atlanta, GA



Cut the cost of caulk with CAMEL-FIL®. The lowest cost filler with the least room for resin.

The problem with many fillers is that you end up using more resin than you'd like.

But low-cost CAMEL-FIL® is a calcium carbonate with a unique particle size distribution that provides exceptionally high load-

ing. So you reduce your resin costs, while using a filler that's low in cost too. Genstar Stone Products Company, Executive Plaza IV, Hunt Valley, MD 21031. (410) 527-4221.

Circle No. 132 on the Reader Service Card

Coming Events

FEDERATION MEETINGS

For information on FSCT meetings, contact Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422 (215) 940-0777, FAX: (215) 940-0292.

1993

(May 16-19)—Federation "Spring Week." Board of Directors Meeting on the 16th; Incoming Society Officers Meeting on the 17th; Spring Seminar on the 18th and 19th, "The Influence of Substrates and Application Methods/Techniques on Coatings Performance." South Shore Harbour Resort and Conference Center, League City (Houston), TX.

(Oct. 27-29)—71st Annual Meeting and 58th Paint Industries' Show. World Congress Center, Atlanta, GA.

1994

(May 12-15)—Federation "Spring Week." Spring Seminar on the 12th and 13th; Incoming Society Officers Meeting on the 14th; Board of Directors Meeting on the 15th. Marriott City Center Hotel, Minneapolis, MN.

(Oct. 12-14)—72nd Annual Meeting and 59th Paint Industries' Show. New Orleans Convention Center, New Orleans, LA.

1995

(Oct. 9-11)—73rd Annual Meeting and 60th Paint Industries' Show. Cervantes Convention Center, St. Louis, MO.

SPECIAL SOCIETY MEETINGS

1993

(Apr. 13)—Pittsburgh Society Symposium. "An Environment Responsible 90s." Airport Marriott, Pittsburgh, PA. (William C. Spangenberg, Hammond Lead Products Inc., 1910 Cochran Rd., Pittsburgh, PA 15220; (412) 344-5811).

(Apr. 21-23)—Southern Society Annual Meeting. "Waterborne Coatings—Riding the Wave to the Future." Opryland Hotel, Nashville, TN. (Mary Finnigan, McCullough & Benton, Inc., 2900 G Carolina Center, Charlotte, NC 28208; (704) 392-2101).

(Apr. 27)—Detroit Society FOCUS Conference. "Waterborne Technology for the Millennium." University of Detroit-Mercy, Detroit, MI. (Valerie E. Gunn, L&L Products Inc., P.O. Box 308, 74100 Van Dyke, Romeo, MI 48065-0308; (313) 752-4571).

(Apr. 29-May 1)—Pacific Northwest Society Symposium. "Understanding the Fundamentals." Red Lion Hotel, Bellevue, WA. (Richard C. Tomczak, Specialty Polymers, Inc., 17316 E. Riverside Place., Bothell, WA 98011; (206) 488-1816 or (206) 979-3875).

(May 4-5)—New York Society Symposium. "Recent Advances in Additives & Modifiers for Coatings." Holiday Inn North, Newark Airport, Newark, NJ. (Mildred Leonard, 520 Westfield Ave., Rm. 208, Elizabeth, NJ 07208; (908) 354-3200).

(May 10)—Philadelphia Society Seminar. "Surface Defects in Waterborne Coatings: Causes and Cures." Philadelphia Court Hotel, Philadelphia, PA. (Peter C. Kuzma, VIP Products Corp., 3805 Frankford Ave., Philadelphia, PA 19124; (215) 535-3025).

(May 25-26)—New England Society. Coatings Tech Expo '93. "Compliance—Options for the 21st Century." Sheraton Tara Hotel & Resort, Danvers, MA. (Joanne Monique, Ashland Chemical, Inc., 400 Main St., Tewksbury, MA 01876; (800) 962-5388).

(June 4-5)—Joint Meeting of the Kansas City and St. Louis Societies. Holiday Inn, Lake of the Ozarks, MO.

(June 14)—Golden Gate Society Manufacturing Committee Seminar. "Process and Compliance." Ramada Inn, S. San Francisco, CA.

OTHER ORGANIZATIONS

1993

(Apr. 18-21)—Inter-Society Colour Council (ISCC) Annual Meeting and Symposium. Doubletree Hotel, Newport, RI. (Ramesh Kumar, Program Chairman, 1993 ISCC Annual Meeting, Hoechst Celanese Corp., 500 Washington St., Coventry, RI 02816).

(Apr. 18-23)—"Durability of Coatings." Symposium sponsored by ACS, Division of Polymeric Materials: Science Engineering, Denver, CO. (Jonathan W. Martin, NIST, Bldg. 226, Rm. B348, Gaithersburg, MD 20879; David Bauer, Ford Motor Co., SRL-E3198, P.O. Box 2053, Dearborn, MI 48121; F. Louis Floyd, Glidden Research Ctr., 16651 Sprague Rd., Strongsville, OH 44136).

(Apr. 20-21)—"Color Pigments, Regulations, and the Environment." Symposium cosponsored by the Dry Color Manufacturers' Association (DCMA) and the Inter-Society Color Council. Newport, RI. (DCMA, P.O. Box 20839, Alexandria, VA 22320-1839).

(Apr. 20-22)—Surface Treatment '93. "Computer Methods and Experimental Measurements for Surface Treatment Effects." International Conference sponsored by Wessex Institute of Technology, Novotel, Southampton, United Kingdom. (Sue Owen, Conference Secretariat, Wessex Institute of Technology, Ashurst, Southampton, Hants, United Kingdom SO4 2AA).

(Apr. 26-30)—"Applied Rheology for Industrial Chemists." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Krauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Apr. 27-30)—Architectural Spray Coaters Association (ASCA) 8th Annual Conference. Sheraton San Marcus Resort & Conference Center, Chandler, AZ. (ASCA, 230 W. Wells St., Ste. 311, Milwaukee, WI 53203).

(Apr. 28-29)—"Paint Technology—Surviving the '90s, Part II." 47th Annual and 20th "Back to Back" Symposium. Sponsored by The Chemical Institute of Canada, Protective Coatings Division, Hélène de Champlain Restaurant, Montreal, Que., Canada; and The Old Mill, Toronto, Ont., Canada. (For Montreal, contact: Martin Ménard, Produits Nacan Ltee., 50 Boul. Marie-Victorin, Boucherville, Que. J4B 1V5, Canada; for Toronto, contact: Robert D. McComb, Tioxide Canada Inc., 350 Burnhamthorpe Rd., W., Suite 210, Mississauga, Ont. L5B 3J1, Canada).

(May 2-6)—RadTech Europe '93. Third Annual RadTech conference. Sponsored by RadTech Europe. Italian vessel T/S Eugenio Costa. (RadTech Europe, Business Office, Pérolles 24, CH-1700 Fribourg, Switzerland).

(May 3-7)—11th Annual Atlas School of Natural and Accelerated Weathering. Sponsored by Atlas Electric Devices Co. Miami, FL. (Margaret MacBeth, Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60614).

(May 4-6)—Hazardous Materials and Environmental Management Conference and Exhibition (HazMat West/Spring). Sponsored by Tower Conference Management Company. Long Beach Convention Center, Long Beach, CA. (Tower Conference Management Co., 800 Roosevelt Rd., Bldg. E—Ste. 408, Glen Ellyn, IL 60137-5835).

(May 4-6)—Plasticcoat '93 Conference and Exhibition. Sponsored by *Products Finishing*. Drawbridge Estate & Convention Center, Ft. Mitchell, KY (Greater Cincinnati, OH Area). (Cindy Goodridge, Gardner Management Services, 6600 Clough Pike, Cincinnati, OH 45244).

(May 4-6)—"Continuous Steel Strip Plating" Symposium. Sponsored by American Electroplaters and Surface Finishers Society (AESF). Ritz-Carlton Dearborn, Dearborn, MI. (AESF, Central Florida Research Park, 12644 Research Pkwy., Orlando, FL 32826-3298).

(May 4-6)—"Fundamentals of Corrosion and its Control." Training course sponsored by LaQue Center for Corrosion Technology. Holiday Inn, Wrightsville Beach, NC. (LaQue Center for Corrosion Technology, Inc., P.O. Box 656, Wrightsville Beach, NC 28480).

(May 9-14)—"Polymer Characterization: Thermal, Mechanical, and Optical." Short course sponsored by American Chemical Society

(ACS). Virginia Tech University, Blacksburg, VA. (ACS, Dept. of Continuing Education, Meeting Code VPI93, 1155 Sixteenth St., N.W., Washington, D.C. 20036).

(May 10-14)—"Dispersion of Pigments and Resins in Fluid Media." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(May 11-13)—"Spray Finishing Technology Workshop." Sponsored by Bowling Green State University and DeVilbiss Ransburg, Toledo, OH. (Richard A. Kruppa, Professor of Manufacturing Technology, College of Technology, Bowling Green State University, Bowling Green, OH 43403).

(May 12-14)—"Frontiers in Polymer Chemistry." Short course sponsored by American Chemical Society (ACS). University of Akron, Akron, OH. (ACS, Dept. of Continuing Education, Meeting Code FRPC9305, 1155 Sixteenth St., N.W., Washington, D.C. 20036).

(May 16-21)—"Polymer Synthesis: Fundamentals and Techniques." Short course sponsored by American Chemical Society (ACS). Virginia Tech University, Blacksburg, VA. (ACS, Dept. of Continuing Education, Meeting Code VPI93, 1155 Sixteenth St., N.W., Washington, D.C. 20036).

(May 17-19)—Styrenics '93. Sponsored by Maack Business Services. Zürich Hotel International, Zürich, Switzerland. (Maack Business Services, Moosacherstr. 14, 8804 Au/Zürich, Switzerland).

(May 17-19)—"Advances in Coatings, Inks and Adhesives Technology." Third Asia-Pacific Conference. Raffles City Convention Centre, Singapore. (Mike Tarrant, Exhibition Director, FMJ Publications Ltd., Queensway House, 2 Queensway, Redhill, Surrey RH1 1QS, United Kingdom).

(May 17-20)—"Coatings Science for Coatings Technicians." Short course sponsored by University of Southern Mississippi (USM), Hattiesburg, MS. (Debbie Ballard or Shelby Thames, USM, Dept. of Polymer Science, Southern Station, Box 10076, Hattiesburg, MS 39406-0076).

(May 17-21)—"Introduction to Paint Formulation." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (UMR Coatings Institute, 142 Schrenk Hall, Rolla, MO 65401).

(May 17-22)—"Interpretations of IR and Raman Spectroscopy." Course sponsored by Fisk Infrared Institute. Vanderbilt University, Nashville, TN. (Fisk Infrared Institute, P.O. Box 265, French Village, MO 63036).

(May 24-28)—"Adhesion Principles and Practice for Coatings and Polymer Scientists." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(May 25-28)—Annual Conference in Science and Technology of Pigment Dispersion. Luzern, Switzerland. (Angelos Patsis, Institute of Materials Science, State University of New York at New Paltz, New Paltz, NY 12561).

(June 2-4)—15th Annual International Conference on Advances in the Stabilization and Degradation of Polymers. Luzern, Switzerland. (Angelos Patsis, Institute of Materials Science, State University of New York at New Paltz, New Paltz, NY 12561).

(June 6-7)—"Industrial Lead Paint Removal and Abatement." Tutorial sponsored by Steel Structures Painting Council (SSPC). Marriott Astrodome, Houston, TX. (SSPC, 4516 Henry St., Pittsburgh, PA 15213-3728).

(June 7-9)—"Engineering Solutions to Industrial Corrosion Problems." Conference cosponsored by the National Association of Corrosion Engineers (NACE) and Norsk Korrosjonsteknisk Forening (NKF). Rica Park Hotel, Sandefjord, Norway. (NKF, Rosenkrantzgate 7, 0159 Oslo, Norway).

(June 7-10)—"Coatings Science for Coatings Formulators." Short course sponsored by University of Southern Mississippi (USM), Hattiesburg, MS. (Debbie Ballard or Shelby Thames, USM, Dept. of Polymer Science, Southern Station, Box 10076, Hattiesburg, MS 39406-0076).

(June 7-11)—"Fundamentals of Chromatographic Analysis." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(June 7-11)—"Environmentally Compliant Coatings." Short course sponsored by North Dakota State University (NDSU), Fargo, ND. (Marek W. Urban, Program Director, or Debbie Shasky, Program Coordinator, Dunbar Hall, Rm. 54, NDSU, Fargo, ND 58105).

(June 8-11)—"Getting into Compliance with Air Quality Regulations for Paints, Coatings, and Printing Facilities." Course sponsored by University of California Berkeley, San Francisco, CA. (Continuing Education in Engineering, University Extension, University of California, 2223 Fulton St., Berkeley, CA 94720).

(June 14-17)—"Coatings Science for Coatings Chemists." Short course sponsored by University of Southern Mississippi (USM), Hattiesburg, MS. (Debbie Ballard or Shelby Thames, USM, Dept. of Polymer Science, Southern Station, Box 10076, Hattiesburg, MS 39406-0076).

(June 14-25)—"Coatings Science." Short course sponsored by North Dakota State University (NDSU), Fargo, ND. (Marek W. Urban, Program Director, or Debbie Shasky, Program Coordinator, Dunbar Hall, Rm. 54, NDSU, Fargo, ND 58105).

(June 21-22)—"Thin Film Coatings: Topics in Coating and Drying Technology." Short course sponsored by the University of Minnesota, Minneapolis, MN. (Jackie O'Brien, Dept. of Chemical Engineering & Materials Science, University of Minnesota, 421 Washington Ave. SE, Minneapolis, MN 55455).

(June 21-23)—International Colouristic Symposium. Sponsored by the Colouristic Section of the Hungarian Chemical Society, Balatonszék (by Lake Balaton), Hungary. (Hungarian Chemical Society, Colouristic Symposium Organizing Committee, H-1027 Budapest Fo u. 68, Hungary).

(June 22-24)—"Predictive Technology" Symposium. Sponsored by American Defense Preparedness Association, Twin Tower Hotel and Convention Center, Orlando, FL. (Frank A. Gagliardi, U.S. Army Armament Research and Development Center, Bldg. 92, Picatinny Arsenal, NJ 07806-5000).

(June 23-25)—"Tecnopinturas '93. First Argentine Congress on the Technology of Coatings, Resins, Varnishes, Printing Inks, and Related Products. Sponsored by the Argentine Chemical Association, Buenos Aires, Argentina. (TAL Organizaciones y Servicios, A.J. de Sucre 1552, 8vo. Piso "A" (1428) Buenos Aires, Argentina).

(June 23-25)—"Coating Process Fundamentals." Short course sponsored by University of Minnesota, Minneapolis, MN. (Jackie O'Brien, Dept. of Chemical Engineering & Materials Science, University of Minnesota, 421 Washington Ave. SE, Minneapolis, MN 55455).

(June 27-July 2)—ORGABROM '93 2nd International Symposium. Sponsored by the Dead Sea Bromine Group in cooperation with the Casali Institute of Applied Chemistry, The Hebrew University of Jerusalem. (Secretariat, P.O. Box 50006, Tel Aviv 61500, Israel).

(July 11-14)—Sixth International Symposium on "Polymer Analysis and Characterization." Crete, Greece. (Judith A. Sjöberg, Professional Association Management, 815 Don Gaspar, Santa Fe, NM 87501).

(July 12-16)—19th International Conference in Organic Coatings Science and Technology. Athens, Greece. (Angelos Patsis, Institute of Materials Science, State University of New York at New Paltz, New Paltz, NY 12561).

(July 25-29)—Conference on "Lead in Paint, Soil, and Dust." Cosponsored by ASTM Committees D-22, E-6, D-1, and D-18. University of Colorado, Boulder, CO. (ASTM, 1916 Race St., Philadelphia, PA 19103).

(July 28-30)—"Basic Coatings for Sales and Marketing Personnel." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (UMR Coatings Institute, 142 Schrenk Hall, Rolla, MO 65401).

(Aug. 2-6)—Gordon Research Conference on "Chemistry and Physics of Coatings and Films." Colby-Sawyer College, New London, NH. (A.K. St. Clair, Head, Advanced Aircraft Program Office, Materials Div., NASA, Langley Research Center, Hampton, VA 23681-0001).

(Aug. 3-5)—"Fundamentals of Corrosion and Its Control." Course sponsored by LaQue Center for Corrosion Technology. Blockade Runner Hotel, Wrightsville Beach, NC. (LaQue Center for Corrosion Technology, Inc., P.O. Box 656, Wrightsville Beach, NC 28480).

(Aug. 9-12)—"Coatings Science of Powder Coatings." Short course sponsored by University of Southern Mississippi (USM), Hattiesburg, MS. (Debbie Ballard or Shelby Thames, USM, Dept. of Polymer Science, Southern Station, Box 10076, Hattiesburg, MS 39406-0076).

(Sept. 5-10)—3rd International Congress on Polymer Photochemistry. Sponsored by Manchester Metropolitan University and University of Milan. Genova, Italy. (Emmezeta SRL, Via C. Farini, 70, I-20159, Milano, Italy).

(Sept. 8-10)—3rd International Paint Congress and Exhibition on Paint Industry Suppliers. Sponsored by the Brazilian Association of

Paint Manufacturers. Palácio de Convenções do Anhembi, São Paulo, Brazil. (Especifica S/C Ltda, Rua Augusta, 2516-2nd, Cj 22, 01412-100 São Paulo SP, Brazil).

(Sept. 8-11)—Conference on "Innovative Responses from an Industry under Siege." Sponsored by the Skandinaviska Lackteknikers Forbund (SLF) Congress. Copenhagen, Denmark. (Michael Symes, President, SLF, Stranboulevarden 38, DK-2100, Copenhagen, Denmark).

(Sept. 12-14)—"Back to Basics." 81st Annual Convention of the Canadian Paint and Coatings Association (CPCA). Queen's Landing Inn, Niagara-on-the-Lake, Ontario, Canada. (CPCA, 9900 Cavendish Blvd., Ste. 103, St.-Laurent, Quebec H4M 2V2, Canada).

(Sept. 14-17)—Eurocoat '93. (AFTPV-5, rue Etex, 75018 Paris-France).

(Sept. 23)—Detroit Colour Council Meeting. Michigan State Management Education Center, Troy, MI. (James Hall, General Motors Corp., 30009 Van Dyke, Warren, MI 48090).

(Sept. 29-Oct. 1)—"Accelerated and Natural Weathering Techniques for Coatings and Polymers." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Oct. 3-5)—"Crosslinked Polymers: Chemistry, Properties and Applications"; "Fundamentals of Adhesion: Theory, Practice and Applications"; and "Polymer Blends and Alloys: Phase Behavior, Characterization, Morphology, Alloying Technology." Conferences sponsored by State University of New York (SUNY) at New Paltz. New Orleans, LA. (Angelos Patsis, Institute of Materials Science, SUNY, New Paltz, NY 12561).

(Oct. 4-6)—"Polyethylene '93." Conference sponsored by Maack Business Services, Swissôtel Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH 8804, AU/ZH Switzerland).

(Oct. 5-8)—"Introduction to Coatings Technology." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Oct. 10-12)—"Advances in Polymer Colloids/Emulsion Polymers"; and "Principles of Polymer Degradation and Stabilization." Conferences sponsored by State University of New York (SUNY) at New Paltz. Orlando, FL. (Angelos Patsis, Institute of Materials Science, SUNY, New Paltz, NY 12561).

(Oct. 12-14)—"Industrial Painting: Application Methods." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Oct. 25-27)—"Polypropylene '93." Conference sponsored by Maack Business Services, Swissôtel Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH 8804, AU/ZH Switzerland).

(Oct. 25-29)—"Image Analysis and Measurement in Scanning Electron Microscopy"; "Scanning Electron Microscopy and X-Ray Microanalysis for Materials Science. An Introductory Course"; and "Scanning Electron Microscopy for Polymeric Science. An Introductory Course." Conferences sponsored by State University of New York (SUNY) at New Paltz. Nevele Resort Hotel, Ellenville, NY. (Angelos Patsis, Institute of Materials Science, SUNY, New Paltz, NY 12561).

(Nov. 1-4)—12th Biennial Symposium on Managing Corrosion with Plastics. Sponsored by National Association of Corrosion Engineers (NACE), American Society for Testing Materials, Materials Technology Institute of the Chemical Process Industries, Inc., SPI Composites Institute, and Technical Association of the Pulp and Paper Industry. Baltimore, MD. (NACE, P.O. Box 218340, Houston, TX 77218-8340).

(Nov. 2-4)—"Fundamentals of Corrosion and Its Control." Training course sponsored by LaQue Center for Corrosion Technology. Holiday Inn, Wrightsville Beach, NC. (LaQue Center for Corrosion Technology, Inc., P.O. Box 656, Wrightsville Beach, NC 28480).

(Nov. 10-12)—Electroless Nickel '93. Conference sponsored by Products Finishing. Orlando Airport Marriott, Orlando, FL. (Cindy Goodridge, Gardner Management Services, 6600 Clough Pike, Cincinnati, OH 45244).

(Nov. 15-16)—"Fundamentals of HPLC." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Nov. 15-17)—"Powder Coatings." Paint Research Association's (PRA) 13th International Conference. Brussels. (Conference Secretary, PRA, 8 Waldegrave Rd., Teddington, Middlesex TW11 8LD, United Kingdom).

(Dec. 6-9)—"Styrenics '93." Conference sponsored by Maack Business Services, Swissôtel Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH 8804 AU/ZH Switzerland).

1994

(Mar. 13-18)—"High Solids Coatings" Symposium. Sponsored by American Chemical Society Division of Polymeric Materials: Science and Engineering. San Diego, CA. (Frank N. Jones, Coatings Research Institute, Eastern Michigan University, 430 W. Forest St., Ypsilanti, MI 48197 or George R. Pilcher, Akzo Coatings, Inc., P.O. Box 147, Columbus, OH 43216-0147).

(Apr. 14-16)—Paint Show '94. Sponsored by Japan Paint Manufacturers Association, Japan Paint Commerce Association, Japan Painting Contractors Association, and Nippon Toryo (Paint) Club. Nippon Convention Center, Tokyo, Japan. (Paint Show '94 Executive Committee, Overseas Operation, c/o Space Media Japan Co., Ltd., Asahi Bldg. 4F, 2-31-3 Taito, Taito-ku, Tokyo 110 Japan).

(Apr. 17-19)—"Volatile Organic Compounds (VOCs) in the Environment" Symposium. Sponsored by ASTM Committee E-47. Montreal, Que., Canada. (Wuncheng Wang, Symposium Chairman, U.S. Geological Survey, WRD, P.O. Box 1230, Iowa City, IA 52244).

(May 1-5)—RadTech '94 North America. Conference sponsored by RadTech International North America. Walt Disney World Dolphin Hotel, Orlando, FL. (Chris Dionne, RadTech International North America, 60 Revere Dr., Suite 500, Northbrook, IL 60062).

(June 5-9)—XXIInd FATIPEC Congress and Exhibition. Budapest Convention Centre, Budapest, Hungary.

(July 11-15)—MACROAKRON '94 International Symposium. Sponsored by the International Union of Pure and Applied Chemistry. University of Akron, Akron, OH. (Dr. Joseph P. Kennedy, Chairman of the Organizing Committee, or Cathy Manus-Gray, Symposium Coordinator, College of Polymer Science and Polymer Engineering, The University of Akron, Akron, OH 44325-0604).

(Nov. 6-10)—International Adhesion Symposium. Sponsored by The Adhesion Society of Japan. Tokyo, Japan. (Hiroshi Mizumachi, Professor, Chemistry of Polymeric Materials, The University of Tokyo, Yayoi 1-1-1, Bunkyo-ko, Tokyo 113, Japan).

Advertisers Index

| | |
|--|----------------|
| BEROL NOBEL AB | Cover 2 |
| BURGESS PIGMENT CO. | Cover 3 |
| GENSTAR STONE PRODUCTS CO. | 80 |
| S.C. JOHNSON POLYMER | 11 |
| MILES INC., ORGANIC PRODUCTS DIV. | 2 |
| ROHM AND HAAS CO. | 4-5, 15 |
| SHAMROCK TECHNOLOGIES, INC. | Cover 4 |
| TROY CORP. | 9 |
| ***** | |
| SITUATIONS WANTED | 78 |

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'Humbug' from Hillman

April is Federation officers' "be kind to Humbug month." By remarkable coincidence, at the time of this writing (February 8th), within the past month I've had correspondence from three of the Technical Society's "BIG SHOTS."

Wise protocol suggests that I start with our hard working, illustrious President, Colin Penny, who took time out from his obviously pressing schedule to write, "As I travel for the FSCT, I have been forced to become an after-dinner speaker. As such, I have taken the trouble to seek advice on the subject. The results of this study might provide you with some fodder for Humbug."

The fodder:

—"An after-dinner speaker either drives his point home to the audience or drives his audience home."

—"Speeches are like babies—easy to conceive but hard to deliver."

—"One of the most popular after-dinner speeches is, "I'll get the bill!"

—"Advice to an after-dinner speaker: A speech does not have to be eternal to be immortal."

... End of fodder!

Then, I heard from the 1992 Roon Awards first prize winner, JCT's Technical Editor, Dr. Bob Brady. Now that our recent pun craze seems to have died down, I'm afraid that he is about to start a dangerous new trend—LIMERICKS! I must say, however, that Bob has selected four amusing samples and only one begins with, "There once was a young girl called . . .!"

"There once was a young girl called Bright
Who could travel much faster than light.
She set out one day
In a relative way,
And returned home the previous night."

"A mosquito was heard to complain
'A chemist has poisoned my brain!'
The cause of his sorrow
Was paradichloro-
diphenyltrichloroethane."

"S.P. Langley invented the bolometer
Which is really a kind of thermometer.
For measuring the heat
Of a polar bear's seat
At a distance of half a kilometer."

"A foolish paint maker named Will
Stirred fulminate up in a mill.
After much agitation—
A great detonation—
And management sent him the bill."

There'll be more from the "Brady Bunch" of stuff later.

Last, and caution prompts me to add—certainly not least—my Publisher and our Executive Vice President, Bob Ziegler, who dares to border on the political:

"It seems that President Clinton, after a couple of months in office, slipped on the tarmac and injured his head while boarding Air Force One. When he awakened in the hospital after being in a coma for three

years, a doctor was called immediately. Following an exam, the President was pronounced fully recovered. Anxious to learn the state of the nation, the President called an aide.

"What happened to the economy?" asked the President. "It's looking terrific," the aide said. "The deficit is gone, the budget is balanced, there is zero unemployment, and our trade overseas is at an all time high!"

Worried about inflation, the President asked, "Well, what is the price of a gallon of gas?" The aide responded, "It's been about the same for the past year—300 yen."

Remember, dear readers, Bob Ziegler is the publisher of the JCT, and as it is now, Humbug is on the last page!

David Heath, our esteemed Birmingham, England correspondent, sent a news clip from that jolly old place, here are excerpts:

Police Spelling is Criminal, Sauces Say by Neil Darbyshire, Crime Correspondent

Scotland Yard may be tempted to introduce a primary English course into its training curriculum following an extraordinary array of spelling and grammatical mistakes found in written crime reports.

Among the items stolen were a Grandfather, an England goalkeeper worth 31 pounds (a football jersey had been stolen) . . . a four-birth tent, a navel telescope, a Bathoven music book and a 25 pound note: value 20 pounds.

Descriptions of suspects were equally intriguing. One was 5 ft 12 in, another suffered from a brusie on the arm and a third who should not be too difficult to identify had large plates in his hair.

Clothing worn by wanted criminals also tended to the bizarre—a pale blue suite, a tucksido, a carkey jacket, a cheque cap, a tea shirt and a polar neck.

One burglar had apparently broken into a flat through the entryphone, another entered through a front door which was actually at the rear of the house, and a third got in by the painstaking method of forcing open a skylark.

One Pc. with a display of monumental hypocrisy, also wrote that a particular suspect did not speech good English.

The batch of 48 literary *faux pas* gleaned from the reports of the same police station was sent anonymously to *The Job*, the newspaper of the Metropolitan Police. When asked to disclose the identity of the police station, a spokesman for the newspaper said: "We never reveal our sauces."

It was also reported that a prostitute arrested grasping a six inch nail insisted she used it as an aid to putting on lipstick. A youth asked why he was carrying a screwdriver in his pocket answered that it was because his mother wouldn't let him carry a knife.

—Herb Hillman
Humbug's Nest
P.O. Box 135
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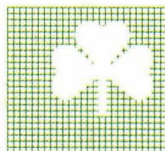
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