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#### GENERAL

The JOURNAL OF COATINGS TECHNOLOGY is published monthly by the Federation of Societies for Coatings Technology for its membership of approximately 7,000 in 26 Constituent Societies in the United States, Canada, Great Britain, and Mexico. The JOURNAL is devoted to the advancement of knowledge in the science and technology of surface coatings, the materials comprising such coatings, and their use and performance.

The Editors invite submission of original research papers, review papers, and papers under the special headings *Open Forum* and *Back to Basics*, and *Letters to the Editor*. All manuscripts will be assumed to be previously unpublished writing of the authors, not under consideration for publication elsewhere. When review papers contain tables or graphs from copyrighted articles, the authors will be required to obtain permission for use from the copyright holders. When the organization with which the authors are affiliated requires clearance of publications, authors are expected to obtain such clearance before submission of the manuscript. Papers presented to associations other than the Federation must be released by written communication before they can be considered for publication in the JOURNAL OF COATINGS TECHNOLOGY. Authors are obligated to reveal any exceptions to these conditions at the time a manuscript is submitted.

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Papers in which proprietary products or processes are promoted for commercial purposes are specifically nonacceptable for publication.

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Letters to the Editor: The JOURNAL will consider for publication all correspondence relevant to the coatings industry and to the contents of the JOURNAL. When a letter concerns an article appearing in the JOURNAL, the original author is usually given an opportunity to reply.

#### ...by Constituent Societies For Annual Meeting Presentation

Ten complete copies of the manuscript are required for committee review. The set of copies should be addressed to the Editor at the address listed previously.

#### ... for Roon Foundation Award Competition

Ten complete copies of the manuscript are required, and should be submitted to the Chairman of the 1994 Roon Awards Committee, N. Bradford Brakke, Lilly Industries, Inc., 521 W. McCarthy St., Indianapolis, IN 46225. (For complete details, see "Roon Awards" section of the JOURNAL in January 1993 issue.)

#### MANUSCRIPT PREPARATION

In general, authors are advised to use the "Handbook for Authors" published by the American Chemical Society as a guide to the preparation of manuscripts (ACS, 1155 Sixteenth St., Washington, D.C. 20036). Another excellent reference work is "How to Write and Publish a Scientific Paper," by Robert A. Day (ISI Press, 3501 Market St., University City Science Center, Philadelphia, PA 19104).

Authors are encouraged to consider submissions in several categories and to prepare their manuscripts accordingly. The categories are:

Original Research Papers: The main technical content of the JOURNAL OF COATINGS TECHNOLOGY will continue to be original research papers. Editors support the trend in scientific writing to a direct, less formal style that permits limited use of personal pronouns to avoid repititious or awkward use of passive voice.

Review Papers: Papers that organize and compare data from numerous sources to provide new insights and unified concepts are solicted. Reviews that show how advances from other fields can beneficially be applied to coatings are also desired. Reviews that consist mainly of computer searches with little attempt to integrate or critically evaluate are not solicited.

Open Forum: Topics for this category may be nontechnical in nature, dealing with any aspect of the coatings industry. The subject may be approached informally. Editors encourage submission of manuscripts that constructively address industry problems and their solutions.

Back to Basics: Papers that provide useful guides to Federation members in carrying out their work are solicited. Topics in this category are technical but focus on the "how to" of coatings technology. Useful calculations for coatings formulation and procedures that make a paint test more reproducible are examples of suitable topics. Process and production topics, i.e., paint manufacture, will also be reviewed in the Back to Basics category.

If a submitted paper consists of the text of a presentation made previously to a monthly or special meeting of a Society for Coatings Technology, or to another technical group, the name of the organization and the date of the presentation should be given. If someone other than the author of the paper made the presentation, this information, too, should be noted. Papers originally composed for oral presentation will have to be revised or rewritten by the author to conform to the style described in this guide.

Manuscripts should be typed with double spacing on one side of  $8^{1}/2 \times 11$  inch (22 x 28 cm) paper, with at least one-inch (2.5 cm) margins on all four sides. All paragraphs should be indented five spaces, and all pages should be numbered at the top center, or upper right corner.

#### Title

The title should be as brief and informative as possible. Selection of titles that are key word-indexable is a helpful and recommended practice.

#### Authors' Biographies and Photographs

Give complete names, company or institutional affiliations, and brief biographical sketches of all authors. If available, submit a 5 x 7 inch (13 x 18 cm) black-and-white photograph with glossy or smooth high sheen surface, for each author. See later section on photographs for further details.

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Only as much review as is necessary should be given to provide an introduction to the subject; the main burden for extensive background should be placed on the list of references.

Standard scientific and technical terminology should be used to convey clear and unambiguous meaning, but the use of technical jargon or slang should be avoided. Authors should bear in mind that the JOURNAL has an international audience, for many of whom English is a second, not native, language. Use of regional idioms or colloquialisms should be avoided. The use of obscure abbreviations is also discouraged. When appropriate, abbreviations should be made in parenthesis immediately following first mention of the term in the text, and then used alone whenever necessary.

Recent issues of the JOURNAL should be consulted for desired style and technical level.

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Metric system units should be used wherever applicable with the equivalent English units shown afterwords in parentheses. The ASTM Metric Practice Guide, E 380-72 (American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103) is a convenient reference.

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Tables, rather than descriptive text, should be used only when they are genuinely helpful. They should be proportioned in accordance with the height and width limitations of the JOURNAL's pages. Each table should be typed on a separate sheet, rather than included in the text, and appended to the manuscript. Each table should be numbered and have a descriptive caption. Tables should be referenced in the text (e.g., "See *Table* 1").

In numerical data in tables, numbers less than one should have a zero before the decimal point.

*Graphs* should be on good quality white or nonphotographic blue-lined  $8^{1}/2 \times 11$  inch paper. Each graph should be drawn on a separate sheet, numbered, and the captions listed on a *copy* of the original graph. Graph captions and legends should also be typed on a separate sheet from original for typesetting.

*Drawings* should conform to the guidelines given for Graphs and should be proportioned to fit the height-to-width ratio of the JOURNAL'S pages and columns.

#### Photographs

All photographs should be sharp, clear, black-and-white prints no larger than 8  $\times$  10 inches in size. Photos should be clearly labeled on the reverse side, taking care not to mar the image.

Color prints and slides are unacceptable.

When illustrations are secured from an outside source, the source must be identified and the Editor assured that permission to reprint has been granted.

#### Nomenclature

Whenever possible, generic names should be used in preference to trade names. When trade names must be used to avoid ambiguity, and the name is a registered trademark, the symbol R, in a circle or parentheses, should be given immediately following, and the manufacturer listed as a footnote. In general, trade names should be used only in footnotes or in an appendix, rather than in the text.

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Nomenclature of chemical compounds should conform to the style of *Chemical Abstracts* and the IUPAC rules. For oligomeric or polymeric materials, characteristics such as molecular weight, polydispersity, functional group content, etc. should be provided.

#### Equations

Equations must be typed, or written clearly, with equations numbered sequentially in parentheses to the right. If Greek letters are used, write out their names in the manuscript margin at the first point of use. Place superscripts<sup>a</sup> and subscripts<sub>b</sub> accurately. Avoid the use of superscripts in a manner that can lead to their interpretation as exponents.

#### Summary

The paper should be concluded with a summary which is intelligible without reference to the main text. The summary may be more complete than the abstract, listing conclusions drawn from the text. A well written summary can serve to inspire the busy reader to turn back to the paper, to read it thoroughly.

#### Acknowledgment

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These should be listed in the numerical order in which they are cited in the text, and should be placed at the end of the manuscript. Names of authors may or may not be shown in the text with reference numbers. If possible, include titles of articles referenced in the literature. The following are examples of acceptable reference citations for periodicals, <sup>12,3</sup> books, <sup>4</sup> and patents.<sup>5</sup>

- Pascal, R.H. and Reig, F.L., "Pigment Colors and Surfactant Selection," Official DIGEST, 36, No. 475 (Part 1), 839 (1964).
- (2) Davidson, H.R., "Use and Misuse of Computers in Color Control," JOURNAL OF COATINGS TECHNOLOGY, 54, No. 691, 55 (1982).
- (3) Stephen, H.G., "Hydrogen Bonding—Key to Dispersion?," J. Oil & Colour Chemists' Assoc., 65, No. 5, 191 (1982).
- (4) Patton, T. (Ed.), Pigment Handbook, Vol. 1, John Wiley & Sons, Inc., New York, 1973.
- (5) Henderson, W.A. Jr. and Singh, B. (to American Cyanamid Co.), U.S. Patent 4,361,518 (Nov. 30, 1982).

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## Comment

#### A Disc by Any Other Name . . .

As any parent-to-be knows, choosing a name for your child can be an intimidating task. You scour the books of baby names, mentally combining the choices with your own last name, searching for that special combination that proclaims your child's uniqueness. When that doesn't work, some people draw from the annals of history (or even Hollywood) in the hopes that whatever qualities made a person famous will somehow be passed on to their namesakes. (Just consider the number of "John Fitzgeralds" in the 1960s or "Farrahs" in the '70s.)

However chosen, a name provides an initial definition upon which (for better or worse) impressions are formed.

This was the challenge facing the FSCT as it sought a name for its Coatings MSDS CD Retrieval System. The System, first conceived by the Technical Committee of the Chicago Society for Coatings Technology, has evolved into one of the most exciting projects ever developed by the Federation. Therefore, its name needed to convey a sense of vision—the vision of those who found a way to use state-of-the-art technology to offer some relief to an industry overburdened by government legislation.

This name also needed to reflect the ever-expanding data base of information contained on the System. The initial disc, released this month, provides access to over 8400 MSDS from leading coatings raw material suppliers. With each quarterly update sent to all subscribers, this data base will continue to grow, offering the most comprehensive source of MSDS for the coatings industry. In addition, powerful search software enables users to have control over the immense amount of data stored on the System.

With these points in mind—an unlimited vision — an ever-changing view — a comprehensive survey—the choice for a name became obvious. Therefore, it is with great pride and satisfaction, that the Federation introduces . . . (insert drum roll here) . . . a new vista in Material Safety Data Sheet access, storage and retrieval . . .



Patricia d'Viola

Patricia D. Viola, Editor

Journal of Coatings Technology

7

## Abstracts of Papers in This Issue

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

#### A New Sample Preparation Technique for the Examination and Analysis of Paint Film Defects—T.J. Veneri and J.A. Kramer

JCT, 66, No. 829, 23 (Feb. 1994)

A paint film cross-sectioning technique has been developed which allows simultaneous characterization of a paint defect and the underlying substrate and pretreatment. The advantages of the technique include speed, accuracy of cross-sectioning the defect, simplicity, lack of polishing artifacts, and a pseudo-three-dimensional perspective which uniquely reveals the relationship between the defect, paint film and substrate. Disadvantages include possible damage to the sample or removal of contaminants by the solvents used.

The prepared sample may be examined using an optical or scanning electron microscopy (SEM), and analyzed by x-ray fluorescence (XFR) or other methods. The technique has proven especially useful for pinpointing the cause of defects resulting from interaction of the substrate or pretreatment with the paint film. This paper describes the practice of the technique and its application to solving production problems related to paint defects.

#### High-Solids Nonaqueous Dispersion Coatings Based on Crystalline Oligoesters—G. Teng and F.N. Jones

JCT, 66, No. 829, 31 (Feb. 1994)

Nonaqueous dispersions (NADs) of a crvstalline oligoester diol were prepared by crystallization in a medium consisting of amorphous diol, reactive diluent (RD), and a solvent. The crystalline diol (6GT) was prepared from terephthalic acid and 1,6hexanediol; RD was prepared from terephthalic acid and glycidyl neodecanoate. The dispersions are opaque, thixotropic liquids with low viscosities at solids of 60 to 70 wt %. X-ray and calorimetry studies show that the dispersed particles are crystalline. Microscopy shows that they have a narrow distribution of diameters, varying from 5 to 20 µm depending on process conditions. When formulated with crosslinkers (melamine or isocyanate resins) and baked at temperatures above the melting point of the crystalline diol, these NADs gave transparent coatings. Glossy pigmented coatings were also prepared. As high-solids coat-

#### Une Nouvelle Technique de Préparation d'Echantillon Pour l'Analyse des Défectuosités des Feuils de Peintures—T.J. Veneri et J.A. Kramer

JCT, 66, No. 829, 23 (Feb. 1994)

Une technique de sectionnement de feuil de peinture a été développée, permettant la caratérisation simultanée d'une défectuosité de la peinture et du subjectile sous-jacent ainsi que la pré-traitment. Les avantages de cette technique sont la vitesse, la précision du sectionnement, la simplicité et le manque d'artéfacts de polissage et d'une pseudo perspective tri-dimensionnelle qui révèle uniquement la relation entre la défectuosité, le feuil de peinture et le subjectile. Les désavantages incluent les dommages possibles à l'échantillon ou l'enlèvement de contaminants par les solvants utilisés.

L'échantillon préparé peut être examiné avec l'aide d'un microscope à balayage électronique ou optique, et analysé par fluorescence aux rayons-X, ou par d'autres méthodes. La technique s'est avérée spécialement utile pour déceler la cause des défectuosités résultant de l'interaction du subjectile, ou du pré-traitement, avec le feuil de peinture. Cette publication décrit la pratique de la technique et de ses applications à résoudre des problèmes de production reliés aux défectuosités de la peinture.

#### Revêtements à Base de Dispersions Non-Aqueuses à Haute Teneur en Matières Solides Basés Sur Des Oligoesters Cristallins—G. Teng et F.N. Jones

JCT, 66, No. 829, 31 (Feb. 1994)

Des dispersions non-aqueuses (NAD) d'un diol d'oligester cristallin ont été préparés par cristallisation dans un médium consistant en un diol amorphe, un diluant réactif et un solvant. Le diol cristallin (6GT) a été préparé à partir de l'acide terphthalique et le 1,6hexanediol; le diluant réactif a été préparé à partir de l'acide terphthalique et du néodécanoate de glycidyl. Les dispersions sont des liquides thixotropiques opaques à basse viscosité et possédant une teneur en matières solides de 60 à 70% par poids. Des études calorimétriques et de rayons-X ont démontré que les particules dispersées sont cristallines. La microscopie démontre que les particules possèdent une distribuUna Nueva Tecnica de Preparacion de Muestras Para La Elimanción y Analisis de Defectos en Las Peliculas de Pintura—T.J. Veneri and J.A. Kramer

JCT, 66, No. 829, 23 (Feb. 1994)

Ha sido desarrollada una técnica de una pelicula de pintura de corte transversal que permite la caractérización simultánea del defecto de pintura, el sustrato implicito y el pretratamiento. Las ventajas de está tecnica incluyen velocidad, exactitud en el corte transversal del defecto, simplicidad, ausencia de artefactos de pulimiento, y una perspectiva pseudo-tridimensional que revela de manera única la relación entre el defecto, la capa de pintura y el sustrato.

Las desventajas incluyen daño posible a la muestra, o remoción de contaminantes por los solventes utilizados.

La muestra preparada puede ser examinada utilizando un microscopic óptico o un microscopio de scanso de electrones (SEM), y analizada por fluorescencia de rayos X (XRF) u otro métodos. La técnica ha probado ser util especialmente para señalar la causa de defectos resultantes de la interacción del substrato o pretratamiento con la capa de pintura.

Este ensayo describa la práctice de la técnica y su aplícación para resolver problemas de producción relacionados a defectos de pintura.

#### Recubrimientos no Acuosos de Altos Solidos Basados en Aligoesteres Cristalinos—G. Teng and F.N. Jones

JCT, 66, No. 829, 31 (Feb. 1994)

Dispersiones no acuosas (NADs) de un diol de oligoéster cristalino fueron preparadas por cristalización, en un medio consistente de un diol amorfo, un diluyente reactivo (RD) y un solvente. El diol cristalino (6GT) fué preparado a partir de ácido tereftálico y el 1.6 Hexanodiol; El RD fue preparado a partir de ácido tereftálico y neo-decanato glicidílico. Las dispersiones son opacas, son liquidos tixotrópicos con viscosidades bajas en solidos del 60 al 70% en peso. Estudios de rayos X y Calorimetria demuestran que las particulas dispersas son critalinas. La microscopia demuestra que tienen una distribución de diámetros angosta variando de 5 a 20 um dependiendo de la condiciones del proceso. Cuando se formulan con resinas de uniones cruzadas (melamina o

ings, these materials provide excellent application properties (resistance to sagging) and a good balance of film physical properties. While some of the formulated coatings stratify on standing, they can be restored to homogeneous, free-flowing liquids by stirring gently.

#### Aluminum Trihydroxide (ATH): A UV Transparent Filler for UV-Curable Coatings—A.A. Parker, E.S. Martin, and T.R. Clever

JCT, 66, No. 829, 39 (Feb. 1994)

Unlike other extenders, aluminum trihydroxide (ATH) absorbs very little 'activate most UV photoinitiators (220 to 400 nm). This is demonstrated by comparing the total transmittance (diffuse and specular) of UV-cured polyurethane films with and without the use of ATH as an extender. Difference spectra between filled and unfilled systems show that ATH does not interfere with the transmittance of UV light. On the other hand, a comparable study with a silica-filled system indicates that a higher proportion of UV light is absorbed. Solid state <sup>13</sup>C NMR and FTIR spectra of ATHfilled, silica-filled, and neat systems show that the final chemical components of the crosslinked polymer matrices are similar. However, FTIR analyses of residual acrylate absorbances near 830 cm<sup>-1</sup> show that the ATH-filled systems exhibit higher degrees of cure than both the neat and the silica-filled systems. This agrees with differential photocalorimetry (DPC) studies which show that the enthalpy of cure increases in the presence of ATH. Diffuse reflectance studies of neat powders indicate that ATH exhibits higher reflectivity than silica in the UV range. Thus, the difference in UV absorption behavior between the filled and neat polymer films, and the difference in the degree of cure can be attributed to differences in filler absorption and reflectivity. Taken together, these trends indicate that, unlike other fillers, ATH can function as a UV transparent extender for UV-curable polymer applications.

## The Influence of Defoamers on the Efficiency of Waterborne Coating Systems—W. Heilen, O. Klocker, and J. Adams

#### JCT, 66, No. 829, 47 (Feb. 1994)

Foam problems during production and application of waterborne systems are common. The reasons for the generation and stabilization of foam, and the types of foam is these systems, have been the subject of numerous discussions. Foam is generated and stabilized by the presence of surfaction étroite de diamètres, variant de 5 à 20 um dépendant des conditions de procédés. Lorsque formulés avec des agents de réticulation (mélamine ou résines isocvanate) et cuits à des températures supérieures au point de fusion du diol cristallin, ces NAD ont donnés des revêtements trasparents. Des revêtements pigmentés brillants ont également été préparé. Comme revêtements à haute teneur en matières solides, ces matèriaux donnent d'excellentes propriétés d'application (résistance à l'affaissement) et une bonne balance de propriétés physiques du feuil. Quelques uns des revêtements formulés ont stratifié, mais ont pu être rendus homogènes par un simple agitement.

#### Trihydroxyde D'aluminum (ATH): Une Matière de Remplissage Transparente Aux UV Pour Les Revêtements Durcissables Aux Rayons Ultra-Violets—A.A. Parker, E.S. Martin, et T.R. Clever

JCT, 66, No. 829, 39 (Feb. 1994)

Contrairement aux autres matières de charge, le trihydroxyde d'aluminum (ATH) absorbe très peu de radiations ultra-violettes pour la gamme de longueur d'ondes qui est habituellement ultilisée pour activer la plupart des photoinitiateurs UV (220 à 400 nm). Ceci est démontré en comparant la transmittance totale (diffuse et spéculaire) de feuils de polyuréthanes durcis aux rayons ultra-violets avec et sans l'utilisation d'ATH comme matière de charge. La différence entre les spectres démontre que l'ATH n'interfère pas avec la transmittance de la lumière UV. Par contre, une étude comparable avec un système contenant de la silice, indique qu'une plus grande proportion de lumière UV est absorbée. Les spectres à l'état solide de résonnance magnétique nucléaire au carbone 13 (<sup>13</sup>c NMR) ainsi qu'à l'infra-rouge à la transformée de fourier (FTIR), pour de systèmes contenant respectivement de l'ATH, de la silice et aucune matière de charge démontre que les composés chimiques finaux des matières réticulées sont similaires. Par contre, les analyses de FTIR des absorbances des acrylates résiduels près de 830 cm démontrent que les systèmes contenant l'ATH possèdent un plus haut degré de durcissement que ceux contenant la silice. ainsi que ceux ne contenant aucune matière de charge. Ceci est en accord avec les études de photocalorimétrie différentielle (DPC) qui montrent que l'enthalpie du durcissement augmente avec la présence de l'ATH.

Des études de réflectance diffuse de systèmes sans aucune matière de charge indiquent que l'ATH possède une plus grande réflectivité que la silice dans la gamme des UV. Donc, la différence d'absorption UV entre les films polymériques avec et sans matière de charge, et la resinas de Isocianato) y se colocan a temparaturas por arriba del punto de fusion del diol cristalino estas NADs dan recubrimientos transparentes.

Recubrimientos brillantemente pigmentados también se preparan como recubrimientos de altos sólidos, estos materiales proveen propiedades de aplicacion excelentes (resistencia "Sagging") y un buen balance de propiedades físicas de película.

Mientras que algunas capas formuladas pueden ser regenerados en liquidos libres de corriente por medio de una sencilla agitación.

#### Trihidroxido de Aluminio (ATH): Un Relleno Transparente Para Recubrimientos Curables de UV—A.A. Parker, E.S. Martin, and T.R. Clever

JCT, 66, No. 829, 39 (Feb. 1994)

A diferencia de otros extendedores el trihidróxido de Aluminio (ATH) absorbe muy poca radiación ultravioleta en el rango de longitud de onda, la cual es comun para activar la mayoria de los rotoiniciadores UV (220 a 400 nm). Esto es demostrado al comparar la transmitancia total (difusa y especular) de películas de poliuretano curadas por UV con y sin el uso de ATH como un extendador, la diferencia espectral entre sistemas con carga y sin carga demuestran que el ATH no interfiere con la transmitancia de la luz ultravioleta. Por otra parte, un estudio comparable con un sistema cargado con sílica indica que una mayor proporción de luz ultravioleta es absorbida. El espectro en estado solido de NMR<sup>13</sup>C

y FTIR de sistemas con carga de ATH, cargadas con silica, y puros, demuestran que los componentes quimicos finales de las matrices de los polímeros de uniones cruzadas son similares. Sin embargo, el analisis de FTIR de absorbencias de acrilato residual cerca de 830 cm<sup>-1</sup> de ATH exhiben grados superiores de curado que los otros dos sistemas. Esto concuerda con los estudios de fotocalorimetría diferencial (DPC) que demuestra que la entalpía del curado se incrementa con la presencia de ATH. Un estudio de reflectancia difusa de polvos puros indica que el ATH exhibe un poder de reflexión superior a la silica en el rango UV. Por tanto, la diferencia en el comportamiento de absorcion de UV entre las capas de polímero puro y cargado y la diferencia en el grado de curado pueden ser atribuídos a diferencias en la absorción de la carga y reflactancia.

Estas tendencias indican que a diferencia de otras cargas el ATH puede funcionar como un extendedor transparente para aplicaciones de polímeros curables de UV. tants commonly found in small concentrations (e.g., wetting agents and polymer emulsifiers). Destabilization of foam is achieved through the addition of substances which orient themselves at the air/liquid interface, resulting in a reduction of surface tension. This paper discusses the different types of foam, the phenomenon of foam generation, and the physical and chemical aspects of the technology and substances available to destabilize foam successfully. différence du degré de durcissement peut être attribuée aux différences d'absorption et de réflectivité de la matière de charge. Tous ces faits démontrent que contrairement à d'autres matières de charge, l'ATH peut fonctionner comme une matière de charge transparente aux UV pour les polymères durcissables aux rayons ultra-violets.

#### L'Influence des Antimousses Sur l'Efficacité des Systèmes de Revêtements Aqueux—W. Heilen, O. Klocker, et J. Adams

JCT, 66, No. 829, 47 (Feb. 1994)

Les problèmes de mousse durant la production et l'application de systèmes aqueux sont chose courante. Les raisons pour la génération et la stabilisation de la mousse, et les types de mousse dans ces systèmes, a été le sujet de nombreuses discussions. La mousse est générée et produite par la présence d'agents tensio-actifs que l'on retrouve en petite concentration (par exemple, agents mouillants et émulsifiants polymériques). La déstabilisation de la mousse est accomplie par l'addition de substances qui s'orientent elles-mêmes à l'interface air/liquide, résultant en une réduction de la tension de surface. Cette publication discute des différents types de mousse, le phénomène de génération de la mousse, et les aspects physico-chimiques de la technologie et sustances disponibles pour déstabiliser la mousse avec succès.

#### La Influencia de Antiespumantes en la Eficiencia de Sistemas de Recubrimento Base Agua—W. Heilen, O. Klocker, and J. Adams

JCT, 66, No. 829, 47 (Feb. 1994)

Los problemas de espuma durante la producción y aplícación de los sistemas base agua son comunes. Las razones para la generación y estabilización de espuma y los tipos de espuma en estos sistemas han sido objeto de numerosas discusiones. La espuma es generada y estabilizada por la presencia de surfactantes comunmente encontrados en pequeñas concentraciones (por ejemplo, los agentes de humidificación y emulsificantes de polimeros).

La estabilización de la espuma es alcanzada por la adición de sustancias las cuales se orientari ellos mismos en la interface aire/liquido, resultando en una reducción de la tensión superficial.

Este documento discute los diferentes tipos de espuma, el fenómeno de generación de espuma y aspectos fisicos y químicos de la tecnolgia y sustancias disponibles para desesttabilizar la espuma de manera exitosa.

### Fred G. Schwab, 1993 FSCT Heckel Award Winner and Member of Cleveland Society, Passes Away on Dec. 9, 1993

By whatever criteria one measures success, Fred G. Schwab was outstanding. His knowledge of technical matters gained him

the position of Executive Director of Coatings Research Group, Inc., of Cleveland, Ohio. His interest in making the industry better led him to the Presidency of the Cleveland Society for Coatings Technology and duties on a national level with the FSCT. Yet, while his knowledge and professionalism led to a successful career, Fred himself would measure success differently-as husband and father in a loving family, and as friend and mentor to many of his colleagues. When he passed away on December 9. in Cleveland at the age of 65, the many individuals whose

lives were touched by Fred remembered him for his friendship and gentle ways.

These friends and the industry gathered last October in Atlanta to present him with the Federation's highest honor, the George Baugh Heckel Award. In his acceptance, Fred thanked and acknowledged the many people who influenced and guided him during his career, including his family who were in attendance.

Born in Louisville, KY, he was graduated from Vanderbilt University in 1948 with a Bachelor's Degree in Chemistry. He was first employed by Jones-Dabney Company, in Louisville, and later worked for Ferbert-Schorndorffer Company, in Cleveland, prior to joining CRGI as a Senior Chemist. He was named to the top position at CRGI in 1985.



As a 35-year member of the Cleveland Society, he served as its President in 1976-77 and also as the Society's Technical and



so as the Society's Technical and Membership Committee Chairman. He was elected an

He was elected an Honorary Member of the Society in 1991 and was the recipient of the group's Frank N. Selden Award and the Award of Merit.

Fred's commitment to the industry brought him to serve on the national committees of the FSCT as Chairman of the Annual Meeting Program and Mattiello Lecture Committees, as well as By-Laws Committee Chairman from 1980 until his death. He also served as a member of the FSCT Board of Directors, as Representative of the Cleveland Society from 1978-92, including a three-year term on the FSCT Executive Committee. His national service extended to membership on the Investment, Corrosion, Professional Development, Memorial, Nominating, Practical Projects, and Paint Show Awards Committees.

Beyond his industry involvements, Fred was an accomplished organist who was also active in his church and worked with the Jaycees and Girl Scout Council.

He is survived by his wife, Doris; two daughters, Becky S. Moldaver and Carol A. Klun, of Cleveland; one son, Gary, of Charlotte, NC; and two grandchildren.

## Guidelines for Submitting Society Papers for the A.F. Voss/American Paint and Coatings Journal Awards

Each year, the A.F. Voss/American Paint and Coatings Journal Awards are presented at the Federation Annual Meeting in recognition of the top Society papers delivered at the program.

Technical Committees of Societies preparing papers for presentation at the 1994 Annual Meeting in New Orleans must advise the Awards Committee by June 1, 1994. Societies which do not meet this deadline will be entered in the 1995 competition.

The following is a brief description of the Awards:

**Purpose:** To recognize the most constructive papers by Constituent Societies of the Federation on the research, development, manufacture, or application of the industry's products or raw materials entering into their preparation.

*Nature:* The awards consist of a total of \$1,000 distributed in accordance with the classifications and amounts decided upon by the AFV/APCJ Awards Committee. Awards are made to Societies, not to authors.

Establishment & Support: Sponsorship is by the American Paint and Coatings Jour-

nal Company. This award was established in 1927 and first awarded in 1929. The Awards Committee is chosen by the President of the FSCT.

**Rules of Eligibility:** Papers must be prepared by Constituent Societies and presented by a member at the Annual Meeting. Papers submitted may have been presented or published within the last twelve months without affecting their eligibility.

Procedures: Interested Societies must advise FSCT of their intention to submit a paper, in writing, no later than June 1, prior to the Annual Meeting. The manuscript must comply with the "Guide for Authors" published in each January issue of the JOURNAL OF COATINGS TECHNOLOGY. Ten copies of the publication manuscript must be submitted to the Federation office by July 30 prior to the Annual Meeting at which the papers will be presented. "Awards Policy" provisions shall apply. Papers submitted after the deadline will be considered for the next year's competition. Strict adherence to deadlines will be enforced

## 1994 FSCT Spring Week to Focus on "Adhesion in Coatings: Technology and Characterization," May 12-13 in Minneapolis

"Adhesion in Coatings: Technology and Characterization" has been selected as the theme for FSCT's Spring Week Technical Program, slated for Thursday and Friday, May 12-13, 1994. The meeting will be held at the Marriott City Center Hotel in Minneapolis, MN. This year's program has been developed by FSCT's Technical Advisory Committee.

Critical to meeting coatings performance requirements is a formulator's ability to understand and measure the adhesion of a coating to a substrate. This has become even more difficult as newer substrates are introduced, most of which require new coatings formulations. Adding to the challenge are the advancements in adhesion technology and the demand for universal adhesion by coatings (that is, one coating to adhere to a variety of substrates).

The two-day program will include presentations by 17 experts in the field, with topics ranging from Surface Technology to Lab Information Management. Seminar attendees will also have ample time to discuss problems and learn time-honored solutions to these problems with the speakers throughout the event.

#### Program

Topics and speakers for the event include the following:

#### OVERVIEW

"Surfaces/Adhesion"—Dr. Gene Sparrow, Advanced R&D, Lake Elmo, MN

"Corrosion/Adhesion"—Richard Granata, Lehigh University, Bethlehem, PA

#### Adhesion Promotion

"Plastic Pretreatments"—Satchit Srinivasan, D&S International, Grand Prairie, TX

"In-Mold Plasma"—Mike Tisack, Ford Motor Co., Detroit, MI

"Surface Modification of Molded Polyolefin Parts with Electrical Discharges"—Mark Blitshteyn, Tantec, Schaumburg, IL

"An Investigation into How Chlorinated Polyolefins Promote Adhesion of Coatings to Polypropylene"— Jonathan Lawniczak, Eastman Chemical, Kingsport, TN

#### TECHNOLOGY

"Powder (Chemistry)"—C. David Green, Ferro Corporation, Cleveland, OH

"Powder (Application)"—Chuck Dannick, RUCO Polymers, Plymouth, MN

"Coil Coatings"—to be announced "High Speed and Low Temperature Cur-

ing Using UV for Procession of Coatings,

Inks, and Adhesives"—Dick Stowe, Fusion UV Curing Systems, Rockville, MD

"Supercritical CO,"—Dr. David Busby, Union Carbide Corp., South Charleston, WV

"Waterbase Paint Technologies for Automotive Plastics"—Dr. Robert Piccirilli, PPG Industries, Inc., Cleveland, OH

#### **TEST METHODS**

"Mechanical Parasitic Energy Effects and Their Accommodation in Intrinsic Adhesion Energy Testing Using the Hesiometer (Blade Cutting) Technique"—Daniel K. Regert, Adhesion International, Spokane, WA

"Film Thickness Measurement (PELT)" —Sam Rosenberg, GSR, Pittsford, NY

"Surface Profiling"—Steve Dawson or Jim Poke, Diffracto, Detroit, MI

"Impact Testing"—A.C. Ramamurthy, Ford Motor Co., Detroit, MI

#### TREATMENT OF DATA

"Lab Information Management"—Jeff Cawley, Northwest Analytical, Portland, OR

#### Registration

The registration for the event is \$175 for FSCT members and \$225 for non-members.

The registration fee includes two luncheons, refreshment breaks and a portfolio containing information on the papers presented at the event.

#### Housing

Requests for seminar room accommodations at the Marriott City Center must be made on the seminar registration form and returned to FSCT Headquarters.

The guest room rate is \$111 for single or double occupancy. The cut-off date for reservations is April 20, 1994.

Located in the city's financial and retail district, the Marriott is directly connected to the world famous Skyway System. The hotel features 584 guest rooms and offers two restaurants, a lounge and health club facilities.

#### Transportation

Discounted air travel arrangements on Northwest Airlines are available for the Spring Week seminar. Contact the FSCT Travel Desk at 1 (800) 448-FSCT and mention the code FSCT-SW or contact Northwest directly at 1 (800) 328-1111 and reference the code NCU9N to receive the discounted fares.

Shuttle transportation from Minneapolis-St. Paul International Airport to the Marriott City Center Hotel is available via Airport Express. The fare is \$10 one way and \$15.50 round trip. Airport Express shuttle service departs from the airport at Area No. 8 every 15 minutes from 6 a.m. to midnight.

#### Nominations Sought for Armin J. Bruning Award

Dr. Robert T. Marcus, Chairman of the Bruning Award Committee, has announced that nominations are being sought for the 1994 recipient of this award. Established to recognize an individual for outstanding contributions to the science of color in the field of coatings technology, the award commemorates Mr. Bruning, the inventor of the Davis-Bruning colorimeter. Mr. Bruning was noted for his devotion to the pursuit of the scientific study of color.

A nominee for the award must have contributed significantly to the field of color study. These contributions could include very basic work which increases our understanding of the interaction of colorants, light and observers (human and instruments). However, the contributions of the nominee could also include various aspects of techniques or theories developed by others, or the teaching of color science or the dissemination of information in a manner which has direct benefit to the coatings industry. The nominee does not have to be a member of a Society or the FSCT.

To nominate an individual for the Bruning Award, please contact Dr. Marcus, Chairman, at Pantone, Inc., 55 Knickerbocker Rd., Moonachie, NJ 07074, (201) 935-5500.

The nomination must include documentation concerning the nominee's qualifications and contributions in the area of color science for the coatings industry. Nominations must be received prior to April 1, 1994.

### "ADHESION IN COATINGS: TECHNOLOGY AND CHARACTERIZATION"

**REGISTRATION FORM** 

May 12-13, 1994 • Marriott City Center Hotel, Minneapolis, MN

NAME           NICKNAME (for badge)           JOB TITLE           COMPANY           ADDRESS           CITY           PHONE	STATE ZIP FAX
I am a member of the following Federation Society:	
MET	HOD OF PAYMENT
REGISTRATION FEES: FSCT members—\$175	Non-members—\$225
Registration fee includes lunches, breaks, and copies	of any support documentation from the speakers.
Payment is due with the registration form.	
Total amount due \$	
Please check one:	
Enclosed is check # payable in U.S	Funds on a U.S. Bank to FSCT.
□ Charge to the following credit card: □ AME	X VISA MASTERCARD
Card #	Expiration Date (mo. and yr.):
Signature (Credit card payment only):	
Please print cardholder's name:	
PLEASE CHECK ONE BOX IN EACH OF THE TWO YOUR COMPANY IS	COLUMNS BELOW: YOUR POSITION IS
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но	TEL INFORMATION
Arrival Date Estimated Time of	of Arrival Departure Date
Room Rate: \$111 (Single or Double Occupancy) Ro	om Requests:  Single Occupancy  Double Occupancy
<ul> <li>One night's deposit enclosed (separate</li> </ul>	check payable to Marriott City Center Hotel)
<ul> <li>One night's deposit using credit card (fill</li> </ul>	in information and expiration date below):
Credit Card:  AMEX V	ISA 🗆 MASTERCARD
Card #	Expiration Date
Signature	
Room Reservations will be held until 6:00 pm unle CHECK-IN TIME IS 3	ss guaranteed by one night's deposit or major credit card and signature 3:00 PM_CHECK-OUT TIME IS 12 NOON
Reservations must be made no late	r than <b>April 20, 1994</b> to guarantee availability and rates.
Attendees paying the registration te	e with a credit card can FAX the form to: (610) 940-0292
492 Nor	rristown Rd., Blue Bell, PA 19422-2350

### **Coatings Industry Honor and Remembrance Fund**

In mid-1992, the Coatings Industry Education Foundation was proud to announce the establishment of the new Coatings Industry Honor and Remembrance Fund, which is administered by the Trustees of the CIEF. The concept of an "Honor and Remembrance" fund is new to our industry, and was first suggested by 1993 FSCT President Colin Penny, who felt that many of us would like to honor friends, spouses, respected colleagues and outstanding employees in a public and substantive way. Colin felt thatby establishing a fund dedicated specifically to the honor and/or remembrance of those special people-the CIEF would be creating a meaningful and lasting tribute to their work. Since the intent of the Trustees is to use the earnings from the principal of this fund for educational assistance in the form of scholarships, fellowships, and grants to colleges and universities with coatings programs, anyone making a donation will also have the additional satisfaction of knowing that their gift will be used to help educate those who will carry on the tradition of scientific and technological excellence in the coatings industryand who may very well be honorees of this same fund, someday.

By recognizing gifts to the Honor and Remembrance Fund in the JOURNAL OF COATINGS TECHNOLOGY, it is the Trustees' intent to give international recognition to both the donors and the honorees, as well as to focus on the educational benefits being derived from such gifts. This is a bold new venture which will enable every individual corporation and society associated with the coatings industry to really "make a difference," by recognizing specific individuals' contributions to our industry, while furthering the educational efforts of the CIEF at the same time. Gifts in any amount (made payable to "CIEF—Honor and Remembrance Fund," and sent to the Federation Office) will be recognized annually in the JOURNAL OF COAT-INGS TECHNOLOGY, and will be divided into the following five categories:

- Gifts up to \$249
- Gifts from \$250-\$499
- Gifts from \$500-\$999
- Gifts from \$1000-\$9999
- Gifts of \$10,000 and greater

All gifts to the Honor and Remembrance Fund will be tax deductible to the extent that the law allows, and may be made as a direct gift to the Fund, as a gift in honor of a living person, or as a gift in remembrance of one who is deceased. Examples:

- The Acme Corporation
- The Ohio Coatings Society, in honor of Maynard Q. Browning
- Mr. and Mrs. Pierre M. Lundquist, in remembrance of John Z. Edwardson

It is currently the intention of the Trustees to reprint the list annually, with some indication (perhaps an asterisk) of gifts which have been added since the last printing. It is also the Trustees' intention to present a suitable plaque, in 1994, to the Federation Office in Blue Bell, listing all donors of record, with sufficient room to add additional donors in the future. As of December 1993, the Honor and Remembrance Fund has received generous, and deeply appreciated, gifts from the following individuals:

### The Coatings Industry Honor and Remembrance Fund (Donations through December 31, 1993)

#### Gifts of \$10,000 and greater

Len and Neta Schaeffer, in remembrance of Fred and Ruth Daniel

#### Gifts of \$1000-\$9999

Mrs. Herbert L. Fenburr, in remembrance of Dr. Herbert L. Fenburr The Houston Society for Coatings Technology, in remembrance of Loren B. Odell The Dallas and Houston Societies for Coatings Technology\* John J. Oates, in remembrance of Elias Singer\*

#### Gifts of \$500-\$999

Akzo Coatings Inc. (Columbus), in remembrance of our employees who died in 1992 The Baltimore Society for Coatings Technology, in remembrance of our deceased members\*

#### Gifts of \$250-\$499

Colin D. Penny\*

#### Gifts up to \$249

The Birmingham Paint, Varnish, and Lacquer Club, in remembrance of Ray Mowl and Ken Cooke\* Sidney Lauren, in remembrance of Fred G. Schwab\*

Mr. & Mrs. George R. Pilcher, in remembrance of Helen Skowronska\*

\*Gift received during 1993





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Based on the terms and conditions herein, we hereby order the number of subscriptions (indicated below) to "Panorama<sup>TM</sup> Coatings MSDS CD Retrieval System" database (the "Product"). We understand that the Product will be delivered to us within 30 days after release of the current version of the Product and receipt of a signed purchase order and prepayment of the subscription fee plus shipping and handling charges and taxes and duties where required, and that our license to use the Product will terminate 12 months or 24 months, depending on the length of the subscription term selected, after delivery of the Product. A subscription is defined as the initial compact disc containing the current database and additional updates to be shipped quarterly over the term of the subscription period.

#### **Subscription Rates**

#### (PLEASE INDICATE QUANTITY AND LENGTH OF SUBSCRIPTION)

Members of the Federation of Societies for Coatings Technology and

#### National Paint and Coatings Association

	Quantity	One-Year 🗖	<u>Two-Year 🗖</u>
Single disc	-	\$900	\$1,600
2-5 discs		\$855 ea.	\$1,520 ea.
6-10 discs		\$810 ea.	\$1,440 ea.
11 + discs		\$765 ea.	\$1,360 ea.

#### Non Member Subscriptions

	Quantity	One-Year 🗆	Two-Year 🗖
Single disc	-	\$1,200	\$2,100
2-5 discs	aa	\$1,140 ea.	\$1,995 ea.
6-10 discs		\$1,080 ea.	\$1,890 ea.
11 + discs		\$1,020 ea.	\$1,785 ea.

#### TOTAL SUBSCRIPTION PRICE

PURCHASE ORDER # \_\_\_

#### LICENSEE ORGANIZATION:

#### BILLING ADDRESS:

SHIPPING ADDRESS:

#### PRIMARY CONTACT:

NA	ME:	
		_

TITLE:\_\_\_\_

PHONE:

FAX:

AUTHORIZED BY:

SIGNATURE:

DATE: \_\_\_\_

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P.O. Received: \_\_\_\_\_ Subscriber Code: \_\_\_\_\_
Payment Received \_\_\_\_\_ Subscription Expires: \_\_\_\_\_

#### 1. Parties to Agreement

The parties to this agreement are Federation of Societies for Coatings Technology (hereinafter "Licensor") and the Licensee identified on the first page of this Agreement ("Licensee" or "us").

#### 2. The Product

The Panorama<sup>™</sup> Coatings MSDS CD Retrieval System, "the Product," consists of the database listed above stored on CD-ROM disc(s) issued quarterly during the term of the subscription agreement, auser's manual, and the software (the "Personal Librarian Software") required to access the database. The database consist of information contained in Material Safety Data Sheets ("MSDS") for raw materials, as well as technical specifications contained in a Raw Material Index for raw materials used in the manufacture of paint, coatings, and inks. The CD-ROM discs are designed to be accessed through a CD-ROM drive coupled to either an IBM-compatible personal computer (PC/ AT<sup>™</sup> 386 or greater with MS.DOS 3.3 or later, with Microsoft Windows<sup>™</sup> 3.0 or later, and MB or RAM minimum). Host adapters and SCSI interface cables are also required.

#### 3. Multiple Subscriptions

Multiple subscriptions shall be defined as orders for multiple discs by a single organization to be shipped to a single address.

#### 4. The License

In consideration of payment of the license fee, which is included in the subscription price, the Licensor grants to Licensee a non-transferable, non-exclusive license to use the Product according to the terms and conditions of this Agreement, which license shall terminate after twelve (12) months or twenty-four (24) months, depending on the term of the subscription, after the delivery of the Product to the Licensee, unless extended by Licensor upon renewal of the subscription at the then current rates. Licensee shall use Product only for internal purposes, shall not use the Product as a component of, or a basis for, a directory or database prepared for commercial sale or distribution outside the Licensee's organization and shall neither duplicate the Product or alter the Product in any way; provided, however, that the Licensee may make backup copies of the Product, in whole or in part, for use only in accordance with the terms in this Section 4.

#### 5. Ownership of Data and Database

The database ordered on the Agreement as formatted for CD-ROM publishing is owned by Licensor and no right to the database in this form or any part thereof is conveyed to Licensee except the right to use it within the Licensee's normal business operations. In no event may persons other than the Licensee and its employees be permitted to use the data in the CD-ROM disc form. In no event may the database be downloaded for sale or conveyance for value by Licensee to a third party.

#### 6. CD-ROM Disc Drives

The Product have been designed to operate on CD-ROM Disc Drives which have been tested by Licensor or in accordance with procedures established by Licensor. A list of such drives and procedures is available from Licensor.

#### 7. Confidentiality

Licensee shall take all necessary action whether by instruction, agreement, or otherwise, to restrict and control the use, copying, protection and security of the Product data, software, documentation and other support materials to assure compliance with the terms hereof and shall prevent access to the Product except to those permitted to have access by the terms of this Agreement.

#### 8. Hotline

For one year from the date of delivery of the Product, Licensor will have consultants available by telephone during its normal business hours to answer questions and provide assistance for Licensee. Use of such hotline will be at Licensee's sole risk and Licensor shall not be liable for any loss or damage arising therefrom, whether resulting from negligence or otherwise.

#### 9. Product Updates

The Product ordered on this Agreement will be updated on a quarterly schedule in the form of completely new current discs with the new information added. Upon receipt of an updated disc, Licensee shall return the outdated disc to Licensor within 30 days. Failure to return the outdated disc will result in the withholding of subsequent updated discs. If and when software updates become available, Licensee shall have the right to purchase such updates at Licensor's then current prices.

#### 10. Lost Discs

CD-ROM discs which are lost or stolen will be replaced at a cost of \$25.00 per disc. Defective discs which are returned to Licensor will be replaced at no charge.

#### 11. Limited Warranty and Disclaimer

Licensor warrants and represents that it has the complete right to enter into this Agreement and to deliver the Product and the database contained in the Product and the data in such database. THE FOREGOING WARRANTY IS IN LIEU OF ANY AND ALL OTHER WARRANTIES. EXPRESS OR IMPLIED, INCLUDING WITH-OUT LIMITATION, WARRANTIES OF MERCHANTABLITY OR FITNESS FOR A PARTICULAR PURPOSE. LICENSOR NEITHER ASSUMES NOR AUTHORIZES ANY OTHER PERSON TO ASSUME FOR LICENSOR ANY OTHER LIABILITY IN CONNECTION WITH THE LICENSING OF THE PRODUCT UNDER THIS AGREE-MENT. ALTHOUGH CARE IS USED IN PREPARING THE DATABASE CON-TAINED IN THE PRODUCT, LICENSOR AND THE SUPPLIERS OF THE DATA ARISING FROM THE USE OF THE INFORMATION CONTAINED ON THIS CD-ROM. THE DATA PROVIDED ON THE PRODUCT WAS FORMULATED WITH A REASON-ABLE STANDARD OF CARE TO INSURE ACCURACY. INFORMATION CONTAINED IN THE DATABASE IS SUPPLIED TO LICENSOR BY THIRD PARTIES, AND LICEN-SOR EXPRESSLY DISCLAIMS ANY RESPONSIBILITY OR LIABILITY FOR THE NEGLIGENCE OR WILLFUL MISCONDUCT OF SUCH SUPPLIERS IN THE PROVI-SION OF THIS INFORMATION. USERS OF THIS PRODUCT ARE SOLELY RESPON-SIBLE FOR COMPLIANCE WITH ANY COPYRIGHT RESTRICTIONS AND A RE REFERRED TO THE COPYRIGHT NOTICES APPEARING IN THE DATABASE ON THE CD-ROM OR IN THE ORGINAL PRINTED MATERIAL, ALL OF WHICH IS HEREBY INCORPORATED BY REFERENCE.

#### 12. Limitation of Liability

Licensee agrees to hold Licensor harmless from any liability arising from incorrect operation of the Product. Licensee further agrees that LICENSOR ASSUMES NO RESPONSIBILITY WITH RESPECT TO LIČENSEE'S USE OF THE PRODUCT AND SHALL NOT BE LIABLE FOR LOSS OF PROFITS, LOSS OF USE OR INCIDENTAL, CONSEQUENTIAL OR EXEMPLARY DAMAGES, EVEN IF AWARE OF THE POSSIBILITY THEREOF, INCLUDING, WITHOUT LIMITATION, LIABILITY UNDER ANY FEDERAL, STATE OR LOCAL ENVIRONMENTAL LAWS OR BEGU-LATIONS. IN NO EVENT MAY EITHER LICENSOR OR LICENSEE BRING ANY CLAIM OR CAUSE OF ACTION AGAINST THE OTHER MORE THAN ONE YEAR AFTER SUCH CLAIM OR CAUSE OF ACTION ARISES. LICENSOR SHALL IN NO EVENT BE LIABLE FOR MORE THAN THE LICENSE FEE THEN PAID FOR THE PRODUCT (WHETHER LICENSOR'S LIABILITY ARISES FROM BREACH OF WARRANTY, BREACH OF ANY OBLIGATION ARISING FROM BREACH OF WARRANTY, OTHER BREACH OF THIS AGREEMENT, OR OTHERWISE WHETHER IN CONTRACT OR IN TORT). SOME STATES DO NOT ALLOW THE EXCLUSION OR LIMITATION OF THE IMPLIED WARRANTIES OF LIABILITY FOR INCIDENTAL OR CONSEQUENTIAL DAMAGES, SO THE ABOVE LIMITATION MAY NOT APPLY TO EACH LICENSEE.

#### 13. Term

The term of this Agreement shall be one year or two years, depending on the applicable subscription fee paid, and may be renewed at the fees current on the renewal date.

#### 14. Termination of License

If Licensee breaches any term of this Agreement, in addition to all other legal remedies, Licensor may immediately terminate the License granted hereunder. Upon termination of the License by Licensor or Licensee for any reason, Licensee shall, unless otherwise agreed to in writing by Licensor, immediately return to Licensor the Product and all copies thereof, whether modified, merged or included with other data or software and shall certify in writing to Licensor that Licensee has not retained the Product or copies thereof. The provisions of this Agreement which protect the proprietary rights of Licensor shall continue in force after termination.

#### 15. Indemnification

Licensee agrees to indemnify and hold Licensor harmless from and against any and all claims of third parties (including copyright infringements) arising out of or related to the use of the Product by Licensee.

#### 16. Notices

All notices, consents or other communications referred to herein shall be in writing, and shall be sent to the other party by first class mail addressed to that party at the address specified in this Agreement or to such alternate address as either party may furnish in writing to the other.

#### 17. No Assignment by Licensee

This Agreement, and the License contained herein, may not be assigned by Licensee.

#### 18. Force Majeure

Licensor shall not be responsible for any failure to perform (or delay in performance), in whole or in part, due to unforeseen circumstances or circumstances beyond Licensor's control, including but not limited to acts of God, war, riot, embargoes, acts of civil or military authority, fire, flood, accidents, strikes and shortages of transportation, facilities, fuel, labor, or materials.

#### 19. Entire Understanding

This Agreement represents the entire understanding of the parties with respect to the subject matter hereof, and there are no representations, promises, warranties, covenants or understandings with respect thereto other than those contained in this Agreement. Without limiting the generality of the foregoing, it is expressly agreed that the terms of any purchase order issued by Licensee with respect to this Agreement of the Product shall not be applicable and that any acceptance of such purchase order by Licensor shall be for acknowledgment purposes only.

#### 20. Illegality and Unenforceability

If a term or condition of this Agreement is found by a court or administrative agency to be invalid or unenforceable, the remaining terms and conditions shall be enforceable to the maximum extent permitted by law.

#### 20. Governing Law

This Agreement shall be governed by and construed in accordance with the laws of the Commonwealth of Pennsylvania without giving effect to the principles of conflict of law thereof.

## Regulatory UPDATE

### February 1994

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.

#### Environmental Protection Agency December 29, 1993—58 FR 68804 Federal Operating Permit Programs; Permits for Early Reductions Sources

#### Action: Proposed rule

Under the Clean Air Act, a rule governing compliance extensions for sources achieving early reductions of hazardous air pollutants (HAPs) was promulgated by EPA and published in the *Federal Register* on December 29, 1992.

Sources qualifying for a compliance extension under the Early Reductions Rule (sources that commit to a 90% emission reduction are eligible for a six-year extension on compliance with subsequent standards) must obtain a permit containing an emission limitation to ensure that the early reductions are maintained throughout the compliance extension period and that they are enforceable at the federal level. EPA is proposing to establish an interim permitting mechanism for such sources until permanent permitting programs become effective under Title V of the Clean Air Act Amendments of 1990.

In November 1993, EPA extended the application deadline for the program from December 1, 1993 to April 30, 1994, so the interim permit program can be used.

EPA is also proposing an amendment to the Early Reductions Rule, which would append to an enforceable commitment information on emission reduction measures employed to achieve early reductions. For further information, contact David Beck, Emission Standards Division (MD-13), U.S. EPA, Research Triangle Park, NC 27711, (919) 541-5421.

#### Environmental Protection Agency December 10, 1993—58 FR 69638 Protection of Stratospheric Ozone; Exemptions from ban on products made with Class II substances Action: Final Rule

EPA has announced, effective January 1, 1994, the promulgation of a final rule implementing the statutory ban on nonessential products containing or manufactured with hydrochlorofluorocarbons (HCFCs) under section 610(d) of the Clean Air Act Amendments of 1990. The final rule was developed by EPA in order to clarify definitions and provide exemptions.

Among the commercial products that are exempt from the ban are: lubricants, coatings, or cleaning fluids for aircraft maintenance that contain HCFCs as solvents, but contain no other HCFCs; mold release agents, used in the manufacture of plastic and elastomeric materials that have HCFCs as solvents, but contain no other Class II substances; and document preservation sprays that are used solely on thick books, books with coated or dense paper, and tightly bound documents.

For further information, contact Cynthia Newberg, Program Implementation Branch, Stratospheric Protection Division, Office of Air and Radiation (6205-J), U.S. EPA, 401 M St., S.W., Washington, D.C. 20460, (202) 233-9729.

Notice—EPA has announced the availability of two control technology documents that would give states guidance limiting emissions of volatile organic compounds from batch processes and industrial waste water treatment.

The batch control technology document covers seven areas of manufacturing, including wood chemicals, resins, and industrial organic chemicals, and affecting roughly 500 facilities.

The control technology document for industrial waste water collection and treatment covers the following four industries: organic chemicals, plastics, and synthetic fibers; pesticides; pharmaceuticals; and hazardous waste treatment, storage, and disposal.

For further information on the batch process guidance, contact Randy McDonald, Emission Standards Division (MD-13), U.S. EPA, Research Triangle Park, NC 27711, (919) 541-5402. Additional information on the industrial waste water collection and treatment guidance may be obtained from Elaine Manning at the same address, (919) 541-5499.

Superfund—According to a statement released in December, the Clinton Administration, in a consensus with other federal agencies, has decided to accept the Treasury Department's proposal to eliminate retroactive liability in the Superfund law. Reportedly, insurance group representatives that would be affected by the proposal are reviewing the document.

Under the proposal, retroactive liability currently mandated by Superfund would be eliminated for waste handling and disposal practices that took place before 1980, when the law was enacted. To replace the loss of revenue when retroactive liability is eliminated, a tax would be imposed on the

The *Regulatory Update* is made available as a service to FSCT members, to assist them in making independent inquiries about matters of particular interest to them. Although all reasonable steps have been taken to ensure the reliability of the *Regulatory Update*, the FSCT cannot guarantee its completeness or accuracy. insurance industry that is expected to generate \$500 million annually.

Reportedly, the retroactive liability proposal does not include a tax on small businesses which has been suggested in the past by the insurance industry. Nonetheless, existing Superfund taxes may be increased as part of the proposal.

While many basic elements of the plan have been agreed upon, certain details are still being considered.

Resource Conservation and Recovery Act (RCRA)— Rep. John Dingell (D-MI), Chairman of the House Energy and Commerce Committee, has indicated he would like to report a "narrow RCRA" bill out of his committee this year. So as not to be confused with an RCRA reauthorization bill, Mr. Dingell would like to restrict the issues covered in his proposal to interstate waste disposal and flow control, newspaper and tire recycling, and composting. Reportedly, Rep. Al Swift (D-WA), Chairman of the House Energy and Commerce Subcommittee on Transportation and Hazardous Materials is also trying to reach a consensus on interstate waste and flow control issues.

In the Senate, it appears Sen. Dan Coats (R-IN), will attempt to take the interstate waste issue directly to the Senate floor shortly after Congress returns on January 25. Sen. Coats' previous legislation on interstate waste control passed the Senate independently of other RCRA legislation during the last Congress. Efforts to negotiate on the issue for inclusion in a comprehensive reauthorization bill have, to date, been unsuccessful. If Sen. Coats' bill, or any RCRA bill, are taken to the floor, amendments to expand the scope to regulate industrial hazardous and non-hazardous wastes are possible.

**Product Liability**—The Product Liability Fairness Act, S. 687, passed by the Senate Commerce Committee earlier this year, may be scheduled for a floor vote early in 1994. While last year was the first time the committee actually generated significant support for the measure, it is unclear as to whether the full Senate would pass such a bill. Congress has been trying to pass product liability bills, unsuccessfully, for the past 15 years.

The House bill, H.R. 1910, sponsored by Rep. Roy Rowland (D-GA), has gained new cosponsors to total 131 to date. If the House Energy and Commerce Subcommittee on Commerce, Consumer Protection, and Competitiveness can pass the measure, followed by passage of the full Committee, then a floor vote is possible before the end of this Congress. However, it is unlikely the full House will act on this issue unless the full Senate first passes a bill.

Clean Water Act—Various appropriations bills, flood relief legislation, and staff changes have all contributed to the Clean Water Act reauthorization delay in the House. The White House National Economic Council and the Office of Management and Budget have also questioned the need for Clean Water Act legislation. Concerns about additional regulation and cost/benefit analysis have been the chief issues raised. However, the Senate Environment and Public Works Committee staff maintain there is strong administration support.

Because of unresolvable differences, the Senate Clean Water bill (S. 1114), is reportedly being redrafted. Redrafting sessions with various environmental and industry groups have included discussions on use reduction and toxic pollutant phase-out provisions, domestic sewage exclusion language, new enforcement authority, and the always controversial wetlands provisions.

The House, reportedly, is in the process of drafting new legislation. Hearings in the public works and Transportation Subcommittee on Water Resources and Environment are not expected until late Spring. Judging from the lack of priority status, this issue has been assigned, it is unlikely the Clean Water Act will be reauthorized this year.

#### States Proposed Legislation and Regulations

#### California

Graffiti—CA A. 2365 (Johnson) applies to drivers' license suspension, restriction, and delay procedure to all acts of vandalism involving the defacing of property, with paint or any other liquid, or by spraying, scratching, writing, or affixing graffiti on a surface of that property. The bill passed the Assembly in September 1993, and was referred to the Senate Committee on Judiciary on January 5.

*Proposition 65 (Regulation)*—California EPA has issued a final regulation amending the list of chemicals that are believed to cause cancer or reproductive toxins. For further information, contact Laurie Monseratt of the California EPA at (916) 327-7333.

#### Connecticut

Air Quality (Regulation)—The Connecticut Department of Environment has issued final regulations implementing the requirements of the 1990 Federal Clean Air Act Amendments, including requiring owner/operators of major stationary sources of VOC emissions to submit VOC emission compliance plans to the Department by May 31, 1994. For further information, contact Phil Florkorski of the Department at (203) 566-4030.

#### Illinois

Air Quality (Regulation)—The Illinois Pollution Control Board has adopted final regulations (effective on December 7, 1993) that specify permitting requirements for small sources of regulated air pollutants (sources emitting less than 25 tons per year of regulated pollutants). For further information, contact Michelle Dresdow of the Board at (815) 753-0947.

#### Indiana

Household Hazardous Products—IN S. 54 (Wheeler) reestablishes the definition of "hazardous household product"; repeals the Household Hazardous Products Act and the Chronic Disease Advisory Committee; makes conforming changes and cross-reference changes with repealed laws. The bill was introduced on January 5 and referred to the Senate Committee on Health and Environmental Affairs.

#### **Massachusetts**

Lead—MA H. 5302 makes an investigation and study of lead paint laws. On January 3, the House refused to concur with the Senate on the original text of the bill. Therefore, the bill was amended in the Conference Committee by substitution of a new text, H.R. 5726, and sent back to the Senate for concurrence.

#### Missouri

Air Quality (Regulation)—The Department of Natural Resources (DNR) has adopted a final regulation that requires regulated sources to submit emission fees and statements based on a methodology that is specified in the regulation. For additional information, contact Todd Crawford of the DNR at (314) 751-4817.

#### **New Hampshire**

*Lead*—NH H. 1473 (D. Holt and Pepino) requires that, after discovery of a lead hazard, an owner has a 60-day period before he must abate the hazard. This period provides the owner time to gather information and, if appropriate, an opportunity for in-place management to work. The bill was introduced on January 5 and referred to the House Committee on Health, Human Services, and Elderly Affairs.

NH S. 650 (Shaheen) establishes a lead-based substance abatement fund to be administered by the New Hampshire Housing Finance Authority; provides that the fund is to be used to assist owners of rental property which is primarily occupied by low-income tenants when such owners are required to undertake lead abatement activities. Makes an appropriation for the startup costs of the fund. The bill was introduced on January 5 and referred to the Senate Committee on Public Institutions, Health, and Human Services.

#### **New Jersey**

Air Quality (Regulation)—The New Jersey Department of Environment has issued final regulations which require regulated sources of VOC emissions for which the state has not yet specified reasonably control technologies, which may include some paint manufacturing facilities, to submit their own plans for controlling VOC emissions. For additional information, contact Janis Hoagland of the Department at (609) 292-0716.

#### **New York**

Lead—NY A. 278 (Clark) increases the penalty for the failure to comply with a notice and demand for resolving a paint condition conducive to lead poisoning from \$2,500 to \$5,000, and mandates such penalty. The bill was released from the Assembly Committee on Rules and returned to the Committee on Health on January 5.

NY A. 3357 (Silver) enacts the Public Works Environmental Lead Abatement Act; provides for regulation of activities relating to the removal of lead-based paint from public works facilities. The bill passed the Assembly in July and was sent to the Senate. On January 5, the bill was returned to the Assembly and referred to the Rules Committee.

NY A. 5974 (Eve) makes various provisions regarding lead inspection and abatement including licensing and certification requirements; makes lead testing requirements; requires coverage for screening and diagnosis for lead by certain insurers and imposes a special surcharge on sale of paint. The bill was released from the Committee on Ways and Means and returned to the Committee on Health on January 5.

NY A. 7964 (Committee on Rules) establishes a Lead Abatement Licensing and Certification Program to reduce the health and safety hazards associated with lead abatement. The bill passed the Assembly in July, 1993, and was sent to the Senate. On January 5, it was returned to the Assembly and referred to the Committee on Rules.

NY A. 8310 (Committee on Rules) directs Commissioner of Environmental Conservation, in consultation with the Commissioner of Health, to study the impact of lead-based paint and lead pipes in buildings and the feasibility of removal and retrofitting such paint and pipes. The bill was released from the Assembly Committee on Ways and Means and returned to the Committee on Environmental Conservation on January 5.

NY A. 8829 (Sponsor) makes provisions regarding bridge paint removal projects and repeals the article on environmental health hazards; provides for the study of paint removal techniques. The bill passed the Assembly in July, 1993, and was sent to the Senate. On January 5, it was returned to the Assembly and referred to the Committee on Rules.

Hazardous Substances Handling and Storage (Regulation)—The Department of Environmental Conservation (DEC) has proposed regulations that would effect standards for storing and handling hazardous substances, including changing the reportable quantities of 164 substances, specifying inspection and testing procedures for above and under ground storage tanks, and clarifying reporting requirements for hazardous substances spills. For further information, contact Mary Ellen Lentine of the DEC at (518) 457-4351.

#### North Carolina

Hazardous Waste (Regulation)—The North Carolina Department of Labor is proposing a new level of training under rules governing hazardous waste operations and emergency response. The DOL is making the proposal to protect the public from threat of environmental harm and property damage or bodily injury. For further information, contact Jill F. Cramer, NCDOL/OSHA, 413 N. Salisbury St., Raleigh, NC 27603-5942, (919) 733-3900.

#### Ohio

Lead—OH S. 162 (Drake) requires lead screening of certain young children; creates a tax credit for lead abatement; provides for licensure of persons performing lead abatement; provides that it is an unlawful discriminatory practice to refuse to sell to or to rent housing because it will be occupied by a young child or pregnant woman. The bill passed the Senate on January 4 and was sent to the House.

#### Texas

Air Quality (Regulation)—The Texas Natural Resources Conservation Commission has proposed several regulations to assist in the state's efforts to reduce VOC emissions by 15% by 1996 in ozone nonattainment areas, as required by the Federal Clean Air Act Amendments of 1990. Among the proposed measures are controls on VOC emissions from wood furniture coating operations. For further information, contact Eddie Mack of NRCC at (512) 239-1488.

The Texas Air Control Board (TACB) has promulgated final rules that add definitions for alcohol substitutes, automotive basecoat/clearcoat system, automotive pretreatment, automotive sealers, automotive specialty coatings, automotive three-stage system, batch, cleaning solution, fountain solution, Municipal Solid Waste Landfill, and the Synthetic Organic Chemical Manufacturing Industry. For further information, contact the TACB Air Quality Planning Annex, 12118 North IH-35, Park 35 Technology Center, Building A, Austin, TX 78753, (512) 908-1451.

The TACB has adopted rules governing surface-coating process emission standards. The rules concern emission specifications for primers and primer surfacers, and adds volatile organic compound limits for precoat, pretreatment singlestage topcoats, and basecoat/clearcoat topcoat systems used in automobile refinishing. For further information, contact the TACB General Office, Regulation Development Division, 12118 North IH-35, Park 35 Technology Center, Austin, TX 78753, (512) 908-1488.

#### Utah

Graffiti—UT H. 31 (Cannon) prohibits the sale of spray paint or broad-tipped indelible markers to minors; prohibits the possession and use of spray paint and broad-tipped indelible markers by minors; requires retailers to restrict free access to spray paint or markers for sale. The bill was prefiled on December 15.

#### Vermont

Household Hazardous Products—VT H. 622 (Schaefer) relates to the shelf labeling law that applies to the sale of hazardous products; allows the Secretary of Natural Resources to add or delete "products" or "categories" to which the shelf labeling law applies.

### Battelle Forecast Expects R&D Expenditures in 1994 To Reach \$164.5 Billion in the United States

Expenditures for research and development (R&D) in 1994 in the United States are expected to reach \$164.5 billion. According to the annual forecast by Battelle, Columbus, OH, the projected \$164.5 billion represents an increase of \$3.8 billion (2.3%), over the \$160.7 billion the National Science Foundation estimates actually was spent for R&D in 1993. Since about two percent of the R&D increase will be absorbed by inflation, Battelle forecasts a negligible increase in real total R&D expenditures. This increase is considerably less than the 10-year average real increase of 2.5% since 1983.

#### Sources of Funds

Industrial funding for R&D will account for 51.6% of the total. Industrial support is forecast to be \$83.6 billion, up 1.6% from 1993.

The study shows an increase of 2.6% in federal support for R&D, with funding expected to be \$69.8 billion. This is 42.2% of the total expenditures for 1994, but it represents a smaller increase than originally proposed in President Clinton's first budget.

Funding by academic institutions is expected to be 6.4 billion, 3.9% of the total. Other non-profit organizations will provide nearly \$3.5 billion (2.1%).

Since 1980, industry and government have switched roles as the primary source of R&D support. Government had been the principal funder before 1980; however, industrial support will continue to dominate in 1994 and for the next several years.

#### Performers of Research

According to the Battelle report, industry will continue to perform the majority of R&D. In 1994, performance by industry is expected to rise to \$114.8 billion, slightly less than 70% of all research. This amount compares with \$16.8 billion (10.2%) by federal government laboratories, \$26.7 billion (16.2%) by academic institutions, and nearly \$6.2 billion (3.7%) by non-profit organizations.

Federal funding supports research in all four sectors. About 46% of the federal R&D dollars are used by industry. Federal laboratories and colleges and universities receive about 24% each, and the remainder, about five percent, goes to other nonprofit organizations.

Industry absorbs almost all of its own funds, either performing the R&D itself or contracting with other industrial performers. Contracts and grants to nonprofit organizations are about half of what is received by colleges and universities. (The figure used for colleges and universities does not include the support of long-range "endowed research" programs.) Nonprofit organizations finance both themselves and academic institutions about equally; colleges and universities consume all of their own funds.

#### Government Support

Defense, energy, space, and health and human services dominate the federal R&D scene and account for 82.6% of the total proposed federal R&D funding for 1994, only slightly less than in 1993. The makeup of this funding will not change significantly in 1994.

According to Battelle, changes in the character of military threats and the associated defense R&D spending, an appreciation of domestic challenges, and the overall federal deficit have had a significant effect on the distribution of resources within the federal R&D budget.

Several factors will influence the federal R&D support: the continuing budget deficit, the restructuring of federal government programs in light of a changing picture of defense obligations throughout the world, and the emphases on technology transfer and short-term projects that have industrial applicability. The overriding concern over the deficit is expected to prompt a reduction in growth of both defense and total government R&D, as was forecast in earlier Battelle studies. However, national security considerations will continue to be felt through advanced research on programs that deal with surveillance and treaty verification.

It is particularly noteworthy that President Clinton's proposals relative to applied research are generally consistent with those forwarded by the Bush Administration.

The emphasis on federal R&D funding as a means of supporting domestic economic growth is evidenced in three initiatives that are expected to continue.

 Congressional action on some of the so-called "big science" programs—including the superconducting supercollider and the space station—came under close scrutiny. The supercollider was canceled outright, and the space station is still at risk. Recent successes may slow efforts to delay or cancel the space station, but its continued political and financial support are considered to be tenuous.

 Efforts are being directed toward reshaping the basic research missions of the National Science Foundation, the National Institute of Standards and Technology, and the Department of Energy in an effort to direct resources toward more immediate applied research programs. While the efforts to reorient much of the science foundation's program toward applied research have not progressed as rapidly as had been sought in earlier administrations, the continued perceived need for more short-term and "relevant" research will most likely influence the organization's long-term planning.

(Continued on next page.)

#### Air Products and Chemicals Reorganizes Chemicals Business to Form Three Divisions

In a move to increase international expansion and improve market focus, Air Products and Chemicals, Inc., Allentown, PA, has reorganized its chemicals business. The reorganization, effective October 1993, streamlines the business from four to three divisions and aligns technology and business management to focus on customer requirements. Financial and human resources from the reorganization will be invested in extending Air Products' chemicals business internationally and in two technology initiatives—industrial coatings and N-vinyl formamide—that the company currently has underway. With this reorganization, the company's chemicals business is now comprised of three divisions—Polymer Chemicals, Polyurethane and Performance Chemicals, and Industrial Chemicals. Air Products' line of polyurethane and Performance Chemicals Division, with Joseph H. McMakin as General Manager. Victor A. Bonanni has been named General Manager of the Industrial Chemicals Division, which now includes the company's polyurethane intermediates business. Continuing as General Manager of the Polymer Chemicals Division is William J. Cantwell.



## COATINGS

### ICI Polyurethanes' Isocyanates Meet All Challenges for High Performance Coating Formulations and Reduced VOCs.

MDI Isocyanates Are Available From the Following Distributors:

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Battelle Forecasts Slight Increase in R&D Expenditures for 1994

(Continued from previous page.)

• Efforts at developing collaborations between industry and the federal laboratories are being pursued more vigorously.

Finally, with the urging of the scientific community, federal support of the "porkbarrel" science projects has come under much closer scrutiny, and the practice of earmarking such funds is diminishing substantially.

#### **Industrial Support**

The Battelle report predicts that industrial support of research will continue to grow in areas related to electronics, communications, sensors, transportation, advanced machinery, environmental protection, and in fields directly influenced by the need for more energy-efficient products and processes.

Sources at Battelle caution against placing too much significance on the distribution of performance among the major industrial sectors. Such classifications do not take into account that many of the largest research-intensive companies have a wide spectrum of interests. Thus, available figures do not accurately represent the line-ofbusiness distribution of R&D performance or the intensity of effort in specific areas of technology.

Special attention also should be given to the fact that significant changes have occurred, and will continue to occur, in the manner in which industry obtains its technological assets. The pattern of industrial support for R&D shows departures from a relatively strong role in basic research, with this having been relegated to the universities on an increasing scale. Furthermore, structural change within industrial laboratories is opening the door for a greater use of subcontracted R&D: the integration of external research capacity in a move toward the "virtual corporation." In addition, greater use is being made of off-shore R&D facilities, those wholly-owned by U.S. industry as well as other technology sources. This is offset, in part, by an increasing amount of R&D performed by U.S. entities for foreign-based corporations.

In spite of significant changes in several major players, near-term industrial plans indicate that the slowdown in R&D growth may be stabilizing. Downsizing in all aspects of operations will have an adverse impact on R&D personnel levels. However, Battelle expects these moves to be offset by an increased interest in collaborative research programs. Such programs will be driven by the development of more precompetitive research, as well as by programs in response to changing regulations. Furthermore, industrial postures in R&D spending will be influenced by the anticipa tion of a stronger federal government role in encouraging public-private partnerships, in promoting permanent R&D tax credits, and in enhancing the roles of the federal laboratories.

In addition, state governments continue to expand their roles and activities in support of a broad range of activities directed toward technology-based economic development and job expansions.

It is especially important to note that industrial support of R&D is accompanied by a greater concern for methods of evaluating R&D.

#### Long-Term Outlook

The study indicates that the R&D growth rate has been slowing and is expected to continue to decline in real terms, although no significant decrease in real dollar support is expected. A similar situation occurred two decades ago, with a very slow recovery.

Industrial support will continue to be affected by conflicting and complex factors. Major changes in the traditional defense industries are forcing realignments within the industry, cutbacks in personnel, and stronger efforts toward definition of new markets—a situation not unlike that in the early 1970s. The trade imbalance and efforts to correct it, as well as efforts to expand markets in response to shifts in government priorities, could spur expanded R&D. In addition, the internationalization of markets—as promoted through expanding trade agreements—will influence R&D expenditures.

In the recent past, the environment that permitted greater rewards for short-term financial results, rather than technological innovation, had an adverse effect on R&D investment. However, the tenor of the federal budget for 1994 and the pro-technology attitude of the present administration give reason for a cautious optimism regarding R&D growth and accountability in the near future.

For more information on the 1994 R&D forecast, write Battelle, 505 King Ave., Columbus, OH 43201-2693.

#### BFGoodrich Acquires Assets of Specialty Chemicals Company

The BFGoodrich Co., Akron, OH, announced that it has acquired all the assets of Sanncor Industries, Inc., Leominster, MA, for an undisclosed purchase price.

BFG specialty chemicals are used in products such as pharmaceuticals, cosmetics, coatings, sealants, and adhesives. BFGoodrich also provides aircraft systems, components, and services.

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### Last Scheduled Wood Furniture Reg-Neg Held; MACT Emission Standard Agreed Upon

The full meeting in the regulatory negotiation (reg-neg)—possibly the final full meeting of the group—convened in Raleigh, NC, on Nov. 30-Dec. 1, to address clean air issues in the wood furniture and kitchen cabinet manufacturing industries.

The intensive two-day negotiations built on and advanced the tentative consensus reached at work group meetings held in early and mid-November between representatives of the Industry Caucus and the Environmental/State/Environmental Protection Agency (ESE) Caucus. Also at the full regneg committee meeting, several of the remaining outstanding issues were resolved.

At the close of the meeting, representatives of CDR Associates, the reg-neg convener, indicated that they did not believe that another full reg-neg committee meeting was necessary; however, industry representatives believe that much work remains to be done. In addition to a significant number of substantive issues which remain unresolved, there will presumably be additional discussions between the reg-neg parties as the U.S. Environmental Protection Agency (EPA) begins to turn the tentative consensus into a more complete regulatory framework and, ultimately, a set of comprehensive, detailed regulations.

In its discussions at the meeting, the full reg-neg committee agreed that the maximum achievable control technology (MACT) emission standard for hazardous air pollutants (HAPs) would be set at 1.0 pounds of HAPs/solid pound for existing sources on a systems-average basis, with simplified recordkeeping requirements. For new sources, the level would be set at 0.8 pounds of HAPs/solid pound. However, the committee and EPA agreed that application of the MACT would be limited to the 189 HAPs regulated under the Clean Air Act. With respect to the control technique guideline (CTG) for the control of volatile organic compounds (VOCs), the full regneg committee confirmed a number of equivalent control strategies tentatively agreed upon at the prior work group meetings. (A CTG is not a national rule; rather, it merely provides guidance to states for use in their development of VOC-control rules by suggesting reasonably available control technology (RACT) for particular sources in ozone non-attainment areas.) The first compliance option involves the use of waterborne topcoat, with a compliance level of 0.8 pounds/solid pound.

The second option is "high-solids" technology applied to topcoat and sealer. The compliance numbers were tentatively set at 1.8 pounds/solid pound for topcoats and 1.9 pounds/solid pound for sealers. The committee also considered setting different compliance numbers for acid-cured varnishes used in the kitchen cabinet industry (2.0 pounds/solid pound for topcoats and 2.3 pounds/solid pound for sealers) due to stringent industry certification requirements. Finally, equivalent technologies would be permitted upon certification of equivalence.

In addition, the full reg-neg committee agreed to certain limitations on the use of conventional air spray application equipment as part of both the CTG and the MACT. Exceptions to the limitations include applications of waterborne or high-solids coatings, high-speed lines, touch-up and repair, and *de minimis* application (where a coatings application step is less than five percent of the total coatings volume). The committee also tentatively agreed to allow an exception for "low-emitting" technologies.

For more information, contact NPCA, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005-5597.

#### November Construction Contracting Retreats 1%

Following the resurgent activity of recent months, the value of construction contracts in November eased back one percent, according to the F.W. Dodge Division of McGraw-Hill, New York, NY. A strengthening housing market was offset by lower totals for nonresidential building and nonbuilding construction (public works and utilities).

The latest month's data brought the seasonally adjusted Dodge Index back to 105 (1987=100), still very close to October's revised 106 which was the highest so far in 1993.

Residential construction advanced six percent in November, with single family housing providing most of the upward impetus. On the other hand, nonresidential construction declined seven percent in November, despite a rebound from a lackluster October in contracts for stores and shopping centers.

Due to a sharp downturn by the often volatile utility segment, nonbuilding construction slipped seven percent in November. Meanwhile, public works construction edged up two percent, with the bridge, sewer, and water supply categories showing expansion. Public works in general has been one of the supportive elements of the building industry recovery during 1993.

#### Grace Completes Packaging Production Unit in Italy

W.R. Grace and Co., Boca Raton, FL, announced the completion of a new \$20 million manufacturing facility to produce rigid, coextruded films at Grace's Cryovac packaging plant in Passirana, Italy.

The Passirana plant manufactures and sells Darfresh flexible and rigid film packaging materials and equipment to wrap perishable food and non-food products.

The new film production unit, housed in a new 42,000 square foot stand-alone building, has the capability of extruding multiple layers of polymers beginning with basic resin pellets. The finished film can be provided to the customer either printed or plain.

#### Hüls Announces Start-Up of Polyester Resin Production Unit

The start-up of a polyester resin manufacturing unit in Mobile, AL, has been announced by Hüls America, Inc., Piscataway, NJ. The unit, part of Hüls' isophorone derivative plant, has the capacity to produce more than six million pounds of low molecular weight polyesters annually.

Products manufactured by Hüls America at its new resin unit are sold under the trade names Dynapol<sup>\*</sup> and Dynacoll<sup>\*</sup> and were formerly imported from Europe.

#### Dow Expands Capacity at Louisiana Glycol Ether Plant

The Dow Chemical Co., Midland, MI, has expanded the capacity of its Plaquemine, LA, glycol ether facility by 15 million pounds. Completed in October, the debottlenecking project brings Dow's total U.S. nameplate capacity to 265 million pounds per year.

#### PPG Venture Announces Thailand Silicas Expansion

PPG Siam Silica Co., Ltd., a venture of PPG Industries, Pittsburgh, PA, and the Mitr Phol Group, has announced a multi-million dollar expansion of its precipitated amorphous silicas plant in Thailand's Rayong Province.

The facility, which makes Hi-Sil 233S, 255S, and HOA precipitated silicas developed by PPG, will direct most of its production increase to rubber reinforcement applications in the Asia/Pacific region's rubber sport shoe and tire industries. The Thai operation began in 1990 with a capacity of 12,000 metric tons and expansion is expected to be onstream in mid-1994.

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## A New Sample Preparation Technique For the Examination and Analysis Of Paint Film Defects

Thomas J. Veneri and Jack A. Kramer Henkel Corporation, Parker+Amchem Division\*

A paint film cross-sectioning technique has been developed which allows simultaneous characterization of a paint defect and the underlying substrate and pretreatment. The advantages of the technique include speed, accuracy of cross-sectioning the defect, simplicity, lack of polishing artifacts, and a pseudo-three-dimensional perspective which uniquely reveals the relationship between the defect, paint film and substrate. Disadvantages include possible damage to the sample or removal of contaminants by the solvents used.

The prepared sample may be examined using an optical or scanning electron microscope (SEM), and analyzed by x-ray fluorescence (XRF) or other methods. The technique has proven especially useful for pinpointing the cause of defects resulting from interaction of the substrate or pretreatment with the paint film. This paper describes the practice of the technique and its application to solving production problems related to paint defects.

#### INTRODUCTION

The production of finished metal and plastic parts involves a number of steps including cleaning, pretreatment, rinsing, and painting. There are numerous opportunities for problems to arise from the forming of the part to the final paint finish. An expensive rework operation may be required if the problems cause defects which mar the appearance of the part. These defects include cratering, blistering, particulate contamination, streaks, dewetting, bubbles, pinholes, telegraphing, and fisheyes.

\*32100 Stephenson Highway, Madison Heights, MI 48071.

Although general causes of such defects are known,<sup>1</sup> identification of the specific cause is much more difficult. Problems with the substrate, processing, or paint can cause defects similar in appearance. Many of the defects are small, and the actual source of the defect may be smaller still.<sup>2</sup>

Current methods for examination of the defects include analysis of the external paint surface,<sup>3-5</sup> removing the paint to expose the substrate,<sup>6</sup> removing pieces of the defect for analysis,<sup>7-9</sup> performing a cross section of a paint flake<sup>6</sup> or a metallurgical cross section of the paint and substrate,<sup>2,10</sup> Analytical techniques used include optical<sup>11</sup> and scanning electron microscopy,<sup>1-3,12</sup> Fourier transform infrared spectroscopy (FTIR),<sup>4,7,8</sup> x-ray diffraction (XRD),<sup>10</sup> and LAMMA (acronym of laser, microscope and mass spectrometer),<sup>5</sup>

A new sample preparation technique has been developed for localized defects which allows examination of not only the physical form of the defect, but also the condition of the underlying substrate/pretreatment. This technique, called "paint film cross-sectioning," is performed by slicing through the paint defect down to the substrate surface, and then



Figure 1-Schematic of the initial cut through a paint defect



Figure 2—Diagram of the positions and order of cuts for the paint film defect cross section procedure



Figure 3—Schematic of defect following paint film crosssectioning

removing half the paint and the defect, exposing the pretreatment in the defect area. It does not require cross-sectioning and polishing equipment, and can be performed relatively quickly. With both the defect and the associated substrate surface accessible for examination, the origin of the problem can be quickly determined.

#### EXPERIMENTAL PROCEDURE

The paint film cross-sectioning technique is performed using facial quality razor blades, a strong magnet or forceps to hold the sample, solvents to soften the paint film, an insulin syringe with a 28-gauge needle to remove paint fragments, and a 10x to 100x stereomicroscope for magnification of the defect area.

Typically, the production part is examined optically to document the number, size, shape, and appearance of the defects. Suitable defects are identified and then cut from the part using a punch, jeweler's saw, or metal shear.

The samples are immersed in acetone for one to five minutes to soften and swell the paint film. The immersion time is dependent on the paint system, thickness, and number of layers. Other solvents, such as methylethylketone (MEK) or N-methyl-2-pyrrolidone (NMP) may be used with more resistant paints. The immersion time should be long enough to produce a rubber-like consistency, but not so long as to delaminate the paint film.

The razor blades used are prepared by bisecting a double edge blade, or extracting the blade from an injection-type cartridge. Industrial type single edge blades and scalpel blades are generally too coarse for clean, accurate cuts. Used blades develop burrs which spoil the cut.

The sample is removed from the solvent and quickly oriented under the stereomicroscope for cutting. The tip of the blade is anchored gently in the paint film next to the defect as the blade is aligned over the defect. The blade is then slowly drawn through the defect at a 30° angle while maintaining the blade perpendicular to the surface, as shown in *Figure* 1. The pressure should be sufficient to cut all the way through the paint film without gouging the substrate.



Figure 4—Photomicrograph of defect caused by outgassing from beneath electrogalvanized zinc layer



Figure 5—Electrogalvanizing defect with associated vent hole

#### EXAMINATION AND ANALYSIS OF PAINT FILM DEFECTS

Additional parallel cuts are then made on the side of the defect to be removed, as well as several cross-cuts to facilitate paint removal (*Figure 2*). The sample may need to be immersed several times to complete the necessary cuts.

The sample is immersed again in acetone or a different solvent to loosen the paint film. This may take another two to ten minutes. The sample is then placed under the stereomicroscope, and the tip of the syringe needle run carefully through the second cut. The angle of the tip is adjusted to loosen the edges and lift the paint without marring the substrate. Additional immersions in the solvent may be necessary to complete the removal of the paint. The strip of paint containing part of the defect is removed last. This strip may be mounted on conductive tape for analysis of the back or cross section of the defect by a variety of techniques. The sample is then air dried with generally little damage to the paint film.

The result of the procedure is a stair-step formation from the substrate to the top of the paint film with the defect exposed in cross section. The tilt angle on the SEM is adjusted to obtain the side view (Figure 3). The substrate under the half of the defect removed may be examined for surface irregularities, pretreatment morphology, or residues. Analysis by SEM/XRF may require a conductive coating of carbon, silver, or gold.

Alternatively, the procedure may be used to selectively remove the entire defect from the substrate, allowing examination of the back of the paint and the surface directly underneath. This can expose causes of defects which are much smaller than the defect itself. Non-defect areas can also be exposed for comparative purposes.

The paint film cross-sectioning procedure generally works well on most automotive paint systems. It is more difficult to use with powder paints and epoxy primers used in coil coating. The procedure has also been used on painted plastics, but delamination of the paint is more difficult to control.

#### APPLICATION EXAMPLES

GALVANIZED GASSING: An electrogalvanized bumper with a zinc phosphate pretreatment, a cathodic electrocoat, basecoat, and clearcoat finish exhibited a row of defects along a formed edge. Some of the defects were cross-sectioned, while others were completely removed to examine the substrate and the back of the paint film.

The photomicrograph in *Figure* 4 clearly shows that defects along the formed edge are bubbles formed by gas expelled from the substrate. The bubbles are generated in each paint layer during the cure cycle for that layer. Examination of the substrate under several of the defects revealed two micron diameter holes in the surface, often associated with the fissure in the substrate (*Figure* 5). The appearance of these paint defects is very similar to those produced by the outgassing of solvents from plastic substrates.<sup>12</sup> The problem was corrected by changes in the electrogalvanizing line at the stell mill.

**PAINT INCLUSIONS:** The paint finish on a sample of aluminum strip produced by a new coil coating line was marred by twenty to thirty 200 micron diameter raised defects per square foot. The paint film cross-sectioning technique revealed the



Figure 6—Photomicrograph of resin bead embedded in paint film



Figure 7—EDX spectra of paint (upper) and resin bead (lower)

#### T.J. VENERI and J.A. KRAMER



Figure 8—Photomicrograph of prepared sample showing the metal surface, two layers of paint and intercoat deposit



Figure 11—Photomicrograph of weld ball in the electrocoat layer, with the zinc phosphate pretreatment morphology clearly visible



Figure 9—Second view of defect after rotation with a higher tilt angle. Note the deposits and voids in the coating



Figure 12—Photomicrograph of paint defect due to nubbing caused by pit in the electrogalvanized layer



Figure 10—Photomicrograph of the zinc phosphate nub and associated paint defect



Figure 13—Second view at edge of pit at a higher tilt angle

presence of 50 micron amber-colored beads of resin embedded in the paint (*Figure* 6). An EDX analysis of the resin bead shows that it contains chlorine, chromium, and zinc, which are not found in the paint film (*Figure* 7). This suggests the contamination is not one of the paint components.

**RINSE DEPOSITS:** A supplier of coil springs for the automotive industry was having ring-shaped paint defects on the lower surfaces of the springs. The shape of the defect is characteristic of a water spot. Examination utilizing the cross-sectioning technique revealed that the contamination is located between two layers of paint (*Figures 8* and 9). The interior of the ring has white deposits which are concentrated around the edges, producing the ring shape. The composition of deposits was determined by EDX. The sodium, phosphorus, chlorine, and zinc present suggest that the spring was reprocessed through the pretreatment section after the initial painting, and was not adequately rinsed before repainting.

The pseudo-three-dimensional view of the defect area better illustrates the source of the problem than would a full metallurgical cross section. The thin, irregular deposits could be easily missed or difficult to analyze.

**NUBBING:** An automotive OEM (original equipment manufacturer) experienced an accumulation of small, raised defects in their electrocoated panels. The defects are approximately 200 microns in diameter. Initial microscopic inspection of the "as-received" defects showed only the appearance of dirt-like contamination at the center of the defect. The true source and nature of the defect could not be adequately assessed without further examination. Paint-film sectioning, as seen in *Figure* 10, shows the real character and extent of the defect.

This technique shows that the defect is due to a large accumulation of zinc phosphate crystals, commonly referred to as "nubs." The dissimilar metals present (zinc and iron) electrochemically accelerate the zinc phosphate coating reaction to produce nubbing of the phosphate coating. The nub originates at the galvanized substrate and extends through the entire thickness of the electrocoat film, protruding out at the top. A small pit is etched in the galvanized coating at the base of the defect area. Nubbing can be reduced by the addition of complex fluorides to the phosphating solution. Had the entire paint film been stripped for examination, the defect and its relationship to the substrate and electrocoat film would have been destroyed. The only evidence of the defect would have been the small pit in the galvanized coating.

WELD BALLS: An automotive production facility experienced problems with particulate contamination in the electrocoat paint section producing numerous small defects in the surface. In this case, the particle could not be cut with the razor blade, so a cut was made next to the particle to expose it for analysis. The SEM photomicrograph in *Figure* 11 shows a weld ball within the electrocoat paint layer, indicating that the electrocoat tank had been contaminated with the weld balls, as opposed to their being attached to the substrate before painting. The phosphate crystal structure is also clearly visible.

GALVANIZING DEFECTS: An automotive manufacturer was having numerous large paint defects in the electrocoat primer

#### EXAMINATION AND ANALYSIS OF PAINT FILM DEFECTS

on a hood section. Three paint film cross sections, an original defect, a fully exposed defect, and a comparative good area are all contained on a one centimeter diameter punched sample. Examination of the prepared sample indicates that the defects are associated with 600 micron diameter pits in the galvanized layer (*Figures* 12 and 13). The iron exposure produces nubbing, resulting in a large build-up of zinc phosphate in the defect area.

**PINHOLING:** Another automotive OEM showed a "pinholing" appearance defect in their topcoated parts. The pinholes, seen after topcoat, are approximately 40-50 microns in diameter and occur at a concentration of 4 defects per square mm area. The pinholes appear to extend down to the substrate below. However, further examination using the paint-film sectioning technique, show that the pinholes in the topcoat are actually caused by voids in the electrocoat layer below. *Figure* 14, a sectioned area under low power SEM magnification, shows a series of holes contained within the electrocoat layer. The topcoat layer sank into those voids when oven-cured, leaving the pinhole appearance as seen in the more highly magnified view of *Figure* 15.

The electrocoat layer of two mils is about twice the normal thickness. Rapid heating of a thick film can cause it to gel before the solvent can escape. Vaporization of the trapped solvent produces bubbles which are cured into the coating.<sup>1</sup>

Without paint-film sectioning, it may have been incorrectly concluded that the defect was caused by solventpopping in the topcoat. However, the true nature of the defect could only be revealed with further examination by paint-film sectioning. Paint-film sectioning also showed that the metal pretreatment process produced a defect- and contamination-free, fine grained crystalline structure on the substrate beneath and adjacent to the defect area.

THOMAS J. VENERI earned his Bachelor of Science Degree in Engineering Metallurgy from Western Michigan University in 1983. Before joining Parker+Amchem in 1988, Mr. Veneri was employed as a metallurgist in the Failure Analysis Laboratory at Chevrolet Central Office, General Motors Technical Center, Warren, MI. Mr. Veneri began his career at Parker+Amchem in Madison Heights, MI, as a Technical Service Representative for the Automotive Group where he specialized in the application of metal pretreatment technology. He now works as a Field Sales/Service Representative for Parker+Amchem's Automotive Group in Central Illinois.

JACK A. KRAMER earned a Bachelor's Degree in Chemistry at Bowling Green State University (1973). His doctoral work in Inorganic Chemistry was performed at the University of Illinois at Champaign-Urbana, and completed in 1979. He accepted a Research Chemist position in the coil coatings business area with Parker Chemical Company. He is currently a Senior Research Scientist in the Analytical Department of Henkel Corporation, Parker+Amchem Division, Madison Heights, MI.

#### T.J. VENERI and J.A. KRAMER



Figure 14—Photomicrograph of the dimpled surface and associated holes in the electrocoat



Figure 16—Crater in the surface of an electrocoated nickelzinc automobile fender



Figure 15—Excessive electrocoat thickness of 2 mil resulted in solvent popping. The pinhole is caused by the topcoat sinking into the void



Figure 17—Crater following paint film cross-sectioning

CRATERING: Figure 16 shows a crater, "as-received," in the surface of an electrocoated automobile fender made from zinc-nickel coated steel. The photomicrograph was taken by SEM at 200x magnification. The crater measures approximately 300 microns in diameter and shows a central void area surrounded by raised, thick edges around the perimeter of the crater. Visually, the crater appeared to be an embedded dirt particle. The crater can be correctly identified using a light microscope, but the bottom of the crater appears to be the substrate, suggesting surface contamination. The paint film cross section seen in Figure 17 shows that there is a thin paint film at the bottom of the crater. This form of crater has been found to be due to spark discharges during the coating deposition process on galvannealed and zinc-nickel substrates. These occur at higher deposition voltages and are related to variations in surface conductivity due to nonuniform distribution of the alloy elements and microscopic spikes in the metal surface.<sup>13,14</sup>

#### CONCLUSION

The paint film cross-sectioning technique was developed to assist the troubleshooting of paint line defects. The crosssectioning technique is performed by bisecting the defect in a softened paint film with a razor blade with the assistance of a stereomicroscope. Additional cuts are made on one side of the defect to facilitate removal of the paint from that area. This results in a stair-step configuration, with the defect exposed in cross section between the metal surface and paint surface "steps." The pseudo-three-dimensional perspective allows examination of the defect with respect to the paint and the metal/pretreatment surfaces. The resulting sample can be examined by scanning electron microscopy, energy dispersive x-ray fluorescence spectroscopy, infrared spectroscopy, or a number of other techniques. The procedure may also be used to remove the whole defect for examination, or analysis of the substrate or underside of the paint film, or to expose a non-defect area for comparison.

The examples of the application of the paint film crosssectioning technique to field problems such as substrate outgassing, rinse spots, particulate contamination, and metal defects illustrate the usefulness of the technique. It is relatively quick and does not require metallurgical equipment to perform. Although solvent damage can occur, the effects are usually minor. It has proved to be a valuable tool in the timely resolution of paint defect problems.

#### ACKNOWLEDGMENTS

The authors wish to thank Craig Patenaude for supplying examples of defects and the associated technical reports, and Henkel Corporation, Parker+Amchem Division, for its support for the preparation of this paper.

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**PAINT/COATINGS** DICTIONARY

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## High-Solids Nonaqueous Dispersion Coatings Based on Crystalline Oligoesters

Ganghui Teng Polaroid Corporation\*

Nonaqueous dispersions (NADs) of a crystalline oligoester diol were prepared by crystallization in a medium consisting of amorphous diol, reactive diluent (RD), and a solvent. The crystalline diol (6GT) was prepared from terephthalic acid and 1,6-hexanediol; RD was prepared from terephthalic acid and glycidyl neodecanoate. The dispersions are opaque, thixotropic liquids with low viscosities at solids of 60-70 wt%. X-ray and calorimetry studies show that the dispersed particles are crystalline. Microscopy shows that they have a narrow distribution of diameters, varying from 5 to 20 µm depending on process conditions. When formulated with crosslinkers (melamine or isocyanate resins) and baked at temperatures above the melting point of the crystalline diol, these NADs gave transparent coatings. Glossy pigmented coatings were also prepared. As high-solids coatings, these materials provide excellent application properties (resistance to sagging) and a good balance of film physical properties. While some of the formulated coatings stratify on standing, they can be restored to homogeneous, free-flowing liquids by stirring gently.

#### INTRODUCTION

Amorphous oligomers and polymers are generally used in coatings; crystalline types are avoided because of their insolubility and the difficulty of achieving homogeneous, defect-free films. However, dispersions of crystalline oligomers offer potential advantages of excellent film properties and useful application rheology. A series of patents and papers<sup>1-3</sup>

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reports that incorporation of crystalline or liquid crystalline para-aromatic units-based moieties into polymers enhances the mechanical properties of finished coatings; combined high hardness and impact resistance can be achieved. Patents<sup>4-6</sup> describe that powder coatings based partly on crystalline, thermoset polyesters containing terephthalate units generally give less orange peel and higher gloss due to lower melt viscosity, more rapid build-up of physical properties during film formation, and outstanding physical properties of the finished coatings, compared to commonly used powder coatings based on amorphous polyesters of similar molecular weight. Because of the insolubility of para-aromatic units-based oligomers or polymers in common solvents used in coatings, direct uses of these oligomers or polymers have been largely limited to powder coatings. In lacquers and dispersions, the para-aromatic units-based moieties are generally copolymerized with other diacids to yield amorphous copolymers.

Direct formulation of para-aromatic units-based oligomers or polymers into liquid, solvent- or waterborne thermoset coatings is of interest because it would allow convenient applications of these oligomers or polymers in coatings. Although preparation of dispersion lacquers through crystallization of polymers from solutions has been reported,<sup>7</sup> preparation of solvent-borne thermoset coatings based on direct formulation of crystalline crosslinkable oligomers or polymers has, to our knowledge, not been described.

This paper reports the convenient preparation of nonaqueous dispersion (NAD), thermoset coatings based on blends of a crystalline oligoester of terephthalic acid and 1,6hexanediol (6GT), a reactive diluent (RD), and a crosslinker (a melamine or triisocyanate resin). In a preliminary communication,<sup>8</sup> we reported the possibility that a series of crystalline oligomers of terephthalic acid and linear, a,w-diols, including 6GT, appeared to have liquid crystalline characteristics at temperatures just above their lowest melting points. Liquid crystallinity has not been firmly established. It is

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This paper is abstracted from Ganghui Teng's Ph.D. dissertation at North Dakota State University.

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clear that these materials are crystalline at room temperature and are liquid at 150°C (curing temperature), the temperatures of greatest interest in this study.

#### **EXPERIMENTAL SECTION**

#### Materials

Glycidyl neodecanoate was obtained from Exxon Chemical Co. under the trade name Glydexx N-10. K-Flex 188 (diesterdiol, DED), hexakis (methoxymethyl) melamine resin (Resimene 746, HMMM), and isocyanate resin (Mondur CB-60, mixed trimers of 2,4-toluenediisocyanate, TIC) were obtained from King Industries, Monsanto Chemical Co., and Miles Corp., respectively. Elvacite AB-1040 (AB dispersant) and TiPure R-960 (TiO<sub>2</sub>) were obtained from DuPont. BYK-020 (defoamer) was obtained from BYK-Chemie. Terephthalic acid, triphenyl benzyl phosphonium chloride (TPBPC), p-toluenesulfonic acid (p-TSA), dibutyltin dilaurate, toluene, and xylene were purchased from the Aldrich Chemical Co. For coatings formulated with isocyanate resin, the solvent was dried over molecular sieves before use; all other materials were used as received.

#### Synthesis of 6GT,6GCH and DED



Dimethyl terephthalate (38.8 g, 0.20 mol), 1,6-hexanediol (35.4 g, 0.30 mol), and zinc acetate dihydrate (0.148 g, 0.2% of total weight) were charged into a three-neck flask equipped with stirrer, thermometer, water condenser, Dean-Stark trap, and nitrogen inlet. The mixture was heated to 220°C in about one hour and kept at this temperature range, while stirring until no more liquid was captured in the condenser (one to two hours). A slow stream of nitrogen through the flask and condenser was maintained during the reaction. The solid product was recrystallized from hot toluene, washed with CH<sub>3</sub>OH, and vacuum stripped at 80°C for 24 hr. The final product was a white solid. <sup>1</sup>H NMR spectroscopy indicates the expected molecular structure and a repeating unit of x =about 2 [NMR (CDCl<sub>3</sub>):1.2-1.8 (very strong, -CH<sub>2</sub>-), 3.6 (medium (1.0), -CH<sub>2</sub>-OH), 4.3 (strong (2.2), -CH<sub>2</sub>-O-CO-), 8.1 (strong (2.2), benzene ring)].

$$HO-(CH_2)_6 = \left[ O - C - C - S \right] - C - O - (CH_2)_6 = OH$$
 6GCH 6GCH

The cycloaliphatic counterpart of the 6GT oligomer (6GCH) was synthesized from dimethyl 1,4-cyclohexanedicarboxylate (mixture of *cis* and *trans*) and 1,6-hexanediol at a mole ratio of 2:3 through a synthetic procedure similar to that of 6GT. The other cycloaliphatic diesterdiol (DED) was purchased from King Industries under the trade name K-Flex 188. The reported chemical structure is drawn here for convenience of discussion.

where R is a mixture of linear and branched aliphatic chains with 5 to 7 carbon atoms.

#### Synthesis of Reactive Diluent (RD)



Terephthalic acid (33.2 g, 0.20 mol), glycidyl neodecanoate (100 g, 0.40 mol; the equivalent weight is determined to be 250 g/mol), and TPBPC (0.2 g, 0.5 g/mol epoxide) were charged into a 250-mL flask equipped with thermometer, stirrer, and water condenser. The materials were stirred and heated to about 220°C over about one hour and kept at this temperature until the terephthalic acid solid phase disappeared (in about 10 to 20 min). The oily product was poured into a 300-mL beaker. Petroleum ether was added carefully with stirring, and the supernatant liquid was decanted. The material was washed with several additional portions of petroleum ether and, while stirring, heated on a heating plate in a hood until the temperature rose to 100°C in order to remove solvent. The final product is a light yellow viscous liquid with an ICI viscosity of 2.4 Pa.s at 50°C and >10 Pa.s at 25°C; it is miscible with toluene or xylene. Yield: 92.5%. NMR (CDCl<sub>3</sub>): 0.85 (very strong, -CH<sub>3</sub>), 1.2-1.8 (very strong, -CH2-, R2CH-), 3.8 (medium, R2CH-O-H(R) or -CH2-O-H(R)), 4.2-4.5 (strong, -CH<sub>2</sub>-O-CO-), 8.1 (strong, benzene ring)].

#### Preparation of Nonaqueous Dispersions and Unpigmented Coatings

In a typical process, 6GT (1.0 g, 0.0033 equiv.) and RD (1.0 g, 0.0032 equiv.) were charged into a 20-mL beaker and heated in a well-ventilated hood until 6GT completely melted (the 6GT reached about 140-150°C). Xylene (1.5 g) was added slowly, forming a homogeneous solution. This hot solution was stirred as it cooled in air. A translucent to opaque dispersion began to form at about 60°C.

In preparation of dispersions with the addition of a crosslinker, a similar procedure was followed except that HMMM (1.0 g) or TIC (2.7 g, 60% solids, 0.0066 equiv.) was added when the solution temperature dropped to about 80°C. After the temperature dropped to room temperature, p-TSA (0.006 g) (for melamines) or dibutyltin dilaurate (0.001
g) (for isocyanates) was added to the dispersion while stirring.

#### **Preparation of Pigmented NAD Coatings**

As a typical procedure for preparing dispersion with melamine resin as a crosslinker, 6GT (10 g, 0.033 equiv.) and RD (10 g, 0.032 equiv.) were charged into a 400-mL stainless beaker and were melted by heating. Half of the total amount of xylene (15 g) was added, followed by the AB dispersant (2.0 g). The material was stirred in a hood, and when the temperature dropped to about 80°C, HMMM (10 g) was added. The solution was stirred continuously until it became a milky dispersion. TiO<sub>2</sub> (15 g) and BYK-020 (1 drop) were added at about 50°C. The mixture was ground on a high-speed dispersing mill until a Hegmann grind of 7 N.S. was reached (in about 30 min). P-TSA (0.15 g) and the second half of the xylene (15 g) were added toward the end of grinding. Additional xylene was added as necessary to replenish evaporation losses during dispersion so that the final weight of the coating was 77 g.

A similar procedure was used in preparing pigmented dispersion with isocyanate as crosslinker. TIC (27 g, 60% solids, 0.066 equiv.) and dibutyltin dilaurate (0.18 g) were used instead of HMMM and p-TSA, respectively. During pigment grinding, the dispersion speed was controlled so that the temperature was kept below about 50°C in order to avoid gelation.

#### Preparation of Clear Coatings Based on 6GCH and DED

6GCH or DED was dissolved in xylene together with the crosslinker (melamine or isocyanate resins) and the catalyst (p-TSA or dibutyltin dilaurate). The coatings were clear, viscous solutions.

#### Film Formation and Testing

Coatings were cast on Bonderite 1000 steel panels using a wire-round rod to obtain a dry film thickness of about 25  $\mu$ m and then baked at 150°C for 30 min, except as noted.

The film properties were tested one day after baking. Pencil hardness, Knoop hardness, reverse impact resistance, and crosshatch adhesion were measured according to ASTM<sup>9</sup> D 3363, D 1474, D 2794, and D 3359, respectively. Film thickness was measured by a magnetic thickness apparatus.

Sagging resistance was measured in accordance with ASTM 4400 method except that an aluminum panel instead of a chart was used because of higher baking temperature. The sample was cast on an aluminum panel using Leneta anti-sag meter (The Leneta Co.), and the panel was set to the vertical direction at the testing temperature for a designated time (such as 150°C for 30 min). The thickness of the thickest unsagged strip was recorded as the sagging resistance value.

#### **Instrumental Methods**

<sup>1</sup>H-NMR spectra were measured at 34°C on a Varian Associates EM 390 NMR Spectrometer with tetramethyl silane as an internal standard.

	Maximum Percent Solids (wt%) <sup>a</sup>			
6GT:RD (Weight Ratio)	6GT:RD Dispersion	With Addition of HMMM (33 wt% of Total Solids)		
3.0	Precipitation observed	Precipitation observed		
2.0		43		
1.5		50		
1.0	60	65		
0.67 (1:1.5)	67	71		
0.5 (1:2)		75		

Differential scanning calorimetry (DSC) was carried out using a DuPont 990 Thermal Analyzer at a heating rate of 10°C/min and a cooling rate of 3°C/min. The sample was contained in a sealed aluminum pan, and an identical empty pan was used as reference.

Microscopy was studied by an Olympus model BH-2 microscope equipped with a crossed polarizer. The samples were prepared on a  $25 \times 62.5$  mm glass slide covered with a cover slide.

Wide angle X-ray diffraction (WAXD) was determined at room temperature with an X-ray diffractometer in the reflection model with a Cu-Ka radiation ( $\lambda = 1.5418$  Å). The samples were cast film on a 27 × 46 mm glass slide and airdried at room temperature before testing.

Viscosity was measured by a Brookfield Cone and Plate Viscometer equipped with a circulated hot water temperature-control system connected to a thermostatic bath.

#### **RESULTS AND DISCUSSION**

#### Syntheses of 6GT, 6GCH, and RD

Syntheses of 6GT and 6GCH were straightforward transesterifications.



Figure 1—Micrograph of 6GT:RD (1:1) dispersion (60% solids in toluene) under crossed polarized light

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The RD was synthesized from terephthalic acid and glycidyl neodecanoate. Since terephthalic acid is insoluble in most solvents (including glycidyl neodecanoate) and has a melting point of above 300°C (it begins to decompose before melting), the reaction of terephthalic acid and glycidyl neodecanoate was heterogeneous with solid terephthalic acid suspended in liquid glycidyl neodecanoate. The reaction was carried out at 220°C and the solid terephthalic acid disappeared in 10-20 min. At such a high temperature, sidereactions (such as transesterifications, esterifications, and etherifications among the products and reactants) are likely to take place, leading to some higher molecular weight molecules. The high viscosity of RD (ICI viscosity: 2.4 Pa.s at 50°C and >10 Pa.s at 25°C) suggests chain-extension reactions.

#### Preparation and Stability of Nonaqueous Dispersions

The dispersion preparation process can be illustrated in the following plot:

1.0 g 6GT + 1.0	a RD	140 °(	C Melt	1.5 g xylene
Homogeneous Solution	Cooling	with	stirring	Non-Aqueous Dispersion

The dispersions containing 6GT, RD, and a solvent are formed from the hot solutions with the same chemical composition during cooling. At typical composition ratios (6GT:RD = about 1:1, or 6GT:RD: crosslinker = about 1:1:1 by weight) and percent solids (60%), both the pigmented and unpigmented dispersions are opaque fluids with thixotropic behavior. The pigmented dispersions became jelly-like after storing at room temperature for several hours, and no discernable phase separation occurred after three months of storage. The nonpigmented dispersions separated into a clear upper layer and an opaque lower layer within three hours, with both layers being free-flowing liquids. Both pigmented

and unpigmented dispersions reverted to homogeneous, freeflowing liquids after minor stirring (or when the containers were shaken). At lower percent solids (< about 45%), layer separation was observed for the pigmented coatings. For the unpigmented coatings, layer separation took place faster at lower solids than at higher solids. At higher 6GT:RD ratio (> about 2:1), precipitation was observed during cooling; at other ratios, the dispersions were generally stable, although the highest percent solids achievable are different. It is noted in this paper that the term "stable dispersion" is used to describe dispersions which remain well-dispersed liquids for at least several hours after each minor stirring and do not form solid precipitates. Table 1 shows the maximum percent solids of 6GT:RD dispersions with different resin ratios. The maximum percent solids increase with decreasing 6GT:RD ratio; at higher percent solids, the dispersions were semisolids. For the same 6GT:RD ratio, addition of crosslinker increases the maximum percent solids (Table 1).

#### Particle Size and Morphology

Figure 1 shows the crossed polarizing micrograph of 6GT:RD (1:1) dispersion in toluene (60% solids). It is seen that the dispersion consists of particles of fairly homogeneously distributed sizes with diameters in the range of 5-10  $\mu$ m. When heated in the microscope, the particles appeared to remain basically unchanged until about 50°C and then began to disappear; no particles were visible above 90°C. At lower 6GT:RD ratio, the dispersion particle size is smaller (with average diameter of about 5  $\mu$ m for 6GT:RD = 1:2). The decrease in particle sizes with increasing reactive diluent is in agreement with a report<sup>7</sup> on certain lacquers prepared by crystallization of polymers from solutions that the addition of certain oligomeric modifiers into polymer solutions reduced the particle sizes.

*Figure* 2 shows the X-Ray diffraction (WAXD) patterns of 6GT:RD (1:1) (a) and 6GT:RD: Resimene 746 (1:1:1) (b) dispersions dried at room temperature. Several sharp peaks

6GT:RD: Crosslinker: TiO <sub>2</sub> (Solid Wt. Ratio)	Crosslinker	Curing Condition (°C: min)	Pencil Hardness	Tukon Hardness (KHN)	Reverse Impact (in-Ibs)	Sagging Resistance (mil)	Appearance
1.0: 1.0: 1.0:0	НМММ	150: 30	3H/4H	10	>160	12	Gl & Tr <sup>b</sup>
1.0: 1.5: 1.5:0	HMMM	150: 30	3H/4H	10	120	10	Gl & Tr
1.5: 1.0: 1.0:0	HMMM	150: 30	4H/5H	12	>160	12	Gl & Tr
1.0: 1.0: 1.6:0	TIC	150: 30	4H/5H	18	>160	12	Gl & Tr
1.0: 1.0: 1.6:0	TIC	70: 120	4H/5H	18	>160	12	Hazy
1.0: 1.0: 1.0:1.5	HMMM	150: 30	4H/5H	14	80	12	GL
1.0: 1.0: 1.6:1.5	TIC	150: 30	6H/7H	22	>160	12	Gl
Controls (solvent-solu	ble clear coatings)						
6GCH:RD:HMMM (1.0: 1.0: 1.0)		150:30	2H/3H	8	>160	7	Gl & Tr
DED:TIC		150:30	2H/3H	12	>160	3	Gl & Tr

Table 2—Film Properties and Sagging Resistance of NAD Coatings<sup>a</sup>

(a) All coatings have percent solids of about 65% with xylene as solvent. For HMMM crosslinked coatings, 0.2% of p-TSA based on the resins was added. For TIC crosslinked coatings, 0.16% of dibutyltin dilaurate based on the resins was added. For TIC crosslinked coatings, 0.16% of dibutyltin (b) GI means [loss] and Tr means transparent.



Figure 2—WAXD patterns of 6GT:RD (1:1) (a) and 6GT:RD: Resimene 746 (1:1:1) (b) dispersions dried at room temperature

together with a medium baseline were observed for both samples, indicating the presence of crystalline domains in the dispersion particles along with considerable amorphous material.

The crystallinity of the dispersions is further demonstrated by the DSC thermograph of a 1:1 mixture of 6GT:RD blended in the melt (*Figure* 3). DSC of pure 6GT is also plotted for comparison. The observed transitions for 6GT:RD blend (15, 52, 75, and 98°C on heating and 75°C on cooling) are lower than those of the pure 6GT oligomer (68, 89, and 111°C on heating and 96, 73, and 60°C on cooling), suggesting the effect of RD on the crystal structures and possible entrainment of the RD in the crystal domains. Transitions below 50°C on cooling could not be determined with the DSC instrument available.

#### Factors Governing Formation and Stability of NADs

As shown previously, crystallization of 6GT from xylene alone yields large crystals, not a dispersion. A stable dispersion forms only when substantial levels of reactive diluent are present as the solution cools. Particle size decreases as the proportion of reactive diluent increases. Each particle may be composed of many individual crystals of the different species of 6GT with RD molecules entrained within the particles and on the surface, as indicated by the reduced transition temperatures. The characteristics of the dispersion formed in the crystallization process must be influenced by an interplay of complex kinetic factors and probably by thermodynamic factors as well. At this stage of the study we can only speculate about what may be happening during the process.

Regarding kinetics of the crystallization process, the observation of a narrow distribution of particle sizes indicates

#### COATINGS BASED ON CRYSTALLINE OLIGOESTERS

that most of the particles grow at about the same time and rate. We envisage that in the early stages the concentration of 6GT is high, that many particles nucleate at about the same time, and that crystal growth is fast. In the later stage, the concentration of RD entrained near the particle surfaces is relatively high, limiting the rate of further growth of the particles.

Regarding thermodynamics, it was observed that the particles seem to have no tendency to grow or agglomerate at 25°C for a period of at least three months, indicating some type of thermodynamic stabilization. On the other hand, the fact that there are weak particle-particle interactions in the dispersion. It is speculated that the fact that both 6GT and RD are terephthalate esters may increase the weak attraction of RD to crystal surfaces, leading to particles that have a thin layer of RD at the surface. While the molecular weight of monomeric RD (as depicted in the previous equation) is probably too low for entropic stabilization. There are probably chain extended molecules in RD with molecular weights high enough to function as entropic stabilizers. The AB dispersant added to the pigmented coatings could provide additional stabilization.

#### Film Formation and Film Properties of NAD Coatings

As shown in *Table* 2, all NAD coatings produced glossy films when cured at 150°C. The unpigmented coatings were highly transparent; however, an unpigmented coating cured at 70°C was hazy. Evidently, it is feasible to form optically homogeneous films by baking the NAD coatings at temperatures above the melting point of the crystalline phase. Apparently, the crystals melt and dissolve in the reactive diluent/ crosslinker solution at least to the extent necessary to make the films appear homogeneous to the naked eye before crosslinking has advanced far enough to impede interdiffusion. According to recent patents, <sup>4,6</sup> powder coatings in which



Figure 3—DSC thermographs of 6GT oligomer (a) and a mixture of 6GT:RD (1:1) blended in the melt (b)



Figure 4—Viscosity vs shear rate of NAD coatings and control oligoester solution

the binders are partly crystalline and partly amorphous also form glossy films.

In *Table* 2, film properties of coatings made from crystalline NADs are compared to those of coatings made from amorphous controls, 6GCH and DED. The controls are oligoester diols of similar molecular weight to 6GT, but they



Figure 5—Shear-thinning behavior of NAD (6GT:RD = 1:2) at different temperature

are amorphous and soluble in xylene, typical of conventional resins for coatings. The NAD coatings have excellent hardness, adhesion, and impact resistance. They are much harder than the control coatings, but there is no detectable compromise of impact resistance. An excellent combination of hardness and impact resistance has been observed in enamels based on liquid crystalline oligomers.<sup>1</sup>

At this stage in our work, we can only speculate as to the reasons for these excellent properties. We previously suggested that within a crosslinked network chain segments with a tendency to adopt ordered structures (crystals or liquid crystals) may tend to form submicroscopic clusters, and. I Recent theoretical work, for example, by Bladon and Warner, which concerns the properties of nematic elastomers (formed by crosslinking liquid crystalline polymers), predicts "that nematic effects can play an important part in determining the physical characteristics of a conventional rubber."<sup>10</sup> Such theories may have an important bearing on the present work and on the properties of coatings in general. Further study of the cause of film properties enhancement is in progress.

#### Application Characteristics of NAD Coatings

The rheology of the high-solids NADA coatings is more complex than that of high-solids coatings based on amorphous oligomers. This rheological complexity, if skillfully used, has the potential to provide substantial advantages in application characteristics; especially in sagging resistance. Sagging is one of the most troublesome problems facing the formulator of high-solids coatings.

As shown in *Table* 2, the NAD coatings had excellent resistance to sagging (10 to 12 mil) compared to normal resistance of the solvent-soluble, amorphous controls (3 to 7 mil). The difference is so large that it may eliminate worries about oven sagging in most practical situations.

The sagging resistance of these NADs is attributable to their extremely strong shear-thinning behavior, in addition to their thixotropic properties. Figure 4 shows the viscosity versus shear rate of NAD coatings with different crystalline oligoester (6GT) contents and a control DED solution. The NAD coatings are much more shear-thinning than the control solution. The shear-thinning behavior increases greatly with increasing 6GT:RD ratios. The NADs remain strongly shear-thinning until their clearing temperature, as shown in Figure 5 for the NAD of 6GT and RD (1:2). Because of their strong shear-thinning behavior, the NAD coatings will have higher low-shear viscosity for minimum sagging and lower high-shear viscosity for smooth application. When the newly applied coating is put into the oven, it will have higher low-shear viscosity from room temperature up to the clearing temperature of the coating. Therefore, sagging is minimized in the early stage of the baking. Above the clearing temperature, the viscosity is expected to drop sharply; however, the resins will begin to crosslink at such a high temperature, preventing the coatings from sagging. The thixotropic behavior of the coatings is also beneficial for sagging resistance. Although the newly applied coatings do not have viscosity as high as unstirred coatings, they will increase in viscosity during the period between application and curing.

#### COATINGS BASED ON CRYSTALLINE OLIGOESTERS

#### CONCLUSION

High-solids nonaqueous dispersion (NAD) coatings based on a crosslinkable, crystalline oligoester can be prepared by a simple process in which the oligoester is crystallized from a solution of a reactive diluent and solvent. With careful matching of reactive diluent and oligoester, stable NADs with particles of fairly uniform size are formed. Crosslinkers and pigments are easily incorporated in the process. When cured above the melting point of the crystalline oligomer, these coatings form glossy, transparent films. Film physical properties are excellent, especially with respect to the combination of hardness and impact resistance. Application characteristics include outstanding resistance to sagging, attributable to the unusual rheological characteristics of the NADs. This research points the way toward a new method for preparing industrially useful high-solids thermoset coatings with excellent application and film properties.

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## Aluminum Trihydroxide (ATH): A UV Transparent Filler for UV-Curable Coatings

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Unlike other extenders, aluminum trihydroxide (ATH) absorbs very little ultraviolet radiation over the wavelength range which is commonly used to activate most UV photoinitiators (220 to 400 nm). This is demonstrated by comparing the total transmittance (diffuse and specular) of UV-cured polyurethane films with and without the use of ATH as an extender. Difference spectra between filled and unfilled systems show that ATH does not interfere with the transmittance of UV light. On the other hand, a comparable study with a silica-filled system indicates that a higher proportion of UV light is absorbed. Solid state <sup>13</sup>C NMR and FTIR spectra of ATH-filled, silica-filled, and neat systems show that the final chemical components of the crosslinked polymer matrices are similar. However, FTIR

#### INTRODUCTION

Inorganic fillers can be used to reinforce and extend polymers while enhancing performance at a reduced cost. However, in UV-curable polymer applications, inorganic fillers and pigments can hinder curing reactions either by reducing the effective transmittance of the source radiation, or by interfering directly with chemical reactions. One of the most notable examples, titanium dioxide (TiO<sub>2</sub>) can both absorb UV light and quench certain radical reactions.<sup>1</sup> Thus, only limited types and amounts of inorganic fillers can be uses in analyses of residual acrylate absorbances near 830 cm<sup>-1</sup> show that the ATH-filled systems exhibit higher degrees of cure than both the neat and the silica-filled systems. This agrees with differential photocalorimetry (DPC) studies which show that the enthalpy of cure increases in the presence of ATH. Diffuse reflectance studies of neat powders indicate that ATH exhibits higher reflectivity than silica in the UV range. Thus, the difference in UV absorption behavior between the filled and neat polymer films, and the differences in filler absorption and reflectivity. Taken together, these trends indicate that, unlike other fillers, ATH can function as a UV transparent extender for UV-curable polymer applications.

UV-curing applications. In fact, spectral overlap between initiation wavelengths and pigment/filler absorption wavelengths will often preclude the use of many conventional initiators, and may necessitate the use of other, wavelength-specific initiator systems.<sup>2</sup>

In typical UV-curable urethane/acrylate systems for coating applications, both the prepolymers and initiator systems are relatively high in cost when compared to inorganic fillers like aluminum trihydroxide (ATH). Thus, resin extension with fillers like ATH could be desirable from the cost standpoint. However, in order to realize the full cost advantage of resin extension, fillers must be relatively inert to the curing process so that they can function without the need for special, and perhaps costly, formulation changes. Secondly, the filler must impart adequate physical properties on the final polymer matrix (i.e., impact resistance, ductility, abrasion resistance, transparency, etc.)

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#### A.A. PARKER, E.S. MARTIN, and T.R. CLEVER

The physical properties of filled polyurethane systems can be conventionally controlled by adjusting the stoichiometry of the "rigid" and "soft" components,<sup>3</sup> by adjusting the degree of cure or crosslink density, or by functionalizing the filler surface with an appropriate surface treatment.<sup>4</sup> However, the inherent optical properties of a filler cannot be as easily controlled. For example, the UV absorbance behavior of a filler will be an inherent function of its composition. Also, the reflectivity will be a function of the refractive index mismatch between the filler and its surrounding organic medium. In turn, the degree of refractive index mismatch, and the filler absorption coefficient will control both the transparency and opacity of a filled system to visible and UV light.<sup>5.6</sup>

In the absence of impurities, aluminum oxide ( $\alpha$ -Al<sub>2</sub>O<sub>3</sub>), aluminum hydroxide (Al(OH)3), and silicone dioxide (SiO2) should absorb very little ultraviolet radiation in the range of 200 nm to 400 nm when compared with transition metal oxides like TiO2. The difference in UV absorption behavior between Al<sub>2</sub>O<sub>3</sub> and TiO<sub>2</sub> is related to a difference in the electronic structure of their respective crystal lattices. Aluminum will exist in the Al<sup>3+</sup> oxidation state in both Al<sub>2</sub>O<sub>3</sub> and in Al(OH)<sub>3</sub>, with a bandgap of approximately 10 eV between the unoccupied metal orbitals (3s and 3p in character), and the filled oxygen 2p orbitals.7 Thus, a charge transfer excitation would be expected to occur in the high energy vacuum UV region (below 190 nm), while no absorption should occur in the UV-C, UV-B, and UV-A regions (210 to 380 nm). On the other hand, the bandgap between the lowerlying unoccupied metal orbitals of Ti4+ (4s in character) and the occupied oxygen 2p orbitals is only about 3.5 eV in the rutile structure in TiO2.7 Thus, TiO2 will experience a strong charge transfer absorption in the UV-A region at about 350 nm.



Figure 1—Solid state <sup>13</sup>C NMR spectra of UV-cured polyurethane films in the presence and absence of S-3 ATH and silica fillers

SiO<sub>2</sub> should behave similarly to Al<sub>2</sub>O<sub>3</sub> and Al(OH)<sub>3</sub> with no absorption in the normal UV. However, diffuse reflectance measurements for an SiO<sub>2</sub> powder (Aerosil from Alfa Products) have been reported to show an apparent absorption at 210 and 275 nm. Similarly, an absorption at 210 nm was also reported for  $\gamma$ Al<sub>2</sub>O<sub>3</sub>.<sup>8</sup> However, it appears that the absorptivity and reflectivity of Al(OH)<sub>3</sub> has not been documented for the UV region.

If indeed solid Al(OH)<sub>3</sub> powder does not absorb in the normal UV, it would follow that "UV transparent" ATH could be an ideal extender for UV-curable polymer systems where the prepolymers and initiators are relatively high in cost compared to ATH. Given that the refractive index for ATH in the visible range is closely matched with many polymers (n=1.57), high levels of transparency in the visible range could also be achieved if desired.<sup>4</sup> The purpose of this work is to focus on the UV transparency hypothesis by comparing the relative effects of ATH and silica on the degree of cure, and on the total UV transmittance of cured urethane/acrylate films.

#### **EXPERIMENTAL**

**COATING FORMULATIONS:** A UV-curable resin formulation similar to U-1012 Resin from UCB Radcure, Inc. was prepared by mixing the following components on a weight basis: 68.43 parts Ebecryl 8800, an acrylated aliphatic urethane resin from UCB Radcure; 14.66 parts OTA-480, a trifunctional oligomeric acrylate from UCB Radcure; 14.66 parts N-VP, N-vinyl-2-pyrrolidone from ISP Inc.; 1.96 parts Irgacure 184 photoinitiator from CIBA-GEIGY Corp.; and 0.29 parts Irganox 1035 oxidation inhibitor from CIBA-GEIGY Corp.

Coatings were prepared with the neat resin in the presence and absence of 10% filler by weight (approximately 4% by volume) for comparative UV/VIS, FTIR, NMR, and DPC studies.

COMPOSITION AND PHYSICAL PROPERTIES OF FILLERS: All of the fillers were characterized for particle size distribution by Sedigraph, for crystal phase structure by X-ray diffraction, and for surface area by N2 BET. The fillers for these studies include SpaceRite<sup>™</sup> S-3 ATH from Alcoa (98.0% Al(OH)3 minimum, gibbsite, 0.7% moisture maximum, 0.01 to 0.16% Na<sub>2</sub>O soluble, 1.0 µm median particle diameter, 5.5 m<sup>2</sup>/g surface area, p=2.42 g/cm<sup>3</sup>); and Syloid<sup>™</sup> 74X4500 hydrated silica from Davidson Chemical Division of W.R. Grace (amorphous SiO<sub>2</sub>, 10.3 µm median particle diameter, 279 m<sup>2</sup>/g surface area,  $\rho$ =2.20 g/cm<sup>3</sup>). In addition, a coating was also prepared with Space Rite S-23 ATH from Alcoa (98.0% Al(OH)3 minimum, gibbsite, 0.01 to 0.5% moisture, 0.00 to 0.04% Na2O soluble, 7.5 µm median particle diameter, 0.7 m<sup>2</sup>/g surface area,  $\rho=2.42$  g/cm<sup>3</sup>) to determine the effect of ATH particle size on UV absorption behavior. All of the fillers were dispersed for five minutes at medium speed with a Cowles blade driven by an air motor.

COATING APPLICATION AND CURING: Coatings were cast on draw-down panels with a 0.003 in. Byrd blade, and were cured according to a common schedule. After casting, the panels were conveyed through a Radiant Products UV processor at a line speed of 20 feet per minute for four passes. A single Hanovia medium pressure mercury UV lamp rated at 200 W/in.<sup>2</sup> output (31 W/cm<sup>2</sup>) served as the radiation source, and it was mounted in a parabolic reflector at a height of 5.5 in. above the substrate. Portions of the cured coatings were then subjected to an MEK rub test to qualitatively compare the number of rubs needed to cause visual haze and distortion.

FILM DENSITIES AND EFFECTIVE POLYMER CONCENTRA-TIONS: The bulk densities of the cured films were gravimetrically determined to be 0.86 g/cm<sup>3</sup> for the neat film. 0.90 g/ cm<sup>3</sup> for the S-3 ATH-filled system, 0.94 g/cm<sup>3</sup> for the S-23 ATH-filled system, and 0.99 g/cm<sup>3</sup> for the silica-filled system. Given that the filled systems contained 90% polymer by weight, the effective polymer concentrations (0.90 [bulk density]) were determined to be 0.81 g/cm<sup>3</sup> for the S-3 ATHfilled system, 0.85 g/cm<sup>3</sup> for the S-23 ATH-filled system, and 0.89 g/cm<sup>3</sup> for the silica-filled system. The effective polymer concentration for each sample was used to represent the weight of polymer that was distributed over the entire matrix volume, including the volume occupied by polymer, filler, and voids.

Scanning electron microscopy crossections of the filled films showed evidence of polymer/particle separations and voids in both of the ATH samples, but not in the silica-filled sample. The frequency of separations and voids was highest in the sample filled with S-3 ATH, which was probably related to incomplete polymer/particle wetting. Thus, the effective polymer concentration values were required in order to account for differences in void volume and cured polymer densities, so that comparative UV/VIS absorption studies could be performed.

UV/VIS SPECTROSCOPY OF CURED FILMS: A dual beam Hitachi U-3110 UV/VIS spectrophotometer equipped with a BaSO<sub>4</sub>-coated integrating sphere (Hitachi model 150-0902) was used to measure the total transmittance (Ttotal) and absorbance spectra for the cured films. All data calculations were performed with Spectra-Calc software from Galactic Industries. All spectra were acquired from 220 nm to 800 nm at a scan rate of 60 nm/min, with a Spectralon<sup>™</sup> secondary standard in the reference port of the sphere. The sample spectra were ratioed to a background spectrum that was run with Spectralon standards placed in both the sample and reference ports. Cured film sections of equivalent thickness (0.0015 in.) were cut from the draw-down panels in order to facilitate the comparison of equal sample path lengths.

The absorbance spectrum of the neat film was subtracted from the absorbance spectra of the filled systems to obtain the absorbance contributions from the fillers, and from the unreacted chromophores in the polymer. However, given that the filled systems had different volume fractions of polymer, the neat spectrum was corrected to account for the lower effective polymer concentrations in the filled systems. Thus, in accordance with Beer's law,<sup>9</sup> a multiplication constant of 0.94 was used for subtraction operations involving the S-3 ATH-filled system, 0.98 for the S-23 ATH-filled system, and 1.03 for the silica-filled system. Thus, if the systems were to contain an equivalent concentration of chromophores (i.e., if they had the same degree of cure), then the corrected difference spectra would represent the absorbance of the fillers. If the systems were to have different levels of



Figure 2—Attenuated total internal reflectance FTIR spectra for neat, silica-filled, and S-3-ATH filled polyurethane films after UV-cure, where the band near 830 cm<sup>-1</sup> is representative of the residual acrylate functionality

cure, then the difference spectra would also contain contributions from unreacted chromophores.

Specular transmittance spectra were also measured for the same films in the absence of the integrating sphere (Tspec, also called "normal" or "regular" transmittance) with air as a reference, and with air run as a background. Since these measurements were obtained without the integrating sphere, most of the diffuse component was excluded. Thus, the relative diffuse transmittance (Tdiffuse) spectra were then approximated by subtracting Tspec from T total.

Replicate runs were also performed to test reproducibility for each type of measurement on samples that were cut from different locations using the cured neat film, and the film containing 10% S-3 ATH. Transmittance values were found to fluctuate by no more than +/- 2% over the entire wavelength region that was analyzed.

UV/VIS SPECTROSCOPY OF POWDERS: The Hitachi U-3110 instrument and integrating sphere were also used to collect diffuse reflectance spectra for the neat powders between 250 nm and 800 nm at a scan rate of 60 nm/min. The powders were loaded into a Spectralon sample cell with a quartz window, while a solid Spectralon standard was placed in the reference port. The sample spectra were then ratioed against a background spectrum which was run with Spectralon in the reference port, and Spectralon powder in the sample port. The spectra were multiplied by a wavelength-dependent correction factor (approximately 0.97 over the entire wavelength range) to correct for the difference in reflectivity between the samples and the Spectralon standard.<sup>10</sup>

SOLID STATE <sup>13</sup>C NUCLEAR MAGNETIC RESONANCE (NMR) OF CURED FILMS: Solid state NMR spectra were acquired for the purpose of comparing the bulk chemical composition of the neat and filled systems after curing. A GE-300 spectrometer at 75 MHz for <sup>13</sup>C analysis was used to collect protoncarbon cross polarized spectra with magic angle spinning (CP/MAS).<sup>11</sup> The sample spinning rate was varied between two and four kHz for the purpose of identifying the spinning side bands. Samples were packed in ceramic rotors with Kel-



Total Transmittance of 0.0015" Films, Integrating Sphere



Table 1—Effect of Fillers on the Enthalpies of Cure for UV-cured Polyurethanes, and on the Relative Residual Vinyl Concentrations from FTIR using the Ratio of Intensities at 830 cm<sup>-1</sup> and 1714 cm<sup>-1</sup>

Sample	Enthalpy (J/g)	Relative Residual Vinyl Concentration
Neat polymer		0.33
Polymer/silica		0.23
Polymer/S-23 ATH		0.21
Polymer/S-3 ATH		0.13



Absorbance from Total %T, integrating sphere

Figure 4—Total UV/VIS absorbance spectra for the neat and silica-filled polyurethane films after UV-cure, and the difference spectrum of the filled polymer minus the neat polymer (corrected for the effective polymer concentration in the filled system) FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR) OF CURED FILMS: FTIR spectra were acquired for the purpose of comparing the bulk chemical compositions of the cured films, and for determining the relative proportion of residual acrylate groups using the vinyl = C - H bending band near 830 cm<sup>-1,12</sup> All spectra were acquired with a Mattson Polaris Spectrometer equipped with a DTGS detector, and a Spectra-Tech attenuated total internal reflectance accessory (ATR). Both the substrate and air surfaces of the film samples were analyzed by ATR using a KRS-5 crystal at a 55° angle of incidence with a resolution of 4 cm<sup>-1</sup>, and with signal averaging of 64 scans. All spectra were baseline corrected using a common correction routine.

DIFFERENTIAL PHOTOCALORIMETRY STUDIES (DPC): The enthalpy of cure upon UV irradiation of the neat and filled resins was determined by using a TA Instruments 930 DPC. A standard high pressure mercury arc lamp with an output of 6 mW/cm<sup>2</sup> was used to irradiate 1 mg quantities of samples for five minutes in open aluminum pans while using an empty pan as a reference. The heat of reaction was measured as a function of time at 30°C under atmospheric conditions. A post-cured five minute exposure was also measured in order to correct for baseline shift during the curing process. Baseline corrections and subsequent peak integrations for the enthalpy of cure were determined with the TA software. The apparent enthalpies of cure (J/g) for the filled systems were then weight corrected to obtain the heat of reaction per unit weight of resin, independent of the filler. The average difference between duplicate runs of samples was used to estimate an error of +/-7% for the enthalpy of cure.

#### **RESULTS AND DISCUSSION**

#### Effect of Fillers on the Degree of Cure

*Figure* 1 shows the <sup>13</sup>C solid state NMR spectra of the neat film, the S-3 ATH-filled film, and the silica-filled film after cure. The peaks near 158 ppm and 178 ppm are characteristic of the polyurethane urea carbonyls, and the PVP/ acrylate carbonyl carbons are spinning side bands (marked with asterisks) since they were observed to shift with changes in the spinning rate.<sup>13</sup> These spectra show that NMR cannot differentiate between the chemical compositions of the neat and filled films. Given that no discernable vinyl carbon peaks occur near 130 ppm, and given that no acrylic carbonyls occur near 167 ppm,<sup>11</sup> it appears that within the sensitivity limits of <sup>13</sup>C solid state NMR, each system has reached a high level of cure.

Like the NMR spectra, the attenuated total internal reflectance (ATR) spectra from FTIR analyses are similar for each sample, independent of whether the "air" or "substrate" surfaces are compared. However, unlike NMR, the higher sensitivity of FTIR<sup>0,14</sup> results in the detection of slight differences in the olefinic C-H bending regions between 700 and 850 cm<sup>-1</sup> as shown in *Figure* 2. Absorption bands in this region are characteristic of residual acrylate groups which can remain as a result of incomplete cure.<sup>12</sup> Although the error associated with these FTIR measurements was not determined, this trend was found to be reproducible.

The relative concentration of residual vinyl groups can be approximated by using an internal ratio method, where the band at 830 cm<sup>-1</sup> is ratioed against the carbonyl band at 1714 cm<sup>-1</sup> for each individual sample<sup>12</sup> as shown in *Table* 1. This analysis shows that the silica-filled system and the neat system have the highest relative residual vinyl contents, while the S-3 ATH-filled sample has the lowest. Thus, even though NMR indicates that the cure levels are high, the enhanced sensitivity of the FTIR technique9.14 results in the detection of incomplete conversion in both the neat and silica-filled polymers. This result is qualitatively supported by MEK rub tests which show that the S-3 ATH-filled system can withstand in excess of 200 rubs without noticeable distortion, while the silica-filled system can only withstand 140 comparable rubs. Thus, these results suggest that the ATH filler may facilitate higher levels of cure.

This hypothesis is also supported by DPC results as shown in *Table* 1. The silica-filled system and the neat system exhibit the lowest enthalpies of cure while the S-3 ATHfilled system exhibits the highest. However, given the level of error in the DPC measurements, the only statistically significant difference occurs between the S-3-filled film and the other three. Still, the trends for all of the samples are parallel to the relative absorbance ratios of the bands at 830 cm<sup>-1</sup> and 1714 cm<sup>-1</sup> in the cured films. Hence, the generally higher enthalpies for the ATH-filled systems are associated with higher levels of cure, where the difference is most significant for the S-3 filled system.

#### UV/VIS Measurements of Cured Films: Total Transmittance and Absorbance

Figure 3 shows the total UV/VIS transmittance spectra for the neat film, the S-3 ATH-filled film, and the silicafilled film after cure. The S-3 ATH-filled system exhibits a significantly higher level of total transmittance over the entire 220 nm to 400 nm range. This suggests that the ATH filler provides a higher degree of UV transparency when compared to the silica filler. However, due to the lower density of the ATH-filled systems, care must be taken to account for the lower volume fractions of polymer. This is accomplished by comparing the concentration-corrected differences between the absorbance spectra for the filled systems, and the absorbance spectrum for the neat polymer.

The total absorbance spectra of the silica-filled polymer and the S-3 ATH-filled polymer (from the total transmittance measurements) are shown together with the concentration-corrected spectrum of the neat polymer in *Figures* 4 and 5, respectively. The difference spectrum in *Figure* 4 shows absorption maxima at about 245 and 280 nm. This difference spectrum is representative of the combined absorbances from the silica filler, and from the unreacted polymer chromophores. The residual acrylate groups that were detected by FTIR could contribute to the absorption behavior between 220 and 250 nm<sup>7</sup> as could the silica.<sup>8</sup> On the other hand, the difference spectrum for the S-3 ATH-filled sample in *Figure* 5 is nearly zero, and it even becomes slightly negative over a





#### Figure 5—Total UV/VIS absorbance spectra for the neat and S-3 ATH-filled polyurethane films after UV-cure, and the difference spectrum of the filled polymer minus the neat polymer (cor rected for the effective polymer concentration in the filled system)

large portion of the UV range. This suggests that the ATH is not absorbing, and that a higher concentration of residual chromophores are remaining in the neat polymer. Thus, even after correcting for the effective concentration of polymer, these results suggest that the ATH filler provides a higher degree of UV transparency than the silica filler.

#### UV/VIS Measurements of Cured Films: Specular and Diffuse Transmittance

The interaction of light with powder in any medium will actually be a complex function of the ratio of absorption to scattering coefficients (K/S) as described by the well-known Kubelka-Munk formalism.<sup>15</sup> Even in the absence of absorption, irregularly shaped particles can scatter light (both



Specular (Normal) Transmittance of 0.0015" Films

Figure 6—Specular (normal) UV/VIS transmittance spectra for neat, silica-filled, S-3 ATH-filled, and S-23 ATH-filled polyurethane films after UV-cure



Diffuse Transmittance of 0.0015" Films

Figure 7—Relative diffuse UV/VIS transmittance spectra for neat, silica-filled, and S-3 ATH-filled polyurethane films after UV-cure

specular and diffuse) over a broad range of incidence angles when their refractive indices are mismatched with the surrounding medium.<sup>5,6,1,5</sup> Diffuse scattering will arise from rays that are first transmitted through the powders, and which then are reflected from other matrix powder surfaces at random angles of incidence. Thus, because diffuse rays are transmitted through the powder particles (unlike specularly reflected rays), they will also carry absorption information.<sup>15</sup>

In cases where absorption is minimal, diffuse scattering can increase the effective pathlength of the source radiation, which can result in a more efficient UV cure.<sup>1</sup> As previously noted, the total transmittance of both UV and visible light is highest for the S-3 ATH-filled system. However, the total transmittance is composed of both specular (normal), and diffuse (scattered) components which can be separated through different types of measurements. For example, in the absence of the integrating sphere, normal transmittance can be measured to yield the relative specular component as



Figure 8—UV/VIS diffuse reflectance spectra for neat S-3 ATH and silica powders

shown in *Figure* 6. These results show that the S-3 ATHfilled polymer exhibits significantly lower specular transmittance values at wavelengths greater than 250 nm when compared to the other samples. On the other hand, the relative diffuse transmittance for the S-3 ATH system is the highest of the three films over the entire wavelength region as shown in *Figure* 7. Thus, higher levels of diffuse scattering in the UV, and lower levels of absorptivity are the likely reasons for the higher cure levels that are observed in the presence of ATH.

These results show that although the S-3 ATH-filled system has the highest total transmittance (Figure 3), much of the UV light is diffusely transmitted, at least in this particular polymer medium. Although this does not alter our transparency hypothesis, it does show that factors like polymer/ particle wetting, void content, and refractive index mismatch can determine the mechanism by which light is ultimately transmitted. For example, although it is not the focus of this paper, the S-23 ATH sample which contains fewer voids as judged from SEM crossections (also shown in Figure 6) provides higher specular transmittance values than the S-3 ATH sample. Higher values should also be possible with refractive index matching, and with appropriate surface treatments to improve wetting and particle dispersion in the matrix. A study of these variables will be critical for attaining coatings with low "haze," and thus will be the focus of a future paper.

#### UV/VIS Measurements of Neat Powders

In the absence of anomalous dispersion (absorption), the refractive index of most materials will increase at shorter wavelengths.<sup>16</sup> Given that the refractive index of air does not appreciably change over the 200 nm to 400 nm wavelength range,<sup>17</sup> the degree of mismatch between the refractive indices of the powders and air should also increase at shorter wavelengths. Thus, in the absence of absorption, this could



Absorbance from Total %T, intregrating sphere

Figure 9—Total UV/VIS absorbance spectra for the neat and S-23 ATH-filled polyurethane films after UV-cure, and the difference spectrum of the filled polymer minus the neat polymer (corrected for the effective polymer concentration in the filled system)



Total Transmittance of 0.0015" Films, Integrating Sphere

Figure 10—Total UV/VIS transmittance spectra for silica-filled and S-23 ATH-filled polyurethane films after UV-cure

result in more specular scattering, which could go undetected by an integrating sphere. In turn, this would lead to a decrease in the apparent reflectivity at shorter wavelengths. Furthermore, if absorption predominates over scattering, then the reflectivity will also decrease.

The diffuse reflectance spectra of neat S-3 ATH and silica powders are shown in *Figure* 8. The reflectivities of both powder samples tend to decrease at shorter wavelengths, but S-3 ATH still exhibits higher reflectivity over the entire wavelength range. While the reflectivity of ATH decreases to 80% at 250 nm, the reflectivity of the silica sample decreases to 60% at 250 nm. Hence, given that the Irgacure 184 photoinitiator has absorption maxima at 203, 242, and 326 nm.<sup>18</sup> it appears that the silica may have more of a UV screening effect than ATH. Conversely, the high reflectivity of the ATH serves as further evidence for its ability to facilitate higher levels of cure under identical curing conditions.

Although the diffuse reflectance measurements of the neat powders are representative of powder concentrates, the trends should be similar at lower volume fractions. In fact, the higher UV reflectivity for the neat S-3 ATH powder is consistent with the observation of a higher diffuse transmittance for the S-3 ATH-filled polymer. However, unlike the neat ATH powder sample which shows a decrease in reflectivity at 250 nm, the absorption spectrum of the S-3 ATH-filled polymer is not affected by ATH. This is likely related to ATH's low absorptivity and low concentration in the polymer matrix. Thus, at a volume fraction of about 4%, ATH is essentially transparent to UV light.

#### Effect of Particle Size on the UV Transparency of ATH

*Figure* 9 shows the difference between the total absorbance spectra for the S-23 ATH-filled polymer, and for the neat polymer. As discussed previously for the S-3 ATH and the silica-filled samples, this difference spectrum represents the absorption contribution from S-23 ATH. Like S-3 ATH (1.0 µm median particle size), S-23 ATH (7.5 µm median

particle size) is essentially transparent to UV light. Consequently, the S-23 ATH-filled polymer also exhibits higher levels of total UV and visible transmittance when compared to the silica-filled polymer as shown in *Figure* 10, as well as a higher degree of cure as shown in *Table* 1. Thus, although the particle size of ATH may have some effect on the degree of cure, the larger particle size appears to have no effect on the transparency of ATH to UV light.

#### CONCLUSIONS

The results of this study show that ATH can effectively function as a UV transparent filler for UV-curable polymer applications. The total transmittance of a UV-cured polyurethane/acrylate polymer can actually be increased by the addition of an ATH filler. At a level of four percent by volume, difference spectra between neat and ATH-filled systems show that ATH does not appear to contribute to the UV absorption of the filled polymers, which suggests that ATH is transparent to UV light. When compared to a silica-filled polymer, the ATH-filled polymers exhibit higher levels of total transmittance, which also correlates with higher degrees of cure as shown by DPC and FTIR analyses.

Taken collectively, these results suggest that ATH can be an ideal filler/extender for UV-curable polymer applications. For example, in addition to ATH's inherently lower cost when compared to the resins, it may be possible to achieve higher levels of cure with less initiator and/or shorter cure times. Future work will be needed to address these issues, as well as the effects of ATH on visible transparency, and on the mechanical behavior of UV-cured polymers.

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## Influence of Defoamers on the Efficiency of Waterborne Coating Systems

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Foam problems during production and application of waterborne systems are common. The reasons for the generation and stabilization of foam, and the types of foam in these systems, have been the subject of numerous discussions. Foam is generated and stabilized by the presence of surfactants commonly found in small concentrations (e.g., wetting agents and polymer emulsifiers). Destabilization of foam is achieved through the addition of substances which orient themselves at the air/liquid interface, resulting in a reduction of surface tension. This paper discusses the different types of foam, the phenomenon of foam generation, and the physical and chemical aspects of the technology and substances available to destabilize foam successfully.

#### INTRODUCTION

Foam problems in aqueous systems often arise in production and during use. Causes of foam generation in these systems and the characteristics of foams have been the subject of multiple articles (see References) (*Figure* 1).

In *Figure* 1, two types of film defects can be readily observed: large, perfectly round craters having raised edges, and much smaller pinholes, seen as indentations. An earlier article<sup>1</sup> characterized the crater-forming foam as macrofoam and the pinhole-forming foam as microfoam. Both macrofoam and microfoam are formed during coating manufacture and application.

Surface active agents (surfactants) are often added to coatings to achieve specific effects. In aqueous systems, typical surfactants include emulsifying agents for emulsifying the intrinsically hydrophobic binders, and wetting agents and dispersants for wetting substrates or achieving pigment dispersion.

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Surfactants function through migration to the coating's interfaces (gas/liquid, gas/solid, or liquid/solid) and usually lower the surface tension of the coating. An undesired side effect of these surface active agents is the tendency of surfactant-bearing liquids to stabilize foam, once sufficient air is present.

Imagine an airflow directed into a liquid, from below. Bubbles formed will usually take on a spherical shape, which is the body having the smallest surface area with respect to a given capacity, and consequently, the lowest surface energy. An array of independent ball-shaped bubbles in a liquid medium is called spherical foam.

Spherical foam can be generated in a liquid with or without the presence of surfactants. Two kinds of foam may be



Figure 1—Surface defects in a coating caused by polyhedraland/or spherical foam (acrylic emulsion paint)



Figure 2—Pure surfactant free liquid and liquid containing surfactants

produced: bubbles having a surface envelope when surfactants are present, or pure, uncoated air bubbles, in the case of a surfactant-free liquid. Air-containing bubbles tend to move upward to the surface of a liquid. Depending on whether or not the liquid contains surfactants, the behavior of the bubble at the air interface is radically different (*Figure 2*).

At the air interface, pure bubbles burst, allowing the captured gas to escape and the liquid that was contained in the bubbles to flow together again. Bubbles that are covered by a surface envelope force the surfactant-layered liquid/air interface in front of them to the point of protruding through the surface, thus covering themselves with a double surfac-tant-lined envelope, called a lamella. The double layer of surfactant allows the formed structure to be stabilized.

The lamella-coated bubbles that are created as previously described gather at the surface and form a foam-head, which consists initially of individual spheres, forced together in the most densely packed hexagonal array. By draining off liquid through the surfactant-rich lamellae, the spherical foam is transformed into polyhedral foam.

Both spherical and polyhedral foam are generated during manufacturing and processing of aqueous coatings. Problems often arise with the formation of polyhedral foam both during production as well as during the filling of these paints. Foam-heads generated during stirring or dispersing procedures or filling of the containers can prolong manufacturing schedules and reduce the efficiency of an industrial plant. The application of aqueous coatings is generally complicated by spherical foam. In any case, both kinds of foam have to be fought effectively by using appropriate additives.

#### **Causes of Foam**

As described earlier, foam is created when air is introduced into the paint. This can happen during production and can also be triggered by the given method of application. Gas, which may form bubbles, can also be introduced into paint through the chemical reaction of curing, as in the case of urethanes. Application to porous substrates such as concrete also allows air to enter a coating, through displacement of air existing in the pores.

The easiest way to avoid air incorporation and foam problems during production is with the appropriate selection of mixing apparatus. Another way to deal with these problems is to store the paint until entrapped air has escaped. Of course, neither of these methods is practical, as paints must be manufactured and filled within a short period of time.

The prevention of bubbles is most difficult during application because practically all of the captured air is transferred to the coating. Some crucial methods for avoiding these situations are film-casting and airless spray painting, but even rolling and brushing encloses air within the coating.

The casting method relies on the outflow of coating through a narrow aperture onto a substrate. Surplus paint is pumped back from an overflow container to the reserve tank. This results in the introduction of extensive amounts of air which are finely distributed throughout the coating. This entrapped air, if not expelled quickly enough, leads to a defective application.

Airless spray application causes foam problems too. Not only is air introduced into the system during stirring, but also during pressurization. As the coating is released from the orifice, it becomes further saturated with air from the atmosphere. Even more severe air entrapment occurs during airassisted airless spray application. During drying, the air in the coating often cannot escape quickly enough, resulting in blisters and pinholes in the dried film.

These problems illustrate that it is important to reduce the introduction of air in the coating so that a defective coating can be avoided or minimized.

#### Foam Stabilization Mechanisms

Kitschener and Coper<sup>2,3</sup> have divided foams into polyhedral and spherical formations. Spherical foam is a dispersion of bubbles in a liquid, which are only stable when they exist in highly viscous or surfactant-containing media. The speed of ascent of spherical foam bubbles is similar to solid spheres and obeys Stokes' law. However, the speed of large air bubbles deviates greatly from the theoretical model; espe-



Figure 3—Schematic diagram of the transformation from spherical foam to polyhedral foam

cially if surface active substances are present. Spherical foam is only able to exist beneath a certain packing density of the gas bubbles (hexagonal close spherical packing). By increasing the percentage of gas bubbles above this packing density, the spherical foam is converted into what is called polyhedral foam, which plays a more important role as far as defoaming is concerned (*Figure 3*). In polyhedral foam formations, the separating walls differentiate themselves with respect to film thickness and pressure. The surfactants present in the walls form the "plateau border" (relatively large wall thickness), resulting in a suction effect onto the lamellae that is inversely proportional to the film thickness. This is understood to be a dynamic system, whose stability emanates from the foaming agent; e.g., continuously pumped-in air.

According to Rossmy, Sänger, and Seyffert,<sup>4</sup> foam stabilizers are mainly those surface active agents that transfer the energy emanating from the foaming agent to the polyhedral foam and produce a counter force to the suction effect caused by a thinning of the lamellae. This is also known as surface transport.<sup>5</sup>

Another mechanism connected with foam stabilization complies with electrostatic principles and often results in the effects previously described (*Figure* 4). If the surface active agents have an ionic character, charges will be present on the inner as well as on the outer surface of the lamella. The drainage, as previously described, minimizes the distance between the coated bubbles until the lamella thins, sufficiently allowing the electrostatic repulsion to produce a strong inner cohesion.

#### Buoyancy

As previously stated, the movement of bubbles in a liquid follows Stokes' law. The rate of ascent is directly proportional to the squared bubble radius and inversely proportional to viscosity, i.e., large bubbles rise faster than smaller ones. As a coating begins to dry, the viscosity at the air interface increases, due to solvent escape. The diffusion path of the volatile particles is shortened. This viscosity increase prevents the rising and coalescence of smaller bubbles on their way to the air interface, and also impedes the drainage effect of liquid through the lamellae of stabilized foam already at the air interface. These effects are evident in both waterborne and solvent-based coatings.

In addition to viscosity effects, entrapped air can be prevented from migrating to the surface by surface tension gradients.<sup>6</sup> Differences in surface energy, due to eddies created by solvent evaporation patterns, lead to areas of varying solvent concentration at the air interface. These are also known as Benard cells (*Figure 5*).

#### **DEFOAMING MECHANISMS**

Ross,<sup>7</sup> as well as Robinson and Wood,<sup>8</sup> describe two possible mechanisms for defoaming action:

(1) The finely dispersed defoamer droplet penetrates into the foam lamella and spreads itself out into the shape of a duplex film. The resulting decrease in surface tension causes the lamella to break.

(2) The defoamer droplet penetrates the lamella and forms a mixed monomolecular film there, which possesses a lower



cohesion compared to the previously existing lamella causing it to break. By this model, a substance is an efficient defoamer if it has a positive spreading coefficient (S) and/or a positive penetrating coefficient (E). These coefficients can be expressed according to the following theoretical principles:

$$S = \gamma F - \gamma E F - \gamma E \tag{1}$$

$$E = \gamma F + \gamma E F - \gamma E \tag{2}$$

where  $\gamma F$  = surface tension of the liquid to be defoamed;  $\gamma E$  = surface tension of the defoamer;

 $\gamma EF$  = interfacial tension between defoamer and the liquid to be defoamed.

However, this model is not completely satisfactory. There are substances which meet E>0 and S>0, but which show little or no defoaming activity. Typical examples are pure silicone oils, which only become good defoamers in waterborne systems after the addition of highly dispersed hydrophobic fumed silica. This increase of efficiency is

#### Table 1—Influence of Defoamer on Gloss Development of an Acrylic Coating

Additive	% of Active Ingredient on Total Weight	Gloss Initial	Gloss after 4 Weeks Storage at 50°C
Mineral oil defe	oamer0.4	40	40
ABA-triblock copolymer	0.4	40	38
Mineral oil defo	oamer 0.7	29	29
ABA-triblock p	olymer0.7	41	36



Figure 5-Surface tension gradients (Bénard cells)

explained by Kulkarni, Goddard, and Kanner.<sup>10</sup> The silicone oil transports the solid particle into the lamella and spreads itself out; consequently bringing the particle into contact with the surfactant film on the surface of the lamella. The particle, which absorbs surfactant molecules and the lamella film, is deprived of the surfactant and breaks. Simultaneously, the hydrophobic particle becomes more hydrophilic due to the absorbed surfactants and changes over from the oil to the water phase. As a result, it can no longer be used for further defoaming activities. This is one mechanism that explains why certain defoamers become less efficient in storage.

#### **Defoamer Formulations**

A defoamer must contain matter which interferes with the previously mentioned stabilization mechanisms. Typical defoamer components include: active substances, surface active agents, and carrier fluids. Active substances are those which prevent generation foam or otherwise breakdown the existing foam. The types of active substances to be used depend on the medium to be defoamed. The complexity of the paint system makes this task even more difficult than with pure fluids. This is very important because the aesthetic look and the substrate-protecting attributes of the applied film should not be negatively influenced.

Proper selection of a surface active agent is critical to defoamer performance, and also influences the effect of the additive on surface defects. Surface active agents focus defoamer activity at the air interface, bringing the active matter (e.g., hydrophobic silica) into contact with the stabilized foam structure. The surface active agent must not be a foam stabilizer in its own right, as are some silicone-copolymers and fluorocarbons. Nor must the surface active agent contribute to surfactant-induced defects such as

craters and pinholes. Carrier fluids act to transfer the generally hydrophobic active substances uniformly into the hydrophilic medium. These fluids often have a lower surface tension than the medium to be defoamed, therefore actively helping to wet the lamella. Aliphatic and aromatic mineral oils, solvent blends, and even

can be used as carrier fluids. All active substances used in defoamer formulations work in conformance with the following mechanisms: spreading by incompatibility and surfactant absorption. Even if more than one mechanism has to be adopted for a defoamer in a given case, the active

water (in the case of an oil/water emulsion),

substances can roughly be classified in the following manner9:

Incompatible spreading: fatty acid amide, fatty acid ester, fatty acid amide ester, polyalkyl glycols, organophosphates, organic polymers (polyacrylics, polyethers), and silicone fluids or polysiloxane-polyether copolymers.

Absorption compounds for foam destruction: metallic soaps, hydrophobic fumed silicas, and organic urea derivatives

Aliphatic and aromatic mineral oils, and even solvent blends, are used as carrier fluids. A typical mineral-oil based defoamer might contain mineral oil (75.0%), hydrophobic silica (10.0%), modified polysiloxanes (7.5%), emulsifier (5.5%), and auxiliaries (2.0%).

Paraffinic mineral oils are being used increasingly as carrier liquids. A disadvantage of the aromatic oils used in the past was their high content of physiologically harmful polycyclic hydrocarbons. Although the aliphatic carrier oils do not pose significant health risks, it can be assumed that the incompatibility of these oils in aqueous solutions would cause a reduction in the degree of gloss. This difference may be attributable to the difference in compatibility of the oils in the dried film after coalescence and after the removal of water. However, the yellowing tendency is less than that for aromatic oils. Table 1 summarizes the effect of different defoamers on gloss development.

Selection of active compounds is determined by the anticipated application range. The mineral oil-based defoamer previously mentioned would be very suitable for flat to medium gloss acrylic, styrene acrylic, and vinyl copolymer emulsions. For medium- to high-gloss paints, the presence of mineral oil may cause loss of gloss definition. In general, the higher the gloss of the coating, the more critical defoamer selection becomes. A defoamer must have a distinct degree of incompatibility with a given paint, otherwise it would not migrate to the air interface, and would not be available to break down stabilized foam. Incompatible substances often cause surface defects such as fisheyes, craters, and crawling. To minimize negative side effects, defoamer formulations having a wide array of active ingredients and carrier fluids must be available to the formulator.

Modification of active dimethylpolysiloxanes with hydrophobic polypropylene glycol-derived polyethers allows for the formulation of a class of defoamers which are particu-

Table 2—Operative Range for Various Defoamer Chemistries	

Basis Ingredient	Ranges Coatings Types	Emulsion Paints	Aqueous Industrial Coatings	Solvent-Free & Solvent-Based Coatings
Pure dimethylpoly- siloxanes		+	-	+
Polysiloxane-polyether copolymers		+	+	+
Polyacrylates		-		+
Polyalkylene glycols		+	+	-
Fatty acid esters		+	-	-
Organo-phosphates		+		-
Key: + Indicates suitable for use. - Indicates not recommend	ed			



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(AB)nA Block Copolymer

Figure 6—Common polysiloxane-polyether defoamer polymeric configurations: (1) ABA triblock copolymer; (2) branched chain copolymer; (3) comb copolymer; and (4) (AB)<sub>n</sub>A block copolymer. Where:

A = O—Si—(CH<sub>3</sub>)<sub>3</sub> or O—Si—(PE)(CH<sub>3</sub>)<sub>2</sub> B = Polypropylene derived polyether

 $O = OSi(CH_3)_2$  and similar

larly well-suited to current emulsion technology. The source polymer is obtained from the hydrolysis of functional silanes -Si—Cl + OH— $R \longrightarrow RSi$ —O—C + HCl, or fromhydrosilylation of unsaturated compounds  $-Si-H + H_2C =$ CH -> SiCH<sub>2</sub>CH<sub>2</sub>-. From these building blocks come the following copolymers:  $AB_nA$ , where B = siloxane linkagewith pendant polyether chain and (AB), A, where B is a difunctional polyether block. A may have methyl or polyether termination. The Si-O-C bond arising from the hydrolysis reaction is often said to be relatively unstable, due to its tendency to rehydrolyze. This is not the case, however, when the number of PO polyether side chains is large, and their length is relatively short. The hydrophobic polyether units swell in the presence of water, protecting the oxygen linkages. When emulsified, further protection of the oxygen linkages is offered by the emulsifier. For these compounds, pH stability is in the 3-11 range, well outside anticipated pH values of most coatings. Hydrosilylation yields Si-C linked copolymers, which are theoretically more hydrolytically stable. Defoamers made from these compounds are still relatively new to coatings applications, however.

The hydrophobic polysiloxane polyether copolymers are generally characterized by a high degree of incompatibility with the foaming medium (water/surfactant solution), while at the same time showing some compatibility with typical vehicles. This results in high defoaming activity while mini-

#### INFLUENCE OF DEFOAMERS

mizing development of craters. Since polysiloxane-polyether copolymers defoam very well without hydrophobic solid matters, silica-free defoamers can be formulated that do not tend to affect the coating adversely.

Different vehicles and formulations require different defoamer structures. Of the polysiloxane-polyether copolymers previously mentioned, four configurations are common in the market (*Figure* 6). Types 1 and 2 have been used successfully in defoaming pure acrylic emulsion paints. Type 3 is a good universal defoamer for mid-gloss coatings. A relatively recently developed polymeric configuration, Type 4, is particularly suitable for defoaming defoamer-sensitive polyurethane dispersion coatings, including clear wood finishes.



Figure 7—Stirring test



Figure 8—Roller test

Synthetic hydrophobic silicas have an essential impact on the efficiency of the defoamer. Defoaming silicas have specific surfaces ranging between 50 and 400 m<sup>2</sup> per gram. The average particle size should be between  $0.01-1.0 \mu$ . The best defoaming is achieved if the hydrophobic silicic acid (silica/ carrier fluid combination) approaches the viscosity of the liquid lamella.

The presence of hydrophobic matter in defoamers can cause various surface defects. In this context, dewetting flaws are dominant. This means that holes in the film are caused by an insufficient wetting of the substrate. A possible explanation for this is that the silica in the defoamer medium at the air interface attracts other surfactants which are in the film, such as wetting agents or emulsifier molecules. This results in localized lower surface tension areas, and an effect somewhat like that observed in Bénard cell formation. The wetting of the substrate is interfered with, and crawling results. Depending on the type of defoamer and the respective requirements (i.e., a flat or high pigment volume concentration (PVC) coating would show much less tendency toward surface defect formation than a lower PVC coating, allowing for a higher silica loading in the defoamer), the amount of hydrophobic silicic acid should not exceed 15% of the final mixture.

#### TEST METHODS FOR DEFOAMER EVALUATION

For practical use, the efficiency of defoamers needs to be tested in the laboratory, even though the test results might not necessarily be applicable to the manufacturing practice.

It is easy to understand that the dosage (i.e., efficiency) of a defoamer in a water-based emulsion coating depends on the selected formula. Especially important are the type of vehicle, the pH range, pigmentation, and chemistry of the dispersing auxiliaries. Although the optimum amount of defoamer needed is mainly defined by the formula, production method has a great impact on the dosage. Especially in connection with the use of a high-shear disperser, a higher dosage might be required to compensate for the impaired efficiency of the defoamer, which is caused by increased dispersion. Both over-shearing and under-shearing a defoamer cause equally adverse effects. Whereas in most cases comparably low shear mixing shows good effects while adding small amounts of defoamer, one negative side effect of lowshear mixing is that the mean defoamer particle size is larger than optimum. This can result in reduced defoamer efficiency and in defoamer absorption onto the extender pigment surface. When this happens, a drop-off in defoamer efficiency after storage can occur. Larger than optimum defoamer moieties can also collect at the air interface as flecks of contamination, causing craters. Since the defoamer is not properly dispersed through the film, poor defoaming efficiency will result. As already mentioned, the develop-



Figure 9—Defoamer active matter recommendation by PVC and vehicle chemistry

ment of efficient defoamers requires the selection of adequate testing methods. The paint industry uses a variety of methods, which do not always correlate with each other. Interestingly, there is no universally accepted standard defoaming test, either in ASTM (American Society for Testing and Materials) or ISO (International Standards Organization).

We have focused on only a few methods which, we believe, allow for sufficiently precise measurements in regard to the suppression of foaming during production and filling as well as prevention of foaming during application. The first method is the stirring test (*Figure 7*).

In a 6 cm diameter beaker, stir 100.0 g of the defoamercontaining emulsion for 1 min at 2500 rpm. For the 4 cm diameter agitator blade, this corresponds to a peripheral speed of 5.2 m/sec. Immediately fill the stirred liquid into a glass flask to the calibration mark and weigh. The weight is a function of amount of air introduced, and can be taken as a measure of defoamer efficiency. This test allows us to determine the optimal mixing container size when the coating formulation is used instead of the emulsion. As a standard, carefully weigh the unstirred emulsion. Its density may be used as is, or a basis point of 100% may be used.

The paint can also become infused with foam during roller application, brushing, or spray painting. Often it is sufficient to use the defoamer to break the foam which is generated during application. The correct amount can be arrived at by using the method previously described.

The surface onto which the paint is applied may vary according to its composition (mineral, wood, metal). Foam generation can also vary, depending on the porosity and structure of the substrate. In other words, rough-structured surfaces require more defoamer—as can be defined by appropriate tests—to break the foam which builds up during application.

The following test method is very similar to working conditions and yields results which are easy to reproduce. In addition, this simple test provides the gradients for defoamer dosage that are sufficient for both production and filling purposes as well as for application (*Figure* 8).

In the roller test, a short-nap foam roller is used to distribute 40 g of paint on a nonabsorbent test card covering an area of 500 cm<sup>2</sup>. Dampen the roller before application. Keep the amount of water used for dampening constant. This ensures that the same amount of water is always added to the paint and that the drying process can be compared to a standard value. The wet film coverage amounts to 15-16 grams per 500 cm<sup>2</sup>. After drying, the number of bubbles are counted. The test cards are then compared to a constant value and evaluated.

Many defoamers can cause a variety of surface imperfections. Here it is important to note that wetting flaws, as well as craters, may have been caused by foam bubbles. Therefore, we note the craters as well as the wetting flaws.

*Table 2* summarizes the operative range of various defoamer chemistries, by coating type. As the table shows, only polysiloxane-polyether copolymers are suitable for multiple use as active defoamer substances in aqueous and solvent or solvent-free coatings. This is valid also for emulsionbased paints and clearcoats.

*Figure* 9 summarizes end-use coating vehicle chemistries, based on our work with defoamers having the four active matter polysiloxane-polyether copolymers listed previously, and correlates vehicle type with typical PVCs of coatings formulated with the appropriate vehicle.

#### CONCLUSION

From a physical perspective, foam or froth represents a meta-stable system. We discussed several interfacial phenomena which help to stabilize foam. Defoamers work through interactions of certain incompatibilities with a given system. To find the right defoamer, structure and efficiency of these agents must be known.

If the necessary information concerning the system of the binding agent and the respective formula is available and the specific production and application conditions are known, it is possible to determine relatively quickly the optimum defoamer dosage.

The number of available defoamers provides the formulator with the possibility of selecting the most appropriate product for a specific situation. In this paper we have demonstrated that theoretical evaluations and practical experience have helped to develop efficient defoamers.

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# Biography

## George G. Sward—Centenarian

#### John C. Weaver

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eorge G. Sward lives in spirit into the next century, beyond the centenary of the date of his birth, April 8, 1892. The Sward hardness rocker probably enjoys the most worldwide use of any hardness tester for protective or decorative coatings.

Mr. Sward's career from its beginnings right up to his passing on November 12, 1983, exemplifies the best in loyal and diligent service to the science and technology of paints and related coatings. He learned hardness the hard way as a youthful apprentice to his blacksmith father in his native small town of, Mediapolis, IA. Mr. Sward worked as a railway mail clerk to pay his way through Iowa State University, where he earned a B.S. Degree in Chemistry in 1919 and an M.S. in Chemistry in 1920. After spending one year in a Sears and Roebuck and Company laboratory in Chicago, he joined the Chemistry Division of the U.S. National Bureau of Standards, now the National Institute of Standards and Technology.

In 1926, Mr. Sward joined the Scientific Section of the Educational Bureau of the paint industry which evolved through the 1920s into the Scientific Section of the National Paint, Varnish and Lacquer Association (NPVLA), now the National Paint and Coatings Association (NPCA). His mentor during those years was Dr. Henry A. Gardner. In 1910, Dr. Gardner moved his scientific operations from Philadelphia to Washington, D.C. In the 1920s the section established a laboratory, where it standardized bubble-tube viscometers, varnish color standards, and a swinging-beam hardness tester. While there, Mr. Sward developed an early distinctness-ofimage device, a falling sand abrasion/ hardness device, and later patented his famous hardness rocker.1

In those early years, the dichotomy between invention of test devices and their commercial production was addressed when Dr. Gardner formed the Henry A. Gardner Laboratory in Bethesda, MD, to manufacture these devices. By familial succession, this evolved into the present BYK-Gardner, Inc., Silver Spring, MD, and the Paul N. Gardner Company, Inc., Pompano Beach, FL.

Mr. Sward's pseudo-retirement in 1957 from NPCA's Scientific Section, where he was director from 1953, became an open-ended consultantship at the Henry A. Gardner Laboratory where he was provided with a desk and services for life.

Through its 13 editions, the *Gardner/Sward Paint Testing Manual* surpasses in the eyes of many the Sward hardness rocker in worldwide acclaim. While Dr. Gardner and his commercial laboratory provided the overall leadership and financial support, it was Mr. Sward who labored to produce the detailed contents of each edition from the fourth in 1928 through the 13th in 1972.

Both men were career-long supporters of ASTM, especially its Committee D-1 on Paints and Related Coatings. Therefore, it was only natural that one climax of their careers was the 1967 bequest to ASTM of the Paint Manual copyright, printing plates, and, most importantly, the services of Mr. Sward. He took this bequest very seriously. The continuing financial support of Mr. Sward by Gardner Laboratory was a major contribution to ASTM. The 13th edition, with a printing of 7500 copies published by ASTM in 1972 exceeded all previous editions in the rigor of its preparation. Instead of writing most of the manuscripts himself, Mr. Sward, with the help of a D-1 advisory committee, recruited 40 specialists to write the majority of its 55 sections; however, he found it necessary to serve as author or co-author for 15 of them.

A 14th ASTM edition of the Gardner/Sward Paint Testing Manual, now in preparation under the editorship of Dr. Joseph V. Koleske with about 80 authors for various sections, is to be published by ASTM in 1994.

Mr. Sward's 1937 entry into ASTM and its Committee D-1 began with service in the Physical Properties subcommittee and later in at least eight other D-1 subcommittees. When asked in the 1970s why he did not advocate early adoption of his rocker as an ASTM standard, he humbly said, "It was not precise enough."

Mr. Sward was elected an Honorary Member of Committee D-1 in 1957 and was made a Fellow of ASTM in 1973. He coordinated the work of D-1 with other ASTM committees and The American Standards Association (ASA), now The American National Standards Institute (ANSI). In addition, Mr. Sward was Chairman of the American Chemical Society's paint division, now the PMSE division. He was a member of the prestigious Cosmos Club of Washington, D.C., and the Fossils of Chevy Chase, MD.

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Presented at the ASTM D-1 Mini Symposium on Hardness. Ft. Lauderdale, FL, on January 21, 1992. \*309 Olin Building, Cleveland, OH 44106.

## Indentation/Penetration Hardness Testing—The Future

Maynard R. Euverard\*

#### INTRODUCTION

The word "hardness" standing alone is meaningless as it connotes many different conditions or properties. A definition from a handbook applies: hardness is the property of substances determined by their ability to abrade or indent one another. An arbitrary scale of hardness (Mohs scale) is based upon 10 selected minerals. For metals, the diameter of indentation made by a hardened steel sphere (Brinell value) serves to measure hardness.

The Brinell value is defined as the ratio in kilograms to the spherical area of indentation in square millimeters.<sup>1</sup> There are other related penetration hardness scales. One of these is the Knoop scale. This scale relates to penetration of a surface by a diamond rather than a sphere, the diamond being ground to an elongated pyramidal form. This scale of penetration hardness has been related to "abrasion" hardness (Mohs scale) as shown in *Table* 1.

If there is a relative smooth curve relationship between Mohs scale and Knoop values, we should be able to assume, within limits, that a measure of either abrasion resistance or resistance to penetration provides a related scaling of coating hardness. *Figure* 1 shows a definite relationship between the two methods of measurements. This permits the measurement of a thin material, such as a protective or decorative coating, without the influence of surface supporting properties, the "anvil effect."

Does the anvil effect rule out penetration or indentation methods of measuring hardness? References have been found that suggest valid results if the coating penetration

is no deeper than 10% of its total thickness and anvil effects can be tolerated up to 20%. A worst case example for our interest would be a one-inch radius steel ball penetrating a one mil coating to the depth of .10 mil. As shown in Figures 2 and 3, the plane area of surface contact is 0.000628 sq in. (0.405 sq mm) and the presence exerted

by the ball on this area is 1880 psi (132.2 kg per sq cm). Placing these values in an understandable perspective: if the depth of penetration is enlarged to one inch, the ball diameter would be 20,000 in. or 1670 ft (508 m), equivalent to a 167-story building. The area of contact of the ball with the surface 62,800 sq in. (40.5 sq m) and the pressure between the surfaces, 18.8 million psi (13217.7 kg per sq mm).

Most investigators have taken the easier path of measuring hardness as a function of surface abrasion that includes the various aspects of surface scratching and cutting. The best references to the many devices are described by Gardner and Sward.<sup>2</sup> However, with respect to classical concepts, do these methods measure hardness? Possibly, in a remote manner, but many methods in this category are subject to or are severely limited by the influence of related physical properties or interpretation of results.

Techniques for producing steel balls of almost any size have been highly developed. The surface uniformity in smoothness and contour is probably not surpassed in these techniques are readily available and low in cost. For these reasons and the poten-





tial for refining penetration instrumentation for use in the coatings industry, the balance of this paper is devoted to penetration hardness by a steel ball or equivalent glass lens.

#### Types of Penetrating Hardness Instruments

There are three general classes of penetrating hardness instruments used in the coatings industry: (1) pendulum hardness testers; (2) rolling ball hardness testers; and (3) direct penetration hardness testers.

Table 1—Hard	dness Scale	Compariso	η
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Mineral	Mohs Scale	Knoop Value
Talc	1	
Rock salt	2	32
Calcite	3	135
Fluorite	4	163
Apatite	5	430
Feldspar	6	560
Quartz	7	820
Topaz		1340
Corundum	9	1800
Diamond		7000

<sup>\*</sup>Deceased. Presented at the ASTM D-1 Mini Symposium on Hardness, in Fort Lauderdale, FL, on January 21, 1992.



Figure 2—Penetration hardness

Pendulum hardness testers function by a rate of energy decay from the height to which the pendulum is raised. This may be the time or number of cycles for the amplitude of swing to drop from a higher to lower level. Typical of such testers are König. Persoz, and Sward.

Rolling ball testers function by a timed period for a ball to roll a specified distance on an inclined plane. On reversing inclined plane testers, number of cycles for a given time also may be the mode of measurement. The angle, with respect to the horizontal at which the ball starts to roll, also may be the mode of measurement. Typical of such testers are Moore, Gardco, and Wolff-Zeidler.

Decorative and protective coatings impose an additional requirement for penetration hardness testers not found when measuring the hardness of metals. Due to the elastic nature of most coatings, the degree of penetration must be determined while the load causing the penetration remains in place. Typical of these testers is the Pfund Indenter and the Gardco Balanced Beam Pfund Indenter.

Figure 4 shows the variables that must be considered. They are: W—weight of the sphere or the sphere and auxiliaries; R—radius of the sphere; y—depth of sphere penetration into the coating; A—planar area of coating supporting the ball, calculated from R and y; and  $\theta$ —the tangent angle of the sphere where it contacts the coating, calculated also from R and y.

It is obvious from *Figure* 4 why the pendulum hardness testers work. The sphere must roll uphill at the tangent angle, first in one direction and then the other. The rate of energy absorption or decline of pendulum swing amplitude is proportional to the tangent angle. Incline plane testers function because the ball will not start to roll until the incline exceeds the tangent angle. Instrument characteristics such as ball diameter, path length, and weight are compared to five instruments in *Figure* 5.

The König instrument<sup>3</sup> is of the pendulum type. It has two steel balls embedded in a horizontal member that straddles the test specimen. The pendulum "bob" swings be-



Figure 3—Penetration hardness

low a platform that suspends the test specimen. The ball diameter is 0.2 in. and the total pendulum load is 0.44 lb. The maximum ball path length is very short at 0.021 in.

The Persoz instrument<sup>4</sup> is also a pendulum type and similar to the König. The balls are larger, 0.3 in. in diameter, and the weight is much greater at a total assembly weight of 1.1 lb. The maximum path length, although longer, is still very short at 0.063 in.

The Sward rocker is made up of two disks, 4.0 in. in diameter and 37 mils thick. It has a total weight of 0.23 lb and at the start of the test, a path length of about 1.60 in.

The Gardco instrument is a reversing freerolling ball type. Angle of incline and time for any set number of cycles are instrument variables. The ball size is 1.25 in. in diameter with a weight of 0.29 lb. Ball travel is 4.75 in. following each reversal. Now under development is a replacement of the large steel ball with a friction-free sled of three steel balls, known as "Gardco Future." The balls are 0.25 in. in diameter with a total sled weight of 0.5 lb (sled weight may be materially increased). Path length travel of the sled is 1.33 in.

Each of these instruments can be graphed with a common horizontal axis as shown in *Figure* 6. Consider first load per unit area.

The family of curves represents free-standing balls with radii from 0.1 to 1.0 in. in steps of 0.1 in. The Sward rocker falls close to the curve of the 0.7 in, radius balls with the Gardco reversing incline plane only slightly higher at 0.75 in. The other three instruments show much higher loading curves since all have loading besides the weight of the balls. The Persoz pendulum shows the highest loading with König next. Gardco Future



Figure 4—Penetration hardness chart of variables

shows a loading equivalent to a free sphere about 1.1 in. radius, but still well below König.

These five instruments are shown on the "tangent angle" in *Figure 7*. The family of curves represents free-standing balls with radii from 0.1 in. in diameter to 1.0 in. in diameter in steps of 0.1 in. The Sward rocker is on a curve with the lowest slope and, as far as tangent angle is concerned, is least sensitive in differentiating between small differences in hardness. The Gardco freerolling ball is also relatively low in this sensitivity. The König pendulum is on the curve of greatest slope, with Persoz considerably less and Gardco Future falling between.

The Sward rocker looks at a sizeable length of the test specimen, over an inchand-a-half at maximum swing. I believe this to be an advantage. It has the disadvantage of imposing a relatively light load on the test surface, and due to the large radius contact disk, its tangent angle is very low. It probably would function best on relatively soft coatings. The potentially largest source of error is in the machining of the radius of the contact disk. Uniformity of the radius of disk width is probably not comparable to that of a steel ball. If true, this could account for variances between instruments.



Figure 5—Penetration hardness instrument characteristics





Figure 9—Penetration hardness Pfund indenter—balanced beam loading

The König pendulum should be the most sensitive of the group. A severe limiting factor of this instrument is that it only sees two lines of the test surface, each only 21 mils maximum in length. In addition, it has next to the highest unit area loading of the group. This high loading, with repeatable passes over the exact same line, may exceed the elastic properties of the coating and have an "augering" effect, changing the nature of the coating at instrument contact.

The same comments apply to the Persoz pendulum as given for the König. The line path is longer but still only a maximum of 63 mils. In addition, the unit loading of the Persoz unit is even higher than the König unit.

The Gardco reversible free-rolling ball instrument, next to the Sward rocker, is insensitive to small changes in hardness. Increasing ball diameter to increase unit loading would only reduce sensitivity. Replacing the single free-rolling reversible ball with a three-ball assembly with auxiliary weight does not only increase unit loading but also greatly increases sensitivity. The unit then becomes the instrument referenced as Gardco Future.

The five instruments described have all

made their contribution to our knowledge of coating "hardness." For the future, the instrument of probably greatest potential is Gardco Future. It combines high loading with good discrimination of small hardness difference. Although unit loading is very



Figure 8—Penetration hardness Pfund hardness meter

high, it is distributed over a path length of 1.33 in. and, therefore, should not be detrimental to the test surface. In addition, the assembly for the balls can be changed to accept either smaller or larger balls and the loading per unit area can be greatly in-

creased. This selective range of variables permits use of the equipment in the testing of the widest possible range of coating hardness.

A development made about 60 years ago in the measuring of hardness by direct penetration has probably not received adequate attention. The concept was simple, as shown in *Figure* 8. The penetrating steel ball is simply replaced by a glass lens, and the spot diameter, which is a function of penetration depth, is accurately determined by a measuring microscope while the load on the lens remains in place.

Studies by Pfund on a new hardness meter were published.<sup>5</sup> In the fifth edition of *Physical and Chemical Examination of Paints, Varnishes, Lacquers and Colors*, by H.A. Gardner, (©1930), it is stated: "doubtlessly, one of the most satisfactory instruments for determining the hardness of varnishes and lacquers is the recently developed by Pfund." The 11th edition, (©1950), by Gardner/ Sward states: "The Pfund Hardness Meter is 'a device which measures the load required to produce a certain indentation by a spherical tool while in contact (under pressure) with the film'." The contact spherical radius is given as 0.125 in. A table shows a



Figure 7—Penetration hardness tangent angle at ball/coating interface





Figure 10—Penetration hardness Pfund indenter—balanced beam loading

#### M.R. EUVERARD



Figure 11—Penetration hardness chart of variables

load range up to 2,700 g and it is stated that a 70x microscope is satisfactory. This reference also states, "in making a determination, instead of obtaining the diameter for a certain load, it is preferable to apply loads that produce diameters both greater and less than the value sought, and then calculate the latter by simple interpolation." Repeatability of the device and method is given as about 6% and the reproducibility at about 12%.

ASTM STP 500, (©1972), also describes the Pfund indentation hardness measurement. It is in general agreement with the earlier Gardner/Sward description and adds: "the Pfund instrument was modified by Bell Telephone Laboratories in the 1950s and, as a result of their work, was adopted by the ASTM as Test Method D 1474." Note that this modification provides only a single load of 1,000 g and, therefore, the use method is



Figure 13—Penetration hardness force measurement

exactly opposite to the recommendations in the original Pfund method. Simplification of the original apparatus by elimination of variable loading is believed to severely limit the utility of the original method. The equipment, as originally proposed by Pfund, was never made available for use by others.

Several years ago, a project was funded to develop an instrument that would permit penetration hardness measurement as initially taught by Pfund. A suitable measuring microscope served to measure penetration spot diameter. The new design of the Balaneed Beam Scratch Adhesion Tester provided a suitable mechanism for the loading of the lens, and designed an adapter assembly for the holding of the lens and microscope, securing them to the balanced beam unit.

This new Pfund indenter with balanced beam loading provides a spot diameter, the



Figure 12—Hardness measuring boat—exploded view

portion of the lens in contact with the coating, as a function of coating penetration as shown in Figure 9. There is a range of useable spot diameter from about 4 to 14 mils, even on just 10% of a 1 mil coating, so there is adequate resolution for differentiating small penetration difference. When unit area loading is calculated against penetration depth for the range of load afforded by the balanced beam unit, we have the family of curves that are shown in Figure 10. Each curve from 0.5 to 5 kg represents major step loading available on the balanced beam unit. Minor step loading is ten-fold between each major step and may be as low as 50 g (as shown). The "2 kg" load curve is equivalent to the single load instrument described in ASTM D 1474, due to a larger lens used in the new unit. The much higher unit loading is 32 times that shown earlier for the freestanding balls without auxiliary weight.

Figure 11 shows the weight of a steel sphere that slightly sinks into a coating surface, producing a tangent angle as shown (greatly exaggerated). A specific amount of force in the horizontal plane is required to move the ball. This force is proportional to the ball weight and the tangent angle. If this force can be measured with sufficient sensitivity, we may have the best measure of penetration hardness yet.

Recent developments in sophisticated linear motion equipment designed for washability and wearability of a surface includes a force transducer in the drive linkage. The sensitivity of this force-measuring equipment should be adequate to provide good resolution in the measurement of hardness by a "hardness measurement boat." Figure 12 is an expanded view of such an auxiliary. Three steel balls extend through the lower surface of a flat stainless steel plate. They are locked in place by a flat locking plate. The balls are located in the plate so that each receive the same downward force of the assembly. The hardness measuring boat is simply placed into the drive fork of the linear testing machine and cycled at a low rate across the surface of the test specimen.

#### INDENTATION/PENETRATION HARDNESS TESTING

The type of recorder printout expected is shown in *Figure* 13. The amplitude of the force measurement is proportional to the ball assembly weight and depth of penetration of the steel balls into the coating and, therefore, the tangent angle. If the amplitude changes with a change in cycle rate, with a proportional change in cycle width shown on the recorder tape, then we also have a measurement of the rate at which the steel balls "flow" into the coating.

#### CONCLUSION

This paper relates to the future of hardness measurement. It is doubtful if any one method will satisfy all future requirements for "hardness" measurement of decorative and protective coatings. If for no other reason, this will be due to failure to agree on a single definition of hardness. This paper has presented three different advancements for the measurement:

(1) A triple ball sled for a reversible inclined plane apparatus;

(2) A refined variable load Pfund indenter; and

(3) A hardness measuring boat for use in force determining and recording linear motion machines.

Only continued research by individual investigators will advance the technique of hardness measurement with these promising developments.

#### References

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- (3) König, W., "Hartemessungen mit einen Pendel-Harteprufer", "Hardness Measurements with the Hardness Rocker," *Farbe* und Lacke, 65, 435 (1959).
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## Society Meetings

#### BIRMINGHAM .....NOV.

#### "Silicone Additives"

Club Past-President Robert McD. Barrett, of B.I.P. Chemicals Ltd., was presented with a 25-year membership pin.

Mr. Barrett was also awarded with the Club's Boss Award for his paper presented at the 1993 Annual Meeting of the FSCT entitled, "Rapid Determination of Solids," In addition, he was presented with a plaque acknowledging the club's membership increase during his presidency in 1992.

The speaker of the evening was Tom Easton, of Dow Corning. He discussed "Sill-CONE ADDITIVES FOR MODERN COATING SYS-TEMS."

Dr. Easton illustrated, by use of slides, the basic silicone-polydimethyl siloxane (PDMS), and its following properties: low surface tension; migration to interfaces in dispersion: low interfacial tension against water, i.e., for spreading and defoaming; low intermolecular forces for use in slip; and very surface active pendant groups (methyl groups), attached to a flexible backbone of Si-O-Si.

The variables of the silicone polyether, he stated, can be changed to either linear or branch, as can the ratio of polyether to siloxane. The result is silicone polyether copolymers, which give miscibility with water and properties for leveling, slip, wetting, and antifoaming, Dr. Easton said.

The speaker noted that silicone polyethers have low molecular weight and good dynamic wetting of surfaces, including plastic. Dr. Easton spoke on the different types of silicones and compared minimum surface tensions of RAKE and ABA copolymers. He pointed out that in many different types of tests, these silicones can be dispersed easily onto the surface with very low surface tensions.

He continued with a discussion on silicone rubber latex in waterborne coatings. He said that they are produced by emulsifying silicone oligomers, which are then polymerized to increase molecular weight. Catalysts and crosslinkers are added and this gives an uncured rubber latex which dries at room temperature to give elastomeric films. These, Dr. Easton said, are normally used as additives in acrylic latex inks and coatings, usually in the range of two to five percent.

In conclusion, the speaker stated that silicone material technology can be used to

enhance the performance of waterborne coatings when compared with conversion.

*Q*. Should we be careful with tin salts as catalysts?

A. Apart from environmental issues, we have not noticed any disadvantages.

DAVID C. MORRIS, Secretary

#### BIRMINGHAM ..... DEC.

#### "Anticorrosive Pigments"

Chicago Society member, Michael Beland, of Halox Pigments, was the evening's technical speaker. His presentation was, "ACCELERATED AND NATURAL COR-ROSION TESTING RELATIVE TO ANTICORROSIVE PIGMENTS."

Mr. Beland stated that there were three traditional approaches to corrosion resistance in coatings: (1) self-sacrificial coatings (zincrich or predispersed zinc coatings); (2) barrier coatings, (epoxy, vinyl, and chlorinated rubber coatings which reduce moisture transmission but rely on there being no breaks in the coating); and (3) inhibition (direct inhibitors using lead pigments or direct inhibitors involving zinc and/or chromate ions.

The speaker noted that the cost of providing safe handling conditions and adequate, legal waste disposal of lead and chrome residues has resulted in their replacement by certain calcium borosilicate corrosion inhibitors. These can be as effective as zinc chromate but they need to be used at the optimum level. Mr. Beland said that, traditionally, salt spray tests have been used to determine the optimum level of corrosion inhibitor to obtain maximum protection in coating systems.

The speaker discussed salt spray, exterior exposure, and prohesion tests on calcium borosilicate inhibitors. The results showed that where the prohesion test correlated with exterior exposure results, salt spray tests did not correlate with exterior exposure and would have caused the inhibitors to be rejected as ineffective.

Mr. Beland spoke about current work being done which compares prohesion and QUV tests, the effects of changes in wet and dry cycle times, temperatures, etc.

DAVID C. MORRIS, Secretary

#### CHICAGO .....JAN.

#### "Low VOC"

"Low VOC HIGH-GLOSS CORROSION RE-SISTANT ALTERNATIVES," was the topic of evening's technical presentation which was delivered by Mike Wildman, of McWhorter, Inc.

Mr. Wildman spoke on recent technological advances that allow paint formulators to obtain excellent corrosion resistance in high-gloss emulsion systems. He stated that these latexes not only achieve highcorrosion resistance, but also high gloss, adhesion, and block resistance direct-tometal in VOC compliant coatings. According to Mr. Wildman, these can be formulated as primers and topcoats and can be applied by spraying, brush, or roller.

The speaker reviewed results of studies, showing how the selection of various inhibitive pigments, TiO<sub>2</sub>, and pigment dis-



PITTSBURGH SOCIETY OFFICERS FOR 1993-94 (from left): Vice President—Mark Harley; Secretary—Ray Lyman; President—Timothy Zeffiro; and Treasurer—Brj Sharma

persants affected gloss, viscosity stability, and corrosion resistance. Mr. Wildman also commented that the studies showed the correlation between use of a prohesion cabinet and actuarial exposures was better than use of the standard salt spray cabinet.

> CLIFFORD O. SCHWAHN Publicity

#### CDIC.....DEC.

#### "Latex Paints"

A moment of silence was observed in memory of Cleveland Society member and 1993 Heckel Award winner Fred Schwab, of Coatings Research Group, Inc., who died on December 10, 1993.

Hugh Lowrey, of Perry & Derrick Company, Inc., the CDIC delegate to the Ohio Paint Council, reported that the Ohio Lead Bill issue was "in legislation." Also, Ohio EPA made its proposal to Federal EPA under Title V of the Clean Air Act. Mr. Lowrey stated that the proposal was "user friendly and Ohio Paint Council is satisfied with the result. In addition, he called attention to preliminary proposals by the Ohio Attorney General and some legislators concerning environmental crimes legislation. Mr. Lowrey said that proposals were of "considerable concern" to industry. As written, they define acts as potentially criminal that may be unavoidable to industry.

Mr. Lowrey, By-Laws Committee Chairman, reported that for the second consecutive month an insufficient number of votes were returned on three local By-laws amendments. The ballot will be repeated at the next monthly meeting.

Art Rich, of Union Carbide, presented a talk on, "Formulating Ultra-Low VOC Consumer Latex Paints."

The continuous pressures on formulators to reduce VOC of trade sales paints was addressed. Mr. Rich pointed out that consumer paints, although relatively low in percent VOC as compared with other coatings, are considered a serious concern by EPA due to the tremendous volume being used.

The speaker discussed his experience with formulation techniques that he has used for low VOC paints. He spoke about gloss ranges, cosolvents and amine selection, pH ranges, pigments, defoamers, biocides, nonionics, and thickeners.

In conclusion, Mr. Rich talked about the accelerated stability of low VOC coatings.

*Q.* Is freeze/thaw stability a function of the polymer or the surfactant selection?

A. In our high-gloss work, it is relative to the emulsion; we are trying to achieve that with semi-gloss formulas.

The educational speaker was Society President Paul R. Guevin, of P.R. Guevin

#### **Constituent Society Meetings and Secretaries**

BALTIMORE (Third Thursday—Martin's West, Baltimore, MD). ALBERT HOLDER, U.S. Navy, David Taylor Research Ctr., Code 2841, Annapolis, MD 21402-5067.

**BIRMINGHAM** (First Thursday—Strathallan Hotel, Birmingham, England). P. HASSALL, Newtown Industrial Paints Ltd., Silica Rd., Amington Ind. Est., Tamworth, Staffs. B77 4DT, England.

CDIC (Second Monday—Location alternates between Columbus, Cincinnati, Dayton, and Indianapolis). JOHN C. AVERY, Cintech Industrial Coatings, Inc., 2217 Langdon Farm Rd., Cincinnati, OH 45237-4792.

CHICAGO (First Monday—Sharko's Restaurant, Villa Park, IL). C. DAVID STROMBERG, Standard T Chemical, 290 E. Joe Orr Rd., Chicago, IL 60633.

CLEVELAND (Third Tuesday—Brown Derby, Independence, OH). MICHAEL A. WOLFE, Seegott Inc., 5400 Naiman Pkwy., Solon, OH 44139.

DALLAS (Second Thursday following first Wednesday—Raddison Hotel, Dallas, TX). PAUL KAPLAN, Cookson Pigments, Inc., 2001 San Miguel Dr., Plano, TX 75704.

DETROIT (Second Tuesday—meeting sites vary). TEDD L. STROBEHN, Boehle Chemical Inc., 19306 W. 10 Mile Rd., Southfield, MI 48037.

**GOLDEN GATE** (Monday before third Wednesday—alternates between Francesco's in Oakland, CA, and Holiday Inn in S. San Franscisco). EVE STROMQUIST, Flecto Corp., 100 45th St., Oakland, CA 94608.

HOUSTON (Second Wednesday—Houston Medallion Hotel, Houston, TX). EDwARD E. Boss, Bosseo Industries, Inc., P.O. Box 680023, Houston, TX 77268-0023.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). WIL-LIAM T. PORTER, Hillyard Industries, Inc., P.O. Box 909, St. Joseph, MO 64502.

LOS ANGELES (Second Wednesday—Steven's Steakhouse, City of Commerce, CA). ROBERT J. SKARVAN, McWhorter Inc., 5501 E. Slauson Ave., Los Angeles, CA 90040.

LOUISVILLE (Third Wednesday—Executive West Motor Hotel, Louisville, KY). ANDREW TRAISTER, Courtaulds Coatings, Inc., 400 S. 13TH ST., LOUISVILLE, KY 40201.

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 Bifthèque 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, ZENECA Resins, 730 Main St., Wilmington, MA 01887.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). CARY GROBSTEIN, Cardinal Color & Chemical, Inc., 50-56 First Ave., Paterson, NJ 07524.

NORTHWESTERN (Tuesday following frist Monday—Jax Cafe, Minneapolis, MN). HAROLD H. CHRISTHILF, The Valspar Corp., P.O. Box 1461, Minneapolis, MN 55440.

PACIFIC NORTHWEST (PORTLAND SECTION—Tuesday before third Wednesday— Rose's, Portland. OR; PUGET SOUND SECTION—Third Wednesday—Barnaby's, Tukwila, WA; VANCOLVER SECTION—Thursday after third Wednesday—Delphi Steak & Pizza, Vancouver), RICHARD C. TOMCZAK, Specialty Polymers, Inc., 17316 E. Riverside Pl., Bothell, WA 98011.

PHILADELPHIA (Second Thursday—Williamson's Restaurant, GSB Bldg., Bala Cynwyd, PA). Howard Salmon, Akzo Coatings, Inc. 100 Belmont Dr., Somerset, NJ 08873.

PIEDMONT (Third Wednesday—Ramada Inn Airport, Greensboro, NC). Bob Bishop, Ashland Chemical Co., P.O. Box 19959, Greensboro, NC 27419.

PITTSBURGH (Second Monday—Montemurro's Restaurant, Sharpsburg, PA). W. RAY LYMAN, JR, Ray Lyman & Co. 3462 Hills Church Rd., Export, PA 15632.

ROCKY MOUNTAIN (Monday following first Wednesday—Zangs Brewery, Denver, CO). PAUL DELMONICO, Old Western Paint Co., Inc., 2001 W. Barberry Pl., Denver, CO 80204.

ST. LOUIS (Third Tuesday—Salad Bowl Cafeteria, St. Louis, MO). JAMES LINDSLEY, Akzo Resins, 2904 Missouri Ave., E. St. Louis, IL 62205.

SOUTHERN (GULF COAST SECTION—third Thursday; CENTRAL FLORIDA SECTION third Thursday after first Monday; ATLANTA SECTION—third Thursday; MEMPHIS SEC-TION—bi-monthly on second Tuesday; and MIAMI SECTION—Tuesday prior to Central Florida Section). Robert WAYNE WERT, Thompson & Formby, Inc., 10136 Magnolia Dr., P.O. Box 667, Olive Branch, MS 38117.

TORONTO (Second Monday—Cambridge Motor Hotel, Toronto). KEVIN PELLING, Inortech Chimie Inc., 4135 LaStrada Hts., Mississauga, Ontario L5C 3V1, Canada.

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



CHICAGO SPEAKER—Mike Wildman speaks at the Society January meeting on "Low VOC High-Gloss Corrosion Resistant Alternatives"

Associates, Inc. Mr. Guevin discussed, "SLIPS AND FALLS." JOHN AVERY, Secretary

### CDIC .....JAN.

#### "Waterborne Systems"

A moment of silence was observed for the passing of CDIC Society Member Mike Knox, of Hilton-Davis Corp.

By-Laws Chairman, Hugh Lowery, of Perry & Derrick Co., Inc., reported that sufficient votes had been received to approve the proposed By-laws amendments. A pointof-order was made that one of the amendments, namely the provision appointing the Society Delegate to the Ohio Paint Council to the CDIC Executive Committee, merited reconsideration.

Manufacturing Committee Chairman David R. Sellers, of PPG Industries, Inc., reported that the development of a manufacturing seminar, encompassing the subjects ISO 9000, hazardous wastes, and equipment, is being considered.

Gil Ericson, of Troy Corp., presented a talk entitled, "A New Dispersant for Water-Borne Systems."

Mr. Ericson highlighted the fundamentals of the technology of pigment dispersion in fluid media. He pointed out that normally dispersion is achieved and stabilized by the use of surfactants, classified as: wetting agents—which displace air and gasses; dispersants—which separate particles; or combinations of the two. Mr. Ericson explained the ionic characterization of materials used, classifying anionic, cationic, nonionic and amphoteric.

In conclusion, the speaker discussed the use of ladder studies to determine use levels, color development, and rheology to determine effectiveness and other factors influencing selection (PVC, oil absorption, surface treatment, etc.).

The educational speaker for the evening was Society Past-President Jim Flanagan, of Flanagan Associates, Inc. He presented a slide show and "recreation of the atmosphere" of the FSCT's Annual Meeting and Paint Industries' Show.

JOHN AVERY, Secretary

#### GOLDEN GATE .....JAN.

#### "Silane Primer"

A moment of silence was observed for Elbert Cole, of Sem Products, who recently passed away.

Louis Sanguinetti, of Jasco Chemical Corp., was elected to Society Honorary Membership. He will be acknowledged with a plaque at the March meeting.



ROCKY MOUNTAIN SOCIETY OFFICERS FOR 1993-94 (from left): President—Edward McCarthy; Treasurer—Christine LesCamela; Secretary—Paul Delmonico; Educational Committee Chairman—Craig Schweiger; Vice President—Lou Hartnell; and Technical Committee Chairman—John Baker

Educational Committee Chairman Jack Duis, of Pacific Coast Chemicals Co., announced that the five-day "Basic Polymers and Coatings" course is scheduled for June.

The technical presentation was given by Gerald Witucki, of Dow Corning Corp. He spoke on "A SILANE PRIMER: CHEMISTRY AND APPLICATIONS OF ALKOXY SILANES."

Mr. Witucki said that formulators in the paint, ink, adhesives, water repellents, and other related industries require materials that resist peeling and penetration in spite of prolonged exposure to heat, cold, moisture, and chemical attack. Research into these problems, he stated, resulted in the development of alkoxy functional silanes for use as adhesion promoters, crosslinkers, and hydrophobes. Mr. Witucki also discussed recommendations for specific organic/silane combinations.

EVE STROMQUIST, Secretary

#### LOS ANGELES .....JAN.

#### "Silanes"

The meeting featured a visit from FSCT President-Elect Joseph P. Walton, of Jamestown Paint Co., and FSCT staff member Michael G. Bell, Director of Educational Services.

Mr. Bell outlined the continuing educational activities of the Federation. He stressed that the goal of the FSCT is to establish a dialogue between headquarters and the individual Societies so that staff can work to establish services for the local Societies. Mr. Bell also addressed the current activities of the Technical Advisory and the Professional Development Committees of the FSCT.

Environmental Committee Chairman, Dave Muggee, of E.T. Horn Co., provided the following report on the latest environment events in the industry:

(1) TOSCA EPA is requesting test information on five chemicals, among which is phenol.

(2) N-methyl-pyrrolidone will be tested in a variety of toxicity tests because of its use in paint strippers.

(3) NIOSH considers methylene chloride as a potential occupational carcinogen.

(4) OSHA proposed reducing permissible exposure limits from 500 ppm to 25 ppm in 1991.

(5) Fiber drums have not been exempted from DOT rules.

(6) OSHA's cadmium standard, as it applies to pigments, has been stayed by the U.S. Court of Appeals; consequently cadmium pigments are still allowed to be used.

The evening's technical speaker was Gerry Witucki, of Dow Corning Corp., who spoke on "ALKOXY SILANES AS ADHESION PRO-MOTERS AND CROSSLINKING AGENTS." During his presentation, Mr. Witucki described the differences among silicate, silanolate, silane, and silsequioxane, all of which are derived from silica (SiO<sub>3</sub>).

The speaker reported that the four things that increase adhesion in all coatings are flow and wetting, forming interpenetrating networks, compatible reactivities, and hydrophobicity (this one being very important because water can break all covalent organic to organic bonds). Silanes improve this hydrophobicity by going through a four-step process including hydrolysis, condensation, hydrogen bonding, and subsequent covalent bond formation with a hydroxy containing substrate such as clay, minerals, or iron. Mr. Witucki explained that the main benefit of the silanes is that they have dual functionality which allows them to promote adhesion and can be used in polymerization reactions as silanols.

Q. Why do water-based systems containing carboxyl resins and epoxy silanes lose their crosslinking ability with time?

A. The silanes will react with the pigments and fillers so one should use a small amount of one of the less expensive silanes to cap-off the reactive sights on the fillers.

The Manufacturing Committee speaker for the evening was Charles Alack, of Semi-Bulk Systems. He gave an overview of a handling system for large quantities of dry material in a paint operation.

ROBERT SKARVAN, Secretary

#### LOUISVILLE .....OCT.

#### "Coatings Manufacture"

Peter Galitzine, of The Argus Company, presented the Hüls Gavel to President Tim Fortney, of American Dispersions, Inc.

Environmental Affairs Committee Chairman Chris A. Lockhart, of Reynolds Metal Company, discussed the need for increased activity from the Society at Kentucky Paint Council meetings.

FSCT President-Elect John A. Lanning, of Courtaulds Coatings, Inc., Porter Paints Division, and a member of the Society, addressed the membership. Mr. Lanning talked about the upcoming Annual Meeting and Paint Show in Atlanta, FSCT-NPCA cooperative efforts, and *The Paint Stone*, FSCT's newest monthly publication designed to keep members informed of FSCT and Society news and events.

Chris Zoga, of Premier Mill Corp., presented the meeting's technical talk on, "The Shape of Things to Come, Transitions in Coatings Manufacture."

The substantial changes taking place in the coatings industry, particularly those that



TORONTO SOCIETY OFFICERS FOR 1993-94 (standing, from left): Dennis Hollands; Manufacturing Chairman—John Porter; Environmental Control Chairman—Jackson Chan; Program Chairman—Mike Molnar; Membership Chairman—Natalie Janowsky; Society Representative—Art Hagopiar; Past-President Vik Rana; Educational Chair man—Walter Fibiger; and Peter Hiscocks. Seated: Secretary—Kevin Pelling; Presi dent—Mike Hazen; Vice President—David Jack; and Treasurer—Bob Ng

force changes in business practice, were reviewed. According to Mr. Zoga, some of these changes are due to environmental regulations, to the globalization of manufacture, and the competitive business environment. He stated that process simplification and automation, and upgraded mixing technology can be used to reduce manufacturing cycles.

According to Mr. Zoga, one way to get process simplification would be to have design teams to improve process flexibility.

In conclusion, Mr. Zoga predicted future automated mixing systems will use product blending techniques to yield successive batch reproduction.

Q. Do you or can you use robotics?

A. A DC-powered inspection cart has been developed that is a self-contained unit with a viscometer, colorimeter, pH meter, grind gauge, and drying oven. It is designed for in-process inspections.

ANDREW TRAISTER, Secretary

#### NEW ENGLAND .....NOV.

#### "Massachusetts Legislation"

The meeting was a joint meeting with the New England Paint and Coatings Association and featured guest speaker Vince Shanly, a legislative council sponsored by the Massachusetts Paint Council. He spoke on "MASSACHUSETTS LEGISLATION."

Mr. Shanly mentioned that government on a state level is not going to go away, and that it will likely continue to grow. One particular bill of note to the coating industry, the speaker said, was the market share liability bill now pending at the State House. This bill, if passed, would make any paint company liable for lead paint abatement even if they have never used lead in their paint manufacturing process. Mr. Shanly emphasized the need to work with legislators rather than reacting against them. To be more effectual, there is a need to do more than just vote on any issue.

MICHAEL JANNUZZI, Secretary

### ST. LOUIS .....JAN.

#### Joint Meeting

This meeting was a joint meeting with St. Louis Paint and Coatings Association.

The first speaker of the evening was Arnold Montgomery, Commissioner of the City of St. Louis Air Quality Control Board. He spoke to the members on operating permits and the Emissions Inventory Questionnaire (EIQ) for the city. He stated that since the St. Louis area has not yet met the National Ambient Air Quality Standards of the Federal Clean Air Act, he could not pass out documents proposed by the city because they have not yet been approved by the Department of Natural Resources. The three forms (basic state permit, intermediate permit, and a federally enforceable permit) should be available by February 24.

The meeting's second speaker was Kevin Sall, Manager of Hazardous Materials Affairs, of NPCA. His topic was, "HM 181: PERFORMANCE ORIENTED PACKAGING."

According to the speaker, domestic regulations are not in line with international regulations; HM 181 adopts international packaging standards, also known as performanceoriented packaging. Under the new regulations, said Mr. Sall, packages are now based on materials, construction, and capacity. In addition, the strength and integrity of packaging is determined by a series of actual performance tests. For instance, steel drums must be subjected to drop tests, leakproofness tests, stacking tests, vibration tests, and hydrostatic pressure tests. Mr. Sall noted that each hazardous group has its own criteria based on the severity of the hazard. All packaging must meet these new requirements by October 1, 1996.

JAMES LINDSLEY, Secretary



### **FSCT to Sponsor March Seminar**

"Formulating for the New Clean Air Act"

### Slated for March 22-23, 1994, in Chicago

The Professional Development Committee of the Federation of Societies for Coatings Technology will conduct the seminar, "Formulating for the New Clean Air Act" on Tuesday and Wednesday, March 22-23, 1994 at the O'Hare Marriott Hotel in Chicago, IL.

One of the many challenges facing companies in the coatings industry is the need to develop coatings which will comply with the new regulations being enacted, while at the same time maintaining the protective and decorative qualities demanded by the user. "Formulating for the New Clean Air Act" will review the new legislation, examine its impact on existing operations, and provide attendees with the necessary information to conform with the new guidelines and continue to produce coatings which meet the demands of the customer. The seminar is designed for anyone involved in coatings development, from the Technical Director to the formulator.

The seminar will feature ten individual presentations and group discussions covering the following topics: REG-NEG Overview, HAPS, Odor, Solvent Blend, VOC Calculations, New Technologies and Applications.

\* \* \* \* \* \*

The fee for the event is \$225 for FSCT members and \$275 for non-members. Further information on the "Formulating for the New Clean Air Act" seminar may be obtained by contacting Michael G. Bell, FSCT Director of Educational Services at (610) 940-0777.

### = Schedule of Events

9:00 am "Formulation Techniques for Water Reducible Coatings" Carol Williams, Reichhold
"Formulating Compliant High-Solids Coatings" Rich Johnson, Cargill
10:30 amRefreshment break
10:45 am
"Abatement Recovery Systems" Bob Grear, Consultant
12:15 pmLunch
1:15 pmFormulation Panel Discussion— "Field Problems: How to Avoid and Make Corrections" Fred Anwari, BFGoodrich, Moderator
3:00 pm Wrap-up/Program Concludes

Wednesday, March 23

#### Tuesday, March 22

9:00 am "Reg-Neg Review, Regulatory Update" Steve Sides, NPCA
10:30 am
10:45 am
11:30 amLunch
1:00 pm
2:00 pm
2:45 pmRefreshment break
3:00 pm"Calculation of VOC in Paints and Coatings" Joe Benga, PPG Industries
"VOC Determination in Paints and Coatings" Hiro Fujimoto, Consultant
4:30 pmWrap-up

## Elections

#### BIRMINGHAM

#### Active

Herron. Maura E.—Albright and Wilson, Oldbury, Warley, W. Midlands.

#### CDIC

#### Active

Getz, Jennifer H.—Hunting Ind. Coatings, Cincinnati, OH.

#### CLEVELAND

#### Active

Anwari, Freidun—BFGoodrich Co., Brecksville, OH.

Borovicka, David A.—Man-Gill Chemical, Parma, OH

- Fitch, John J.—BFGoodrich Co., Brecksville. Harding, Chris C.—Coatings Research Group
- Inc., Cleveland, OH.
- Loye, Kenneth T.—Engelhard Corp., Beachwood, OH.
- Mendat, Ryne P.—Parma.

#### Associate

Corrigan. Brian P.—Nacan Products Ltd., Hudson, OH.

#### DETROIT

#### Active

- Blenheim-Bunts, Merlene-BASF Corp., Southfield, MI.
- Bowers, John—Chrysler Corp., Auburn Hills, MI. Gordon, Wendy M.—The Sherwin-Williams Co.,
- Troy, MI. Green, Robert W.—The Sherwin-Williams Co.,
- Troy. Hill, Michael R.—BASF Corp., Southfield.
- Hill, Michael R.—BASF Corp., Southfield.
- Katalinich, Kenneth P.—BASF Corp., Southfield. Kraus, Richard M.—Tremco Autobody Tech.,
- Brighton, MI. McNeight, Anna M.—Ford Motor Co., Redford,
- MI.
- Nichols, Alyson M.—BASF Corp., Southfield. Palackdharry, Peter J.—PRA Laboratories,

Ypsilanti, MI.

#### **KANSAS CITY**

#### Active

- Akdogan, Iskender-Pratt & Lambert, Inc., Wichita, KS.
- Brown. Kenneth J.—Pratt & Lambert, Inc., Wichita.

Brown, Roger D.—Pratt & Lambert, Inc., Wichita. Heinrich. David S.—Pratt & Lambert, Inc., Wichita

- Johnson, Steven D.—Lilly Industries, Inc., N. Kansas City, MO.
- Mack, J. Stuart—Pratt & Lambert, Inc., Andover, KS.
- Saghi, Eugene—Pratt & Lambert, Inc., Wichita. Scrimger, Robert W.—Pratt & Lambert, Inc., Wichita
- Wytiaz. Mark J.-Pratt & Lambert, Inc., Wichita.

#### Associate

- Bauer, David M.—J.M. Huber Cal. Carb., St. Peters, MO.
- Bavaro, Paul T.—Abner Hood, Inc., Riverside, MO.

Eaton, David M.—Abner Hood, Inc., Riverside. Eaton, Raymond N.—R.N. Eaton & Co., Inc.,

- Riverside. Holly. Bruce E.—Hüls America Inc., Chicago, II.
- Myers, Charles L.—Morton-Myers Co., Kansas City, KS.

#### LOUISVILLE

#### Active

- Hutchins, Robert E.—Devoe & Raynolds Co., Louisville, KY.
- Riggs, Kevin J.—Red Spot Paint & Varnish Co., Evansville, IL.
- Sensmeier, Art G.—Red Spot Paint & Varnish Co., Evansville.

#### Associate

- Schweitzer, Robert L.-Du Pont Co., Inc., Prospect, KY.
- Wood, Gary S.—Reynolds Metals Co., Louisville, KY.

#### MONTREAL

#### Active

- Blindeman, Edouard—Technical Coatings, Montreal, Que.
- Boulay, Robert-Sico Inc., Outremont, Que.
- Corbo, Fausto S .- Abrex Inc., Laval, Que.
- DuPont, Daniel-Sico Inc., Longueuil, Que.
- Gagnon. Chantal-Produits Nacan Ltee.,
  - Boucherville, Que.
- Ghawi. Samir Sami-Montreal.
- Lafontaine, Gaetan-Sico Inc., Longueuil.
- Nicole, Herve—Sico Inc., Outremont. Pilon, Celine—Sico Inc., Outremont.
- Remi, Briand—Polyval/Robar, Boisbriand, Que.
- Seguin, Sylvie—Sico Inc., Outremont.
- Tousignant, Line—Sico Inc., Longueuil.

#### Associate

#### Bedard, Jean-Shell Canada Ltd., Anjou, Que.

- Lariviere, Jean-Produits Chimiques St.-Lawrence Inc., Baie D'Urfe, Que.
- Margeson, John L.—Industry & Science Canada, Ottawa, Ont.
- Martel, David R.-Harcros Pigments Canada, Montreal, Que.
- Millette, Luc-Frank E. Dempsey & Sons, Lachine, Que.
- Spilberg, Sydney—Vulcan Packaging Inc., Dollard Des Orneaux, Que.

#### **NEW ENGLAND**

#### Active

- Bolton, James A. Jr.-Grafted Coatings Inc., Stratford CT
- Cohen, Lawrence B.—Chartwell International Inc., Sharon, MA.
- Daniels. Thomas D.-Samuel Cabot Inc., Newburyport, MA.
- Henderson, Richard A.—Samuel Cabot Inc., Newburyport.
- Hogan, Donald F.—Westfield Coatings, Westfield, MA.
- Jenei, Imre-Raffi & Swanson Inc., Wilmington, MA.
- Johnson, Richard E.-The Coatings Lab., Westbrook, ME.
- Lander, Robin S.—Franklin Paint Co., Franklin, MA.
- Pinstein, Leon B.—American Finish & Chemical, Chelsea, MA.
- Rani, Lalha-Stahl Permuthane, Peabody, MA.

#### Associate

- Anderson, Gene C.—Chemcentral Corp., Nashua, NH.
- Camphell, Tom C.—Campbell & Co., Charlemont, MA.
- Schmitz, George M.—S.P. Morell & Co., Tarrytown, NY.

#### Retired

Lopolito, Giuglio-Burlington, MA.

Lukens, Donald N.—D.N. Lukens Inc., Westboro, MA.

#### PACIFIC NORTHWEST

#### Active

- Cora. Alida O.—SPL Coatings Technology, Burnaby, B.C.
- Fiore, Guy—Benjamin Moore & Co. Ltd., Langley, B.C.
- Holubec, Mary R.—The Willamette Valley Co., Eugene, OR.
- Johnson, Tracy D.—Parker Paint Mfg. Co., Inc., Tacoma, WA.
- Killin, Melissa R.—Specialty Polymers, Woodburn, OR.

65

McBreen, Ken K.—Aspen Paints, Seattle, WA. McIntyre, Jeffrey J.—E.T. Horn Co., Seattle.

#### Associate

- Abbott, Carolyn A.—W.R. Grace & Co.-Conn., La Palma, CA.
- Bailey, E.B. Pug-Lilyblad Petroleum, Tacoma, WA.
- Bauer, David M.—J.M. Huber Cal. Carb., St. Peters, MO.
- Chlipala, Robert F .--- RFC Co., Bellevue, WA.
- Liang, Philip-Horizon Chemicals Ltd., Richmond, B.C.
- Palermo, David I.—Cytec Industries, Santa Ana, CA.
- Seto, Felix Y.—Hoechst Canada Inc., Coquitlam, B.C.
- Solt. David G.—S.C. Johnson Polymer, Irvine, CA.
- Taylor, Stewart M.—Tioxide North America, Lake Forest, CA.

#### PITTSBURGH

#### Active

Demosky, Micki—Westinghouse, Manor, PA. Ewing, William S.—Matthews International Corp.,

Pittsburgh, PA

Rediske, James E .- Miles Inc., Pittsburgh.

Woznick, Mark E.—PPG Industries, Inc., Allison Park, PA.

#### Associate

Giura, Anthony L .- EnviroCure, Pittsburgh, PA.

#### **ROCKY MOUNTAIN**

#### Active

- Challinor, John E.—Swansea Minerals Inc., Scottsdale, AR.
- Gillan, Rick J.—Gillan's Engineering, Westminster, CO.
- Lian, Norman D .- Tracor GIE, Provo, UT.
- Radcliffe, Jeffrey M.—Luzenac America, Englewood, CO.
- Summons. Wayne L.—Sashco Inc., Commerce City, CO.

#### Associate

Thompson, Danny L.—Chemcentral, Kansas City, MO.

#### Retired

Meyer, Klaus H .- Arvada, CA.

#### TORONTO

#### Active

Phan, Lien-Nacan Products Ltd., Brampton. Ont.

Associate

#### Associate

Clubb, Cary D.-Eastman Chemical, Markham, Ont.

Lockhart. Jeff B.-L.V. Lomas Ltd., Brampton, Ont.

## Future Society Meetings

#### Chicago

(Mar. 7)—"IMPROVED RHEOLOGICAL & SUSPENSION CHARACTERISTICS OF EPOXY AMINE AND WATER REDUCIBLE COATINGS WITH FUMED & HYDROPHOBIC SILICA"—Maria Nargiello, Degussa Corp.

Degussa Corp. (Apr. 4)—"How Good & Color Match Can You Afford?"—John Du, Hüls America.

#### Cleveland

(Mar. 15)—"FORMULATING COATINGS WITH FLUORESCENT PIGMENTS"—David Heyl, Day-Glo Color Corp., Sterle's Slovenian Country House, Cleveland.

(Apr. 12)—"FAUX FINISHING—MARBL-IZING, WOOD GRAINING, ETC."—Mike Mac-Neil, Executive Caterers, Mayfield Heights.

(May 18)—BFGoodrich Tour. "Use of Statistical Methops in EMULSION POLYMER DESIGN"—Vic Stanislawczyk, BFGoodrich Co., BFGoodrich R&D Center, Brecksville.

#### Dallas

(Mar. 3-4)—Southwestern Paint Convention, South Shore Harbour Resort, Houston, TX.

(Apr. 14)—"WATERBORNE TECHNOLOGIES FOR LOW VOC"—Rich Johnson, Cargill, Inc.

(May 12)-Past-Presidents' Night.

#### **Golden Gate**

(Mar. 14)—"AQUEOUS POLYURETHANE DISPERSION FOR COATINGS AND INK"—Richard C. Coogan, ZENECA Resins.

(Apr. 18)—"ZERO VOC WATER-BASED COATINGS"—Arthur Rich, Union Carbide Corp. (May 16)—"ADHESION OF COATINGS TO PLASTIC"—Rose Ryntz, Ford Motor Co. (June 13)—Manufacturing Committee Seminar.

#### New York

(May 10)-PaVaC Awards Night.

#### **Pacific Northwest**

(Mar. 17)—"AQUEOUS POLYURETHANE DISPERSIONS FOR COATINGS AND INK"—Richard C. Coogan, ZENECA Resins.

(Apr. 21)—"ZERO VOC WATER-BASED COATINGS"—Arthur Rich, Union Carbide Corp.

(May 19)—"ADHESION OF COATINGS TO PLASTIC"—Rose Ryntz, Ford Motor Co.

#### Philadelphia

(Mar. 10)—"GOOD TESTS—BAD TEST-ING"—Saul Spindel, DL Laboratories.

(Apr.)—Awards Night.

(May 10)—Manufacturing Committee Presentation.

#### Toronto

(Mar. 14)—Annual Symposium.

(Apr. 18)—"Learning to Anticipate the Weatherability Performance of Automotive Paint Jobs"—John Gerlock, Ford Motor Co.

(May 9)—"LOOK BOTH WAYS, TO IM-PROVE YOUR WET DISPERSION PROCESS"— Chris Zoga, Premier Mill Corp.

### FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY

#### Presents

#### **SPRING WEEK '94**

May 12-15 Marriott City Center Hotel • Minneapolis, MN

Featuring FSCT Seminar on "Adhesion in Coatings: Technology and Characterization"

#### Spring Week Schedule

May 12-13—FSCT Spring Seminar May 14—FSCT Incoming Society Officers Meeting May 15—FSCT Board of Directors Meeting

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004	024	044	064	084	104	124	144	164	184	204	224	244	264	284
005	025	045	065	085	105	125	145	165	185	205	225	245	265	285
006	026	046	066	086	106	126	146	166	186	206	226	246	266	286
007	027	047	067	087	107	127	147	167	187	207	227	247	267	287
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Coatings Technology Reader Service Card February 1994 Issue

Your Company (Check One Block) AA 
Manufacturers of Paints, Varnishes, Lacquers, Printing Inks, Sealants, Adhesives BB I Manufacturers of Raw Materials CC Manufacturers of Equipment and Containers DD Sales Agents for Raw EE Government Agency FF Research/Testing/Consulting GG Educational Institution/

Library HH Paint Consumer JJ Other **Your Position** (Check One Block) Management/Adm.
Mfg. & Engineering
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# People



Richard D. Borzelli has joined Daniel Products Co., Inc., Jersey City, NJ, as Vice President of Operations. Mr. Bor-zelli brings 25 years of domestic and international experience in the chemical industry, encompassing management, manufacturing, engineering, and

R.D. Borzelli

marketing to this position. He most recently served as Vice President, Manufacturing at International Specialty Products, Wayne, NJ. Prior to joining ISP, Mr. Borzelli spent 20 years with the Process Chemicals Division of Diamond Shamrock Corp.

Para Inc., Brampton, Ont., Canada has named Gerry A. Parsons Technical Director, Mr. Parsons will be responsible for research, development, and quality control. In addition, he will provide technical support to sales and production personnel. A member of the Montreal Society, Mr. Parsons' background includes management positions at DeSoto Coatings and Sico, and technical positions with The Sherwin-Williams Co.

Leon Manian has joined the staff of KTA-Tator, Woodland Hills, CA, as a Coatings and Linings Consultant. Prior to joining the company, Mr. Manian served as a Field Corrosion Engineer, Project Group Leader, and Production Field Corrosion Section Head for an international, energy-related joint venture company. He brings more than 15 years of experience in corrosion control to his new position.

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Send resume and expression of interest to: President, CRGI, P.O. Box 2371, Birmingham, AL 35201. In an effort to improve communications, reduce redundancies, clarify responsibilities, and meet a cost-reduction target, Union Carbide Corp., Danbury, CT, has announced a restructuring that will eliminate four divisions and create nine strategic businesses.

Reporting to William H. Joyce, President and Chief Operating Officer will be: E.J. Boros-Vice President, General Manager, Specialty Polymers and Specialty Products; D.L. Brucker-Vice President, Process and Project Engineering and Distribution Operations, and Manufacturing Infrastructure Management; J.F. Flynn-Corporate Vice President/General Manager, Solvents and Monomers; L.P. McMaster-Corporate Vice President and General Manager, Ethylene Oxide/Glycol; G.D. Mounts-Vice President and General Manager, Ethylene Oxide Derivatives; G.E. Playford-Corporate Vice President and General Manager, UCAR Emulsion Systems; F.D. Rvan-Vice President and General Manager, Unipol Polymers; and D.C. Scheid-Vice President and General Manager, Specialty Polyolefins.

The four eliminated divisions are: Industrial Chemicals, Polyolefins, Solvents and Coatings Materials, and Specialty Chemicals.

The Organic Products Division of Miles, Inc., Pittsburgh, PA, has announced the appointment of **Hans-Georg Schmitt** to the position of Vice President, Marketing. In this capacity, Dr. Schmitt is responsible for the U.S. marketing efforts for intermediates, commodity chemicals, and specialty products. Formerly the head of worldwide marketing, material protection products, he originally joined the company in 1978 as a Research Chemist.

M. Thomas Dreslinski and James S. Vandenberg were promoted to executive positions at Man-Gill Chemical Co., Cleveland, OH. Mr. Dreslinski has been appointed Vice President and General Manager of the Transportation/Automotive Group. He will work out of the Birmingham, MI, office.

Mr. Vandenberg has been appointed Vice President and General Manager of the Metalworking Group. He will oversee the Eastern and Western metalworking regions as well as coolant sales, from the Cleveland office.

In other news, **Frank J. Jarm Jr.** has joined the company as an Account Manager in the Transportation and Automotive Division. He will work with customers in the Greater Cleveland and Northeast Ohio area. Werner Schmitz has been appointed Corporate Vice President and Treasurer of Hüls Corp., Piscataway, NJ. Dr. Schmitz previously served as Corporate Vice President and CFO of MEMC Electronic Materials, Inc.

Also named as Corporate Vice President, in addition to General Counsel and Secretary, is **Paul T. O'Brien**. Most recently, Mr. O'Brien served as Executive Vice President, as well as general Counsel and Secretary for Hüls America.

As two of six Corporate Vice Presidents, both Dr. Schmitz and Mr. O'Brien will report directly to Alexander M. Lietmann, Vice Chairman and CFO of Hüls Corp. Each corporate vice president will head a business segment created to provide central services to the organization's three operating groups—Hüls America, Inc., MEMC Electronic Materials, Inc., and Rohm Tech, Inc.

Lockhart Chemical Co., Pittsburgh, PA, has selected **Joseph G. El-Dick** as Director of European Operations. In this capacity, he will be responsible for expanding sales and customer support services throughout Europe. Mr. El-Dick, who joined the company in 1987, has been Vice President in charge of Manufacturing Operations.

The newly-created position of Vice President—Quality, Safety, and Environment for Liquid Carbonic Corp., Oakbrook, IL, has been accepted by **Dick Rymer**. Mr. Rymer joined the company in 1969 as a Sales Representative and most recently served as Director of Ouality.

John Romane replaces Mr. Rymer as Director of Quality. Mr. Romane started with the company in 1989 as Manager of Special Accounting. His most recent position was Manager of Quality.

The National Decorating Products Association, St. Louis, MO, has elected its 1994 Board of Directors. Elected as officers are: President— Jan Satrom, Grand Forks, ND; Vice President—Ed Makarenko, Red Deer, Alberta, Canada; and Treasurer—Arlan Hatloe, Everett, WA. New directors on the board include: Edward Agostinelli, Mobile, AL; W. James Daly, Seattle, WA; Frank Facciobene, Jr., FL; and Robert Hansen, Arlington, TX. The Dow Chemical Co., Midland, MI, has made recent appointments in the Dow Plastics division. **P.A.** (**Pedro) Martinez-Fonts** is the Director of Markeing for the Thermoset Applications Group. Mr. Martinez-Fonts has marketing responsibilities for epoxy resins, intermediates, and polyurethane products for North America. He joined Dow in 1970 and has held a variety of positions in the areas of sales and marketing, and financial and personnel management in Central and North America.

J.F. Kirsch is Business Operations Manager of Epoxy and Intermediate Resin Products. Mr. Kirsch joined the company in 1979 and has held positions in sales, marketing, and market development assignments. Previously, he served as Product Group Manager, Epoxy Resin Products.

Accepting the position of Market Group Manager for Epoxy Resin Products is **Timothy O. King.** In his new role, Mr. King will be responsible for the strategic positioning of Dow epoxy products with the Coatings and Composite industries. He most recently served as District Sales Manager.

Jeff Johnston has been named the North American Market Manager for Industrial, Protective, and Civil Engineering Coatings Applications and the North American Thermoset Resins Distribution Manager for the Thermoset Applications Group. Mr. Johnston joined Dow in 1986 and has held jobs in sales and customer financial services, and has served as the Canadian Epoxy Resin Products Market Manager.

The Powder Coatings Division of Ferro Corp., Cleveland, OH, has appointed William E. Thompson as Director of Sales and Marketing. Mr. Thompson will be responsible for sales, marketing, and technical service efforts for the division in the U.S., Canada, and Mexico. He joined Ferro Corp. as Appliance Marketing Manager in 1991.

Neil Doidge has been named Customer Support Manager in the Calcium Carbonate Operations of ECC International, Atlanta, GA. He will direct and coordinate customer support activities. Mr. Doidge, who began his career with ECC in 1971, most recently served as Product Support Manager.

Buckman Laboratories International, Inc., Memphis, TN, has elected **Wallace E. Puckett** as Vice President, Research and Development. Since joining the company in 1987, Dr. Puckett has held various positions with the company including Product Development Manager in Personal Care, a new division for the company.

Robin Ehorn has accepted the position of Sales Project Coordinator for Raabe Corp., Menomenee Falls, WI. Ms. Ehorn will coordinate new projects in addition to the research and organization of all package components, as well as quote development.

# **Obituaries** -

Helen Skowronska, the first female President of the Cleveland Society, died on December 28, 1993. She was retired from The Sherwin-Williams Co., following 26 years of service.

Ms. Skowronska, who became a member of the Cleveland Society in 1962, moved through the Chairs of the Society, serving as President in 1977-78, as well as Program Chairman (1976). In addition, she served as Membership Chairman (1971-72, and 1979-82). In 1986, Ms. Skowronska was honored with the Frank Selden Award for rendering signal service to the Cleveland Society. She received her 25-year membership pin in 1986 and was granted Honorary Membership in the Society in 1989.

Ms. Skowronska made many contributions to the Federation. She served as a member of the Publications Committee and Editorial Review Board (1971-80) and the Definitions Committee (1980-88). Ms. Skowronska also held a two-year term as a

George Selden, Past-President of the Cleveland Society, died recently.

Mr. Selden became a member of the Cleveland Society in 1937 while he was employed with Upco. During 1946-47, he worked for Interchemical Corp., Cincinnati, OH, and was a member of the CDIC Society. Mr. Selden resumed membership in the Cleveland Society and served as its President in 1958.

Mr. Selden was also active in Federation activities. He was Chairman of the Technical Advisory (1955) and Publicity (1957) Committees. Mr. Selden served as Chairman of the Mattiello Lecture Committee from 1961-65 and 1970-71, as well as a member of the Paint Industries' Show Committee in 1965. He has been a retired member since 1987.

Mr. Selden participated in the Federation research project on "Film Formation, Film Properties, and Film Deterioration."

Harold M. Werner, a 40-year employee of The Glidden Co., died on October 25, 1993. He was 73.

A native of Reading, PA, Mr. Werner received a B.S. Degree in Chemistry from Albright College in 1942. After graduation, he joined

Glidden's Reading facility as a Varnish Chemist. Mr. Werner rose through the ranks there to become Technical Director of the company's Eastern Region before being transferred to Glidden's Cleveland, OH,



H.M. Werner

Member-at-Large for the Federation Board of Directors during 1981-83. From 1973 to 1991, she was Chairman of the Technical Information Systems Committee, which

compiled the index for articles appearing in the JOURNAL OF COATINGS TECH-NOLOGY. She was also involved in two papers, "Cleveland Condensing Type Humidity Cabinet" and "Cleveland Condensing Type Humidity Cabinet, Part II," which were presented at the



H. Skowronska

1963 and 1965 FSCT Annual Meetings, respectively.

At the time of her death, Ms. Skowronska was employed as a part-time librarian in the Cleveland Public Library System.

Charles Lewis Davis Jr., Past-President of the Southern Society, passed away on October 30, 1993, in Port Orange, FL. He was 60 years old.

A native of Hapeville, GA, Mr. Davis was a United States Air Force veteran. He spent most of his life working in the paint and coatings industry. Mr. Davis had previously been employed by the O'Brien Corp., Johnson Paints, Inc., and Coronado Paints. In 1981, he joined Vi-Chem, Inc., and relocated to Port Orange.

Mr. Davis joined the Southern Society in 1975 and served as Chairman for the Central Florida Section during 1979-80. He moved through the Society Chairs and became President of the Southern Society in 1987-88.

Mr. Davis is survived by his wife, Glenda; two sons, Charles, III and Christopher; one brother, Frederick; and one grandson.

headquarters. In 1975, Mr. Werner was Operations Manager of Glidden's affiliate in Wuppertal, Germany. He retired from the company in 1981.

Mr. Werner was a member of the Philadelphia and Cleveland Societies throughout his career and retirement. In addition, he was a member of ASTM Committee D-1 on Paints and Related Coatings and served as the committee's secretary from 1970-85 and as D-1 Chairman from 1990-92. In 1978, he was the first recipient of the committee's Henry A. Gardner Award. In 1982, he was named an ASTM Fellow.

Mr. Werner is survived by his wife, Mildred; one son, Bruce; two daughters, Carol and Lucy; and several grandchildren.

# **Book Review**

#### EXTERIOR DURABILITY OF ORGANIC COATINGS

by Eric V. Schmidt

Published by FMJ International Publications Limited Queensway House 2 Queensway Redhill, Surrey, England (1988) viii + 334 pages

#### Reviewed by Charles R. Hegedus Air Products and Chemicals Allentown, PA

Let's start with the basics. My edition was paperback with 334 pages, 177 figures (five of which were color), and numerous tables. The text was written in three parts. Part I. "The Fundamentals," contains two chapters that discuss "The Weather" and deterioration of unprotected substances, respectively. Part II describes the loss of protective effect from two mechanisms: degradation of organic coatings by weathering and the loss of coating adhesion to the substrate. Part III, "Good Painting Practices," provides advice on preparation, pretreatment, painting, and performance of coatings on a number of substrates which include iron and steel, zinc, light metals, masonry, wood, and polyvinyl chloride.

I will state early on that I will keep this book in my library and refer to it occasionally. However, it should be considered that this is from someone who refers to all available literature often. Others may not find this book very useful and I will attempt to explain why as this review continues.

In the author's words as provided in the Preface, "This book is born out of practical experience . . . " (The author has over 40years experience as a coatings technologist and manager.) He refers back to his feelings of helplessness during his early years in the paint industry because of his lack of practical experience. (I recall similar sentiments.) In order to help future generations, he wrote this book as a source of information for inexperienced paint chemists. However, he feels that the contents will serve as confirmation for seasoned veterans, as well as provide useful information to applicators and specifiers of coating systems.

As I read through the first two chapters, I became aware of two frequent issues which I find in organic coatings text books: repetition of concepts which have already been adequately addressed in the literature (in both text and article format) and the lack of rigorous presentation of technical information. An example of the first issue is the second chapter within the text which goes into some detail on the corrosion of metals. There are numerous texts and journals that present this information quite well and the information does not need to be repeated in this forum. It would suffice to refer the reader to several of these corrosion specific texts. On the author's behalf, the presentation on masonry and wood degradation is fair and is not nearly as easily found throughout the literature. In terms of the second issue, most coatings texts provide information in a general, qualitative fashion as opposed to rigorous explanations based on fundamental science and engineering. An example of this is when the author explains that, "It is a law of nature that all unstable products and chemical compounds will revert to the stable ones." (And therefore, this is why corrosion will occur.) Why not describe this process in terms of the fundamental thermodynamics and kinetics of corrosion? If the text was designed for young paint chemists, surely the intended reader will be familiar with thermodynamics and physical chemistry, and they probably will feel relieved that these subjects have applied value and were not taken in vain!

Getting off this soapbox, there were other parts of the text which were confusing, incorrect, and where the author failed to present all of the pertinent information. In the chapter on weather, the author appropriately talks about micro- and macro-climates as part of "The Weather," but he frequently refers to industrial pollutants as if they were entirely weather related. Agreeably, these pollutants play a big role in the degradation of coatings and their substrates, but they should not be described as part of the weather. Another example of confusing information is a "Map of Corrosion" which illustrates the annual losses of metals. The area of the United States is far different from data frequently published by automotive experts which illustrates that industrial locations, especially those in colder climates in which salt is used for melting ice, have much higher corrosion rates. In addition, the map of Europe does not correlate well with known acid rain areas which are known to cause more corrosion. Concerning corrosion, the author states, "There are no great differences in the behavior of the different alloys and pure aluminum." An aerospace corrosion specialist would disagree vehemently with this statement. Finally, an example of misleading information is the discussion of paint chalking which the author accurately describes as coating degradation. However, he fails to mention that some coatings are designed to chalk in order to maintain their "clean" appearance.

There are several other examples throughout the book with which I take exception. One is the relatively small number of references (16 on exterior degradation of coatings by weather, 12 on adhesion loss, none on coating polyvinyl chloride). Nonetheless, it is difficult to argue with 40 years of proven experience and that is why I will refer to this book when looking for an answer to a practical problem. In particular, Part II which describes coating failure mechanisms (degradation and adhesion loss) will provide some assistance and Part III which discusses good painting practices will be useful. One final note, the author frequently refers to European standards such as the SIS Swedish Standards and the British Code of Practice in his discussion of good painting practices.

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# The Federation of Societies for Coatings Technology Presents

72nd Annual Meeting

& 59th Paint Industries' Show

## Theme: "Excellence Through Innovation"

October 12 - 14, 1994 Ernest N. Morial Convention Center New Orleans, LA



# Kent State University Releases Spring Schedule for Rheology, Dispersion, and Adhesion Courses

The Coatings and Rheology Division of the Separation and Surface Science Center in the Chemistry Department of Kent State University, Kent, OH, will conduct three short courses this spring. The courses are: "Applied Rheology for Industrial Chemists," April 25-29; "Dispersion of Pigments and Resins in Fluid Media," May 9-13; and "Adhesion Principles and Practice for Coatings and Polymer Scientists," May 23-27.

Rheology fundamentals will be introduced followed by instrument selection and their use for meaningful measurements. Lecturers will discuss processing and performance problems and the selection of stress or strain controlled measurement. The relevance of rheology to application, flowout, and defects formation of liquid systems and its use in the coatings industry is presented. Flow modification; thermal mechanical properties analysis during cure; the rheology of latexes and thermosets; control and measurement of crosslink density; and the application of rheology to engineering problems will be addressed.

#### "APPLIED RHEOLOGY FOR INDUSTRIAL CHEMISTS"

#### Monday, April 25

"Rheometry"—Irvin M. Krieger, Case Western Reserve University; "Fundamentals of Linear Viscoelasticity"—Irvin M. Krieger; "Rheology of Dispersions"—Irvin M. Krieger; and "Rheological Instruments and Selection"—Edward A. Collins, E.A. Collins, Inc.

#### Tuesday, April 26

"Meaningful Rheological Measurements"—Edward A. Collins: "Application of Rheology to Processing Problems"— Charles L. Rohn, Rheometrics, Inc.; "Application of Rheology to End-Use Performance Problems"—Charles L. Rohn; and "Rheology Measurements: Control Stress or Control Strain, Which to Use?"—Abel Gaspar Rosas, Physica USA, Inc.

#### Wednesday, April 27

"Rheology of Fluid Coatings: Application, Flowout, and Defect Formation"— Clifford K. Schoff, PPG Industries, Inc.; "Rheology in the Protective and Decorative Coatings Industry"—Richard R. Eley, The Glidden Co.; "Thermal Mechanical Properties of Coatings"—Daniel J. Skrovanek, Miles, Inc.; and "Physical/Chemical Characterization of the Cure Process by Thermal/Mechanical/FTIR Analysis"—Theodore Provder, The Glidden Co.

#### Thursday, April 28

"Rheological Additives for Flow Modification"—Sharad Thakkar, Scitex Digital Printing, Inc.; "Correlation of Film Morphology with Drying Behavior"—John W. Vanderhoff, Lehigh University; "Rheology of Latexes"—John W. Vanderhoff; and "Chemorheology of Thermosetting Coatings"—Richard R. Eley.

#### Friday, April 29

"Control and Rheological Measurement of Crosslink Density in Films"—Loren W. Hill, Monsanto Chemical Co.; and "Application of Rheology to Engineering Problems"—Donald Bigg, Battelle-Columbus Laboratories.

#### \* \* \* \*

#### "DISPERSION OF PIGMENTS AND RESINS IN FLUID MEDIA"

Relevant surface chemistry fundamentals will be presented in the dispersion course, followed by lectures on dispersing agent selection; dispersion of inorganic, organic silica, and carbon black pigments, and the evaluation of dispersion quality by rheology and particle size analysis. Experts will discuss dispersion of resins and latexes in water and organic solvent systems. Discussion of dispersion equipment and selection of mixers; ball, sand, and other media mills; high-viscosity dispersion equipment; and the use of optical microscopy for evaluating processing results will be included.

#### Monday, May 9

"Fundamentals of Surface and Colloid Chemistry I"—Richard J. Ruch, Kent State University; "Dispersant Selection Based on Pigment Functionality"—Robert F. Conley, Mineral and Resource Technology; "Fundamentals of Surface and Colloid Chemistry II"—Richard J. Ruch; and "Wetting and Dispersing Agents in Aqueous and Non-Aqueous Systems"—Robert W. Vash, BYK-Chemie, USA.

#### Tuesday, May 10

"Mineral Pigment Processing Parameters and Their Influence on Polymer Properties"—Robert F. Conley; "Pigment Dispersion"—Theodore Vernardakis, Sun Chemical Corp.; "White Pigments—Processing and Rheology"—Robert F. Conley; and "Recommended Dispersion of Fumed Silica and Carbon Black for Optimum Performance"— Maria Nargiello, Degussa Corp.

#### Wednesday, May 11

"Introduction to Dispersion Rheology"---Richard R. Eley, The Glidden Co.; "Determining Dispersion Quality by Rheological and Related Methods"--Richard R. Eley; "Overview of Dispersion Equipment for Inks and Coatings"---Ramon Pineiro, Daniel Products Co.; and "Particle Size Analysis of Coatings Systems"--Theodore Provder.

#### Thursday, May 12

"Primary Mixing and Blending"-Leo Dombrowski, Gibraltar Chemical; "High-

(Continued on next page.)

#### Northwestern Society for Coatings Technology's 23rd Annual Technical Symposium

#### "TECHNOLOGICAL TOOLS FOR IMPROVED FORMULATION AND PROCESS CONTROL"

The 1994 Annual Technical Symposium of the Northwestern Society is slated for March 15, 1994 at the Bloomington Marriott Hotel, Bloomington, MN. Scheduled presentations and sponsoring companies include:

"Design of Experiments for Coatings Breakthrough"—Stat-Ease, Inc.;

"Rheology Modifications of Water-Based Paints"—Aqualon; "Current Topics in Accelerated Corrosion Testing"-Q-Panel Co.; and

"Total Color Management"—Minolta The pre-registration cost of the symposium and dinner is \$50 per person. For additional information, contact Pat Fischer, H.B. Fuller Co., 1200 Wolters Blvd., Vadnais Heights, MN 55110 (612) 481-3368 or Rod Stockstad at (612) 375-7729.

### Steel Structures Painting Council Hosts Two Lead Paint Abatement Courses

Two educational courses—the tutorial on "Industrial Lead Paint Removal and Abatement" and "Lead Instructor Training for Supervisors and Foremen of Industrial Lead Paint Abatement Projects"—sponsored by the Steel Structures Painting Council (SSPC), Pittsburgh, PA, are scheduled throughout 1994.

The two-day tutorial on "Industrial Lead Paint Removal and Abatement" presents information on complying with environmental and health regulations; containment, removal, and disposal techniques; and legal and health consequences. Facility owners, engineers, specifiers, consultants, regulators, industrial hygienists, and others interested in learning the most recent techniques in all facets of abating and removing lead paint from industrial structures should benefit from this event.

The "Lead Instructor Training for Supervisors and Foremen of Industrial Lead

#### SYMCO '94 Slated for March

On March 3, 1994, the Chicago Society for Coatings Technology, in conjunction with the Chicago Paint and Coatings Association, will host "SYMCO '94, Changing Times." The symposium will be held at the Chicago Marriott-Oakbrook.

The program will include the following topics and speakers:

"The Regulation of VOCs in Architectural and Industrial Maintenance Coatings"—James Sainsbury, The Glidden Co.;

"Performance Improvement in Environmentally Friendly Coatings"—Edward W. Orr, BYK-Chemie, USA:

"Ethylene Vinyl Acetate Terpolymers and Their Application in Solvent-Free Paint Systems"—W.D. Currie, Nacan Products, Ltd.;

"Fundamentals of Radiation Curing"— Kevin P. Murray, Applied Polymer Systems, Inc.;

"The Future: Survival, Growth, and Trends"—Jim St. Clair, UCAR Emulsion Systems;

"Powder Coatings: A Compliant Finishing Technology Comes of Age"—Steven L. Kiefer. Morton International, Powder Coatings Div.; and

"Controlling Biological Contamination in Coatings Manufacturing Process"—William E. Machemer, Troy Corp.

The afternoon will conclude with a "Meet the Speaker" cocktail hour.

The registration fee of \$100 per person includes a continental breakfast, two breaks, and lunch. For additional information or to register, contact either Jeannine Thielmann, ANGUS Chemical, (708) 215-8600 or Sue Rodgers, BYK-Chemie, (708) 582-1553. Paint Abatement Projects" covers the training requirements and techniques necessary to allow supervisory personnel to train their workers. This six-unit presentation concludes with an exam and receipt of a certification card indicating completion of an OSHA Lead Instructor Training Program.

The dates and locations of the courses are: March 8-10, Detroit, MI; March 11-13,



Greenwich, CT; April 5-7, Chicago, IL; June 5-7, Houston, TX; June 10-12, Orlando, FL; July 27-29, Denver, CO; Sept. 17-19, Los Angeles, CA; Oct. 4-6, Dallas, TX; Oct. 18-20, Baltimore, MD; Nov. 12-13, Atlanta, GA; and Dec. 13-15, Louisville, KY.

For more information, contact the Steel Structures and Painting Council, 4516 Henry St., Ste. 301, Pittsburgh, PA 15213-3728.

#### Spring Schedule Announced by Kent State University

Continued from previous page.

Viscosity Dispersion and New Dispersion Techniques"—James White, White Chemical Co.; "Small Media Milling and Dispersion Technology"—Leo Dombrowski; "Principles of Ball and Pebble Milling"— Warren Fuller, Paul O. Abbe, Inc.; and "Attritor Grinding and Dispersing Equipment"—Arno Szegvari, Union Process, Inc.

#### Friday, May 13

"Dispersing Fine-Particle Materials: I— Determining Equipment Requirements (and Choices Based on Ingredients): II—Evaluating Processing Results Via Optical Microscopy"—David G. Boss, Maginet-Projects.

#### \* \* \* \*

#### "Adhesion Principles for Coatings and Polymer Scientists"

The adhesion course will outline surface chemistry and rheology relevant to adhesion, deformation, and fracture of elastomeric and glassy adhesives, surface preparation, and tack and adhesion promoters. Speakers will lecture on adhesion in composites, adhesion to solids, surface analysis, release coatings, structural adhesives, and bond durability. Other subjects include adhesives in the web form, practical aspects of pressure sensitive adhesives, caulks and sealants, plastic to plastic adhesion and application methods.

#### Monday, May 23

"Interfacial Energies and Their Role in Adhesion"—Richard J. Ruch, "Deformation and Fracture of Elastomeric Adhesives"— Alan N. Gent, The University of Akron; "General Rheology and its Application to Adhesion"—Donald L. Hunston, National Institute of Standards and Technology; and "Fracture Behavior of Glassy Adhesives"— Donald L. Hunston.

#### Tuesday, May 24

"Fracture Mechanics and Bond Durability Considerations"—James Koutsky, University of Wisconsin; "Etching, Cleaning, and Surface Modification of Polymer and Other Surfaces"— James Koutsky; "Principles of Elastomer Tack"—Gary R. Hamed, The University of Akron; and "Organofunctional Silanes as Adhesion Promoters and Crosslinkers"—Bruce A. Waldman, OSi Specialties, Inc.

#### Wednesday, May 25

"Adhesion in Composite Materials: Principles, Measurement, and Effect on Composite Mechanical Properties" —Lawrence T. Drzal, Michigan State University; "Microscopic/Spectroscopic Analysis of Adhesion to Solid Substrates".—James P. Wightman, Virginia Polytechnic Institute; "Application of Surface Analysis to Adhesion of Coatings"—Kenneth D. Bomben, The Perkin-Elmer Physical Electronics Laboratories; and "Bonding and Chemistry of Structural Adhesives"—Kurt C. Frisch, Jr., 3M Co.

#### Thursday, May 26

"Corrosion Aspects of Paint Adhesion and Adhesive Bond Durability"—Ray A. Dickie, Ford Motor Co.; "Surface Chemistry of Release"—Michael J. Owen, Dow Corning Corp.; "Fundamental and Practical Aspects of Pressure Sensitive Adhesives, Caulks, and Sealants"—Krishan C. Sehgal, Union Carbide Corp.; "Formulation, Application, and Evaluation of Adhesives in Web Form"—James A. Miller, Chemsultants International Network; and "Plastic to Plastic Adhesion"—Rose Ryntz, Ford Motor Co.

#### Friday, May 27

"Bonding Plastics and Elastomers" and "Adhesive Application Methods"—Edward M. Petrie, ABB Transmission Technology Institute.

These programs are designed for research and development personnel who have interest in coatings, adhesives, elastomers, inks, and composites. Information may be obtained from Carl J. Knauss, Kent State University, Chemistry Dept., P.O. Box 5190, Kent, OH 44242-0001.

#### NDPA Announces Two-Show Schedule in 1995

The National Decorating Products Association, St. Louis, MO, has announced that starting in 1995, the association will change to a spring/fall show concept, eliminating the regional NDPA show structure that currently exists. This change pertains strictly to U.S. shows only and does not affect the current 1994 show schedule.

The new, two-show format will be supplemented by trade and educational fairs serving regional and local markets. An initial series of trade fairs has been scheduled in the first half of 1994 for northern California, southern California, and Seattle.

The new 1995 spring show is tentatively set for Atlanta, GA, while the new fall show is slated for the McCormick Place in Chicago, IL, Sept. 29-Oct. 1, 1995.

The previously announced 1994 show schedule remains in place: the 37th Annual Southern Decorating Products Show, Feb. 11-13 at the Georgia International Convention Center, College Park (Atlanta), GA; the Eastern Decorating Products Show, April 23-24 at the Garden State Convention and Exhibit Center, Somerset, NJ; and the 47th Annual National Decorating Products Show, Oct. 28-30 at McCormick Place, Chicago. There is also a trade show in Canada, sponsored by the Canadian Decorating Products Association, scheduled for March 5-6 at the International Centre, Mississauga (Toronto), Ontario.

The 1994 trade and education fairs are scheduled for: April 30-May 1. Airporter Garden Hotel, Irvine, CA; June 4-5, The Inn at Semi-Ah-Moo, Blaine, WA; and June 25-26, Napa Valley Exposition Center, Napa, CA. The Irvine show is sponsored by the Arizona and Southern California chapters. The Blaine, WA show is sponsored by the Puget Sound chapter. The Napa show is sponsored by the Northern California Chapter. The shows will feature trade fairs as well as educational events, such as the NDPA certification seminars.

#### 51st Southwestern Paint Convention

#### Sponsored by the Houston and Dallas Societies for Coatings Technology

#### March 3-4, 1994 South Shore Harbour Resort and Conference Center League City (Houston), TX

The 51st Southwestern Paint Convention will be held March 3-4, 1994, at the South Shore Harbour Resort and Conference Center, League City (Houston), TX. This event, cosponsored by the Houston and Dallas Societies, will feature three technical sessions focusing on coatings, manufacturing, and regulatory affairs. A tentative schedule of presentations includes:

"Introduction to Paint Technology"-Steve Cooper, Rohm and Haas;

"A Formulating Guide for the Nineties"—Henry Solle, Union Carbide;

"Principles of TiO<sub>2</sub> Grade Selection"—Ernestine M. Medeck, SCM Chemicals:

"Introduction to Alkyd Technology"—Joe Peters, Cargill, Inc.;

"Defoamers—Theory and Practice"—Ron Broadbent, Henkel Corp.; "Advances in Color Technology and the Impact on the Paint Manufacturer"—James T. DeGroff, Colortec Associates;

"Dispersion of Organic Pigments"—Ted Vernardakis, Sun Chemical Corp.;

"Good Tests—Bad Testing"— Saul Spindel, D/L Laboratories;

"Best Method to Manufacture Dry Powder Coatings"—Richard Welker, PE, Entex Plast Consulting;

"Exploration of Waterborne Coatings Manufacturing Technique—A Nuts and Bolts Approach"—Mark Druckenbrod, Myers Engineering: and

A DOT presentation by Paul Best, PBI Technologies.

For more information on the Southwestern Paint Convention, contact Joseph Caravello, Guardsman Products, Inc., 137 N. Hall Dr., Sugarland, TX 77478; (713) 242-9439.

#### The Polytechnic University Introduces Two Short Courses

The Polytechnic University, Brooklyn, NY, will host two new intensive short courses focusing on polymeric materials. The courses will be held at the Conference Center of the Park Ridge Marriott Hotel, Park Ridge, NJ.

The "Thermal Analysis in Polymer Research and Production," which is scheduled for April 18-20, will cover the following topics: instrumentation, techniques, properties, quantitative analysis by specific heat and enthalpy measurements, structure-property relationships, organic compounds, polymers, polymer stability and processing conditions, water in polymers, thermal analysis in polymer flammability, compounding and the role of additives, physical aging of polymers, thermal hazards, problem solving, and future trends.

"Viscoelastic Properties of Polymers," slated for April 21, will cover instrumentation and experimental conditions, basic principles and definitions, polymer structureproperty relationships, dynamic mechanical analysis, thermal stimulated current analysis, and dielectric thermal analysis. An optional pre-course program, where instrument companies exhibit and demonstrate their new instruments, will take place on April 20.

The registration fee for "Thermal Analysis in Polymer Research and Production" is \$1100. The cost for "Viscoelastic Properties of Polymers" is \$450. For additional information, contact Dr. Eli M. Pearce, Polymer Research Institute, Polytechnic University, Six MetroTech Center, Brooklyn, NY 11201.

#### ISPAC-7 Scheduled for May 23-25, in Switzerland

The Seventh International Symposium on Polymer Analysis and Characterization (ISPAC-7) will be held May 23-25, 1994, in Les Diablerets, Switzerland. This three-day symposium will consist of poster sessions, invited lectures, round-table discussions, and an information exchange on recent advances in polymer characterization approaches, techniques, and applications.

ISPAC-7 will focus on molecular characterization in relationship to properties of polymeric systems. Topics will include aqueous polymeric systems (water-soluble polymers, interacting systems, and physical and chemical gels) and heterogeneous polymeric materials (blends, composites, and multilayered materials). In addition, an introductory course on polyelectrolytes and the characterization of water-soluble polymers will be held on May 22, preceding the symposium.

Further information and registration forms may be obtained from ISPAC Registration, 815 Don Gaspar, Sante Fe, NM 87501.

# Federation of Societies for Coatings Technology Spring Seminar Papers



"Coatings Technology in the 1990s" May 1990, Louisville, KY

> "Formulating for the Future" May 1991, Philadelphia, PA

FSCT announces the availability of its Spring Seminar papers from 1990 to 1993

"Understanding Corrosion Protection (How Rusty Are We?)" May 1992, Boston, MA

"The Influence of Substrates and Application Methods/Techniques on Coatings Performance" May 1993, Houston, TX

FSCT member price: \$40.00 Non-member price: \$50.00

> To order, contact: Federation of Societies for Coatings Technology 492 Norristown Road Blue Bell, PA 19422-2350 Phone: (610) 940-0777 \* Fax: (610) 940-0292

# Literature

#### Waterborne Coatings

Waterborne systems are featured in a publication. Numerous epoxy and acrylic waterborne systems are covered in this brochure, as well as typical properties, a user's guide, preferred systems based on application, and system suggestions based on specific end-user applications. Write Shell Chemical Co., Manager, Resins Communications, One Shell Plaza, P.O. Box 2463, Houston, TX 77252-2463, for a free copy of the "Waterborne Coatings Guide."

Circle No. 200 on Reader Service Card

#### Tristyrylphenol Surfactants

One of a series of tristyrylphenol-based surfactants is the topic of a product release. This product is a phosphate ester of ethoxylated tristyrylphenol and is to be used as a dispersant for agrochemical, paint, and textile formulations. To learn more about Soprophor 3D33, write Rhône-Poulenc, Prospect Plains Rd., CN Box 7500, Cranbury, NJ 08512-7500.

Circle No. 201 on Reader Service Card

#### Solenoid Valves

A catalog features an all-purpose solenoid valve with a Teflon\* Bellows seal. This publication describes and illustrates this thermoplastic valve, which is designed to be used with acids, caustics, solvents, chlorine solutions, and ultra-pure liquids. To receive a copy of this catalog, write Plast-O-Matic Valves, Inc., 430 Route 46, Totowa, NJ 07512.

Circle No. 202 on Reader Service Card

#### Manufacturing Control System

An updated version of a manufacturing control system that provides integrated modules for formulation, regulatory compliance, MSDS scanning, batch ticketing and inventory control, quality control, report writing, and all accounting functions is the topic of a product release. Some of the reported highlights include flexible formula development and costing, powerful user-defined properties, raw material and formula queries, automatically generated MSDSs and labels, SARA reports, and complete inventory control, including lot tracking. For further information on the SNAP Manufacturing Control System-Version 3.1, contact Pamela Stemle, Advanced Software Designs, P.O. Box 647, Chesterfield, MO 63006.

Circle No. 203 on Reader Service Card

#### Waterborne Surfactants

The performance of a company's surfactants in waterborne industrial coating formulations is discussed in a guide. These surfactants reportedly provide the following benefits: internal and external microfoam reduction of surface roughness, improved substrate wetting, pigment grind efficiency/ grind viscosity reductions, corrosion resistance, and foam suppression. For a copy of "The Benefits of Surfynol<sup>®</sup> Surfactants in Waterborne Industrial Maintenance Coatings," write Air Products and Chemicals, 7201 Hamilton Blvd., Allentown, PA 18195-1501.

Circle No. 204 on Reader Service Card

#### Sampling Kits

Sampling kits packaged to provide the tools to analyze different sample types, including liquids, gels, pastes, powders, films, and reflective samples are highlighted in a data sheet. For technical information on the Baseline FTIR Sampling Kits, contact Spectra-Tech, Inc., 652 Glenbrook Rd., Stamford, CT 06906.

Circle No. 205 on Reader Service Card

#### Patching Compound

Literature has been released on a new patching compound for repairing small cracks and holes in interior drywall, plaster, and concrete surfaces. This product reportedly provides five to seven minutes working time and sets in eight to 12 minutes. Contact United States Gypsum Co., P.O. Box 806278, Chicago, IL 60680-4124, for more information on Sheetrock<sup>®</sup> Patching Compound.

Circle No. 206 on Reader Service Card

#### Polyurethane Coatings

A technical data sheet is now available on a new product which reportedly eliminates bubbles, pinholes, downglossing, and other problems caused by moisture in polyurethane systems. This low-toxicity moisture scavenger removes moisture from the formulation and can be used to chemically remove moisture from raw materials, including polyols, pigments, and fillers. To learn more about Zoldine<sup>8</sup> MS-Plus, request a copy of "TDS 43" from ANGUS Chemical Co., 1500 E. Lake Cook Rd., Buffalo Grove, IL 60089.

Circle No. 207 on Reader Service Card

#### Dipcoater

A dipcoater for dipping parts and producing coated test panels in the laboratory according to ASTM D 523-920 is the topic of a product release. This instrument uses a cord wound around a step cone pulley on the shaft of a motor. A second panel is used as a counter balance. More information on the three-speed and 21-speed Payne Type Dip Coaters is obtainable from Paul N. Gardner Co., 316 N.E. 1st St., Pompano Beach, FL 33060.

Circle No. 208 on Reader Service Card

#### **Fluorescent Pigments**

Literature has been released on a line of aqueous fluorescent pigment dispersions. These products are based on a formaldehyde-free pigment with an average particle size of less than one micron. They are compatible with water-based and waterborne coatings and ink products. For technical data, samples, and color guides on the EPX dispersions, write Day-Glo Corp., 4515 St. Clair Ave., Cleveland, OH 44103.

Circle No. 209 on Reader Service Card

#### Aerosol Paint Users Guide

A new "how to" brochure for aerosol paint users has been published. This pamphlet, which also includes a troubleshooting section, serves as a guide for commonly asked questions ranging from surface preparation to recycling information. Write Jeff Jennings, Raabe Corp., P.O. Box 1090, Menomonee Falls, WI, 53052-1090, for a complimentary copy of "How to Spray Aerosol Touch-Up Paint."

Circle No. 210 on Reader Service Card

#### **Melamine Resins**

A brochure describes the physical properties, toxicity, solubility, viscosity, and reaction chemistries of a class of melaminebased polyols. These resins reportedly combine the attributes of polyurethanes with the heat-resistant properties of aminotriazines in the same molecule. Other features include high hydroxyl functionality; low formaldehyde content, and compatibility with amino, phenolic, UF resins, and polyurethanes. To learn more about the Cylink HPC <sup>°</sup> melamine resins, contact Brian McSwigan. Cytec Industries, Warners Plant, P.O. Box 31, Linden, NJ 07036.

Circle No. 211 on Reader Service Card

#### Micropowder Additive

A new micropowder PTFE fluoroadditive has been introduced through literature. This product is designed to improve lubricity, reduce wear, increase gloss and release, and reduce blocking in a variety of applications such as composites, coil coatings, paints, waxes, finishes, inks, polymers, and greases. Additional information can be obtained by writing DuPont "Teflon" MP 1600 Micropowder, CRP-711, Room 231-AA01, Wilmington, DE 19880-0711.

Circle No. 212 on Reader Service Card

#### **Colorants Reference Guide**

A reference guide detailing a range of colorants for architectural and industrial coatings is now available. The literature furnishes descriptions and applications of the colorants that make up the company's architectural/industrial coating colorant lines. This guide is available in both English and Spanish. For a copy of "When It Comes to Colorants, We've Got Your Number," write Hüls America, Inc., 80 Centennial Ave., Piscataway, NJ 08855-0456.

Circle No. 213 on Reader Service Card

#### Hydrocarbon Mixtures

Gaseous and liquid hydrocarbon process monitoring mixtures are featured in a brochure. The 10-page, four-color publication covers information on grades of hydrocarbon gas standards, cylinder specifications, and special handling equipment. For more information, request Form #6985 from Liquid Carbonic, Corporate Communications, 810 Jorie Blvd., Oak Brook, IL 60521-2216.

Circle No. 214 on Reader Service Card

#### Light Booth

The availability of a light booth that evaluates color, metamerism, and fluorescence is presented in a product release. This color viewing system can be used for inspection and color matching of paints, plastics, textiles, paper, colorants, cosmetics, printing, and packaging. This system produces four spectrally dissimilar sources of illumination-daylight, cool white fluorescent, incandescent and ultraviolet. Contact Minolta Corp., Instrument Systems Division, 101 Williams Dr., Ramsey, NJ 07446, for more information on the GTI ColorMatcher.

Circle No. 215 on Reader Service Card

#### Accelerator

A data sheet announces a patented accelerator formulated for use with epoxy resins and polyamide and amine hardeners. This device is a room-temperature-cure material that can be used alone or as a coaccelerator with conventional accelerators such as tertiary amines, salicylic acid, and phenols. For more information on the PF LMB 6015-1, contact Marcel Gaschke, Ciba Coating Systems, Seven Skyline Dr., Hawthorne, NY 10532.

Circle No. 216 on Reader Service Card

#### **Electrochemical Newsletter**

A four-page newsletter describes products, research, literature, and upcoming events for the electrochemistry analyst and researcher. Some of the new products featured in the latest issue are: an impedance analyzer, impedance software, potentiostat, a flat cell, and information on a scanning reference electrode technique. For a copy of "Electrochemical Instruments News," contact EG&G Princeton Applied Research, Electrochemical Instruments Division, P.O. Box 2565, Princeton, NJ 08543.

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standard. Exceptionally white, fine particle size, wet-ground priced. Produced from white Calcite. Provides uniform product produced from high-grade calcite limestone. CAMEL-TEX.\* Fine ground general purpose grade of cal-Low vehicle demand, rapid dispersibility.

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Genstar Stone Products Hunt Valley, MD 21031 (410) 527-4225

Circle No. 123 on the Reader Service Card

#### **Hydrochloric Acid**

An application report describes the quantitation of trace element impurities in semiconductor grade hydrochloric acid. It also provides details of how the difficulties involved in the presence of the bulk chloride matrix were overcome. For a free copy of "The Analysis of Semiconductor Grade Hydrochloric Acid by Electrothermal Vaporization-ICP-Mass Spectrometry," write The Perkin-Elmer Corp., 761 Main Ave., Norwalk, CT 06859-0012.

Circle No. 218 on Reader Service Card

#### **Drum Filling**

An insert that allows a person to fill standard drums faster with or without the lid on is the topic of a data sheet. This product, which contains a patented, breathable vent, reportedly accommodates follower plates, high-speed mixers, and suction pumps. For a free sample and product specifications of the Membrane Vented 55, write CDF Corp., 100 Enterprise Dr., Marshfield, MA 02050.

Circle No. 219 on Reader Service Card

#### **Pelleted Carbon**

A pelleted activated carbon produced from metallurgical grade coal is introduced through literature. This product is designed to be used in place of domestically produced wood-base pelleted carbon in the recovery of toluene or similar compounds. For technical data on Xtrusorb<sup>®</sup> 800, contact Calgon Carbon Corp., P.O. Box 717, Pittsburgh, PA 15230-0717.

Circle No. 220 on Reader Service Card

#### **Gravity Filters**

A bulletin describes a line of gravity filters that operate automatically without a valve, backwash pump, flow controller, or other instruments. This publication lists operating principles, applications, advantages, dimensions, and performance data of the filters. For a copy of the "Automatic Valveless Gravity Filter" bulletin, write U.S. Filter, P.O. Box 560, Rockford, IL 61105.

Circle No. 221 on Reader Service Card

#### **Production Batch Attritors**

A brochure, complete with illustrations and descriptions, discusses how attritors work. This six-page publication contains photos, a color chart detailing engineering data, and information about standard grinding applications. For a free "Production Batch Attritor" brochure, write Union Process, 1925 Akron-Peninsula Rd., Akron, OH 44313.

Circle No. 222 on Reader Service Card

#### Sieve Desiccants

Molecular sieve desiccants for reactive urethane systems are introduced through literature. These products are available either as powder or concentrated molecular sieve/ castor oil paste, and were pioneered for use in maintenance coatings (concrete, steel, pipes, and tankage), flexible surfaces, adhesives/sealants/putties, roof coating materials, and structural molds. Additional information on the Sylosiv\* products, contact Grace Davison, P.O. Box 2117, Baltimore, MD 21203-2117.

Circle No. 223 on Reader Service Card

#### **Oily Waste Reduction**

A brochure includes informative charts outlining specifications, features, and benefits of an oily waste treatment system. Typical applications discussed include processing spent coolants, rinse water from parts cleaning, compressor blow-down condensate, paint and ink wash-down solutions, and other emulsified oil and particle-containing wastes. For a complimentary copy of "It's Not Just Your Oily Waste They're Hauling Away," contact Robert Cross, Cuno Separations Systems, 50 Kerry Place, Norwood, MA 02062.

Circle No. 224 on Reader Service Card

#### Scorch Retarding Coagents

A line of acrylic coagents designed to enhance elastomer heat resistance, weatherability, chemical resistance, adhesion, and abrasion resistance is the subject of a product release. For more information on the Saret<sup>®</sup> non-nitroso scorch-retarding coagents, contact Sartomer Co., 468 Thomas Jones Way, Exton, PA 19341.

Circle No. 225 on Reader Service Card

#### Water-based Products

A company has introduced a low-VOC water-based dispersion, a one-component water-based dispersion, and a zero-VOC water-based polyurethane in a product release. The low-VOC (182 g/l) aliphatic polyurethane water-based dispersion finds use in industrial coatings where low cosolvent allows for quick, tack-free dry and block resistance. The one-component water-based dispersion is designed to adhere to plasticized substrates in industrial coatings. The zero-VOC water-based polyurethane is designed for industrial product finishes, maintenance coatings, architectural coatings, and transportation coatings. For more information on LOW 22-25, OW 24, and NVP2000, write Jeannine Derba, K.J. Quinn & Co., Inc., 135 Folly Mill Rd., Seabrook, NH 03874-0158.

Circle No. 226 on Reader Service Card

#### **Aqueous Acrylic**

Information on a high jet black aqueous acrylic dispersion that is designed to afford low conductivity (non-arcing) properties has been printed. For more information, or for a sample of BS 15539, contact CDI Dispersions, 27 Haynes Ave., Newark, NJ 07114.

Circle No. 227 on Reader Service Card

# Why Renew?

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For more information, contact your local Society, or write to Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422

# **CrossLinks**

## Natural Products I by Earl Hill



Solution to be Published in March Issue

No. 58

#### ACROSS

- 1. Short for 23 Down
- A complex solvent derived from fermentation
- 7. Verdigris (Syn.); copper corrosion product
- 8. Natural resin from pine. Besides coatings, useful in bowling and pool playing
- Metal, rhymes with pink
   Another name for 30
- Down 14. Cyanopsis tetra
- gonolobus, G\_\_\_\_\_ 17. Semidrying seed oil, also
- used to make rope 18. Iceland \_\_\_\_\_
- 20. Red color from madder root

- 22. Excellent metal drier 24. An antioxidant
- hydrocarbon found in vegetable oils
- 25. Dark bituminous material, useful in roof coatings
- 26. Toxic, heavy metal
- 28. 23 Down derived
   29. An auxiliary drying
- metal 32. Synonym for 24 Across
- Trifunctional alcohol component of alkyd resins
- Fibrous mineral, frowned upon for toxicity
   A ketone solvent
  - A ketone solvent obtained from 13 Down

#### DOWN

- A natural paint made from eggs, gum, and pigments
- Natural crystalline calcium sulfate extender pigment
- Flax seed drying oil
   Metal sometimes for
- Metal sometimes found in driers
   Probably the most
- common drying oilA grease from sheep's
- wool 11. Common extender
- pigment, C\_\_\_\_\_ 13. A natural pine solvent
- from the class of 28 Across

- 14. Wood (25 Across) phenolic with antiskinning properties
- 15. AKA 19 Down
- 16. Resinous gum used as a plasticizer in varnishes, B\_\_\_\_\_
- AKA Juniper Gum
   East Indian semifossil resin.
- B\_\_\_\_\_23. The real stuff for 1
- Across 27. Yet another gum
- obtained from trees, A
- 30. Sticky stuff
- 31. Muscovite (Syn.)

# **Coming Events**

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.

#### 1994

(Mar. 22-23)—"Formulating for the New Clean Air Act." Seminar conducted by the Professional Development Committee of the FSCT. O'Hare Marriott Hotel, Chicago, IL.

(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. § 11)-73rd Annual Meeting and 60th Paint Industries' Show. Cervantes Convention Center, St. Louis, MO.

#### 1996

(Oct. 23-25)-74th Annual Meeting and 61st Paint Industries' Show. McCormick Place North, Chicago, IL.

#### SPECIAL SOCIETY MEETINGS

#### 1994

(Mar. 3)—"SYMCO 94, Changing Times." Sponsored by the Chicago Society and Chicago Paint and Coatings Association. Chicago Marriott, Oakbrook, IL. (Jeannine Thielmann, ANGUS Chemical, 1500 E. Lake Cook Rd., Buffalo Grove, IL 60089, (708) 215-8600 or Sue Rodgers, BYK-Chemie, (708) 582-1553).

(Mar. 3-5)—Southwestern Paint Convention. Sponsored by Houston and Dallas Societies. South Shore Harbour Resort & Conference Center, League City (Houston), TX. (Joseph Caravello, Guardsman Products, Inc., 137 N. Hall Dr., Sugarland, TX 77478; (713) 242-9439).

(Mar. 8)—"Back to Basics." Seminar sponsored by the Baltimore Society. Martin's West, Baltimore, MD. (Aaron Nutter, Bruning Paint Co., 601 S. Haven St., Baltimore, MD 21224, (410) 342-3636).

(Mar. 15)—"Technological Tools for Improved Formulation and Process Control." Sponsored by the Northwestern Society. Bloomington Marriott Hotel, Bloomington, MN. (Pat Fischer, H.B. Fuller Co., 1200 Wolters Blvd., Vadnais Heights, MN 55110, (612) 481-3368 or Rod Stockstad, (612) 375-7729).

(Apr. 12)—"New Technologies for Achieving Durable Compliant Coatings." Sponsored by the Detroit Society. Michigan State University Management Education Center. Troy, MI. (Joe Lesnek, Chrysler Corp., 800 Chrysler Dr., CIMS 483-16-02, Auburn Hills, MI 48326-2757; (810) 576-6516).

(Apr. 20)—"Coatings A-Z." Sponsored by the Louisville Society. Executive West Motor Hotel, Louisville, KY. (Mike Moilanen, United Catalysts, Inc., 1230 S.12th St., P.O. Box 32370, Louisville, KY 40232).

(Apr. 20-22)—Southern Society Annual Meeting. Peachtree Corners Hilton, Atlanta, GA. (Jeff Shubert, 2157 Mountain Industrial Blvd., Tucker, GA 30084; (404) 938-3600).

(Apr. 28-May 1)—47th Annual Spring Symposium. Sponsored by the Pacific Northwest Society. The Empress Hotel, Victoria, B.C.,

Canada. (Ed Linton, Cloverdale Paint Inc., 6950 King George Hwy., Surrey, B.C. V3W 4Z1, Canada; (604) 596-6261).

(June 10-11)—Joint Meeting of the St. Louis and Kansas City Societies. Holiday Inn, Lake of the Ozarks, MO.

1995

(Feb. 20-22)—Western Coatings Societies' 22nd Biennial Symposium and Show. Sponsored by the Golden Gate, Los Angeles, Pacific Northwest, and Rocky Mountain Societies. Hilton Hotel and Towers, San Francisco, CA. (Gordon Pioch, WCS Chairman, Eureka Chemical Co., P.O. Box 2205, S. San Francisco, CA 94083; (415) 761-3536).

#### OTHER ORGANIZATIONS

#### 1994

#### North America

(Feb. 20-23)—"Colorimetry of Fluorescent Materials." Conference sponsored by the Inter-Society Color Council. The Woodland in Colonial Williamsburg, VA. (Ginny Baca, Hunter Associates Lab., Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Feb. 20-24)—Second North American Symposium on Recent Advances in Polymer Blends and Alloys. Sponsored by the American Chemical Society, PMSE Division. Hilton Head, SC. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(Feb. 21-23)—Annual Meeting of The Adhesion Society and "Fundamentals of Particle Adhesion," symposium. Clarion Plaza Hotel, Orlando, FL. (Prof. J.G. Dillard, Dept. of Chemistry, Virginia Polytechnic Institute and State University, College of Arts and Sciences, Blacksburg, VA 24061-0212).

(Mar. 5-6)—38th Annual Canadian Decorating Products Show. Sponsored by National Decorating Products Association (NDPA). International Centre, Toronto, Ontario, Canada. (Ruth Wilms, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132).

(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).

(Mar. 14-16)—Seventh Annual Conference on Industrial Lead Paint Abatement and Removal. Sponsored by Steel Structures Painting Council (SSPC). Hyatt Regency, Greenwich, CT. (SSPC, 4516 Henry St., Ste. 301, Pittsburgh, PA 15213-3728).

(Mar. 14-17)—"Coatings Science for Coatings Technicians." Short course sponsored by University of Southern Mississippi (USM). Hattiesburg, MS. (Shelby F. Thames or Debbie Ballard, USM, Dept. of Polymer Science, Box 10076, Hattiesburg, MS 39406-0076).

(Mar. 23-25)—Electrocoat '94. Sponsored by Products Finishing Magazine. Hyatt Orlando, Orlando, FL. (Cindy Goodridge, Gardner Management Services, 6600 Clough Pike, Cincinnati, OH 45244).

(Mar. 28-30)—"Introduction to Polymer Colloids/Emulsion Polymers." Orlando, FL. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(Mar. 28-30)—"Fundamentals of Adhesion." Orlando, FL. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(Mar. 28-30)—"Polymer Blends and Alloys." Orlando, FL. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(Mar. 28-Apr. 1)—"Basic Composition of Coatings." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(Apr. 12-13)—"Regulations—Green Trends into the 21st Century." 34th Annual Symposium sponsored by the Washington Paint Technical Group. Ramada Hotel, Tyson's Corner, VA. (Mark Padow,

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Photoresists



National Paint and Coatings Association, 1500 Rhode Island Ave., N.W., Washington, D.C. 20005-5597).

(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).

(Apr. 18-20)—"Thermal Analysis in Polymer Research and Production." Short course sponsored by Polytechnic University, Brooklyn, NY. (Eli M. Pearce, Polymer Research Institute, Polytechnic University, Six Metrotech Center, Brooklyn, NY 11201).

(Apr. 18-22)—"Introduction to Paint Formulation." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(Apr. 20-22)—9th Annual Conference. Sponsored by the Architectural Spray Coaters Association (ASCA). Westin Mission Hills Resort, Rancho Mirage, CA. (ASCA, 230 West Wells St., Ste. 311, Milwaukee, WI 53203).

(Apr. 20-27)—Surface Treatment '94. Hannover Fairgrounds, Hannover, Germany. (Hannover Fairs USA Inc., 103 Carnegie Center, Princeton, NJ 08540).

(Apr. 21)—"Viscoelastic Properties of Polymers." Short course sponsored by Polytechnic University, Brooklyn, NY. (Eli M. Pearce, Polymer Research Institute, Polytechnic University, Six Metrotech Center, Brooklyn, NY 11201).

(Apr. 23-24)—Eastern Decorating Products Show. Sponsored by National Decorating Products Association (NDPA). Garden State Convention & Exhibit Center, Somerset, NJ. (Ruth Wilms, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132).

(Apr. 24-26)—ISCC Annual Meeting. Sponsored by the Inter-Society Color Council. Detroit, MI. (Ron Oldchurch, Chairman, ISCC Poster Papers Committee, 1680 N. Hwy 101 #11, Leucadia, CA 92024).

(Apr. 25-29)—"Applied Rheology for Industrial Chemists." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, Kent State University, P.O. Box 5190, Kent, OH 44242-0001).

(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).

(May 2-4)—"Fundamentals of Adhesion: Theory, Practice, and Applications." Lake Mohonk, New Paltz, NY. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(May 2-4)—"Polymer Blends & Alloys: Phase Behavior, Characterization, Morphology, Alloying Technology." Lake Mohonk, New Paltz, NY. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(May 2-4)—"Basic Coatings for Sales and Marketing Personnel." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(May 2-4)—"Advances in Membrane Technology." Lake Mohonk, NY. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(May 2-5)—"Science & Technology of Pigment Dispersion." Lake Mohonk, New Paltz, NY. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(May 4-5)—"Paint Volatile Organic Compounds (VOC)." Course sponsored by American Society for Testing and Materials (ASTM). Chicago, IL. (Tina Falkenstein, ASTM, 1916 Race St., Philadelphia, PA 19103).

(May 8-12)—85th AOCS Annual Meeting and Expo. Sponsored by the American Oil Chemists' Society (AOCS). Atlanta Marriott Marquis, Atlanta, GA. (AOCS, P.O. Box 3489, 1608 Broadmoor Dr., Champaign, IL 61826-3489).

(May 8-13)—37th Annual Technical Conference of the Society of Vacuum Coaters (SVC). Westin Hotel/Copley Place, Boston, MA. (SVC, 440 Live Oak Loop, Albuquerque, NM 87122-1407).

(May 9-11)—"Degradation and Stabilization of Polymers." Lake Mohonk. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(May 9-13)—"Dispersion of Pigments and Resins in Fluid Media." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, Kent State University, P.O. Box 5190, Kent, OH 44242-0001). (May 11-13)— 11th Annual Atlas School of Natural and Accelerated Weathering. Miami, FL. (Margaret MacBeth, Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60614).

(May 16-19)—"Coatings Science for Powder Coatings." Short course sponsored by University of Southern Mississippi (USM). Hattiesburg, MS. (Shelby F. Thames or Debbie Ballard, USM, Dept. of Polymer Science, Box 10076, Hattiesburg, MS 39406-0076).

(May 16-20)—"Introduction to Paint Formulation." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(May 16-21)—"Interpretations of IR and Raman Spectroscopy." Course and workshops sponsored by Vanderbilt University, Nashville, TN. (Clara Craver, Director, Fisk Infrared Institute, P.O. Box 265, French Village, MO 63036).

(May 23-27)—"Adhesion Principles and Practice for Coatings and Polymer Scientists." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, Kent State University, P.O. Box 5190, Kent, OH 44242-0001).

(June 6-9)—"Coatings Science for Coatings Chemists." Short course sponsored by University of Southern Mississippi (USM). Hattiesburg, MS. (Shelby F. Thames or Debbie Ballard, USM, Dept. of Polymer Science, Box 10076, Hattiesburg, MS 39406-0076).

(June 6-10)—"Advances in Emulsion Polymerization and Latex Technology." Short course sponsored by Lehigh University, Bethlem, PA. (Mohamed S. El-Aasser, Emulsion Polymers Institute, Lehigh University, 111 Research Dr., Bethlehem, PA 18015).

(June 13-15)—"Evaluating Coatings for Environmental Compliance—VOC & Lead Abatement." Conference sponsored by Steel Structures Painting Council (SSPC). Buena Vista Palace, Lake Buena Vista, FL. (Dee Boyle or Krista Hughes, SSPC, 4516 Henry St., Ste. 301, Pittsburgh, PA 15213-3728).

(June 13-16)—"Coatings Science for Coatings Formulators." Short course sponsored by University of Southern Mississippi (USM). Hattiesburg, MS. (Shelby F. Thames or Debbie Ballard, USM, Dept. of Polymer Science, Box 10076, Hattiesburg, MS 39406-0076).

(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).

(July 18-20)—"Basic Coatings for Sales and Marketing Personnel." Short course sponsored by University of Missouri-Rolla (UMR), Rolla, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401-0249).

(Sept. 28-30)—"Accelerated and Natural Weathering Techniques." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, Kent State University, P.O. Box 5190, Kent, OH 44242-0001).

(Oct. 4-5)—"Advanced Radiation (UV/EB) Curing Marketing/Technology." Seminar sponsored by Armbruster Associates Inc. Marriott Hotel, Newark Airport, Newark, NJ. (David Armbruster, Armbruster Associates Inc., 43 Stockton Rd., Summit, NJ 07901).

(Oct. 4-7)—"Introduction to Coatings Technology." Short course sponsored by Kent State University. Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, Kent State University, P.O. Box 5190, Kent, OH 44242-0001).

(Nov. 13-17)—Third North American Research Conference on Organic Coatings Science and Technology. Sponsored by the American Chemical Society, PMSE Division. Hilton Head, SC. (A.V. Patsis, Institute of Materials Science, State University of New York, New Patz, NY 12561).

#### Australia

(Apr. 5-8)—1994 Australian Master Painters Convention. Sponsored by The Federation of Master Painters & Signwriters of Australia. Sydney Convention & Exhibition Centre, Darling Harbour. (Total Concept Conference, P.O. Box 1221, Crows Nest, NSW, 2065).

#### Asia

(May 18-19)—Fourth Asia/Pacific Coatings Show. Organized by the Paint Research Association. Hong Kong Convention and Exhibi-

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tion Center, Hong Kong, China. (Jane Malcolm-Coe, FMJ International Publications Ltd., Queensway House, 2 Queensway, Redhill, Surrey, RH1 1QS, England).

#### Europe

(Mar. 8-10)—"Finishing '94." Exhibition sponsored by Paint Research Association. Telford Exhibition Centre, Shropshire, England. (Chris Reynolds, Finishing '94, Turret Group plc, Turret House, 171 High St., Rickmansworth, Herts, WD3 1SN, England). (Mar. 14-18)—"Recycle '94." Forum and Exposition. Sponsored

(Mar. 14-18)—"Recycle '94." Forum and Exposition. Sponsored by Maack Business Services. Congress Centre, Davos, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804 AU/ Zürich, Switzerland).

(Apr. 19-20)—"Specialty Plastics '94." Conference sponsored by Maack Business Services. Swissôtel, Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804 AU/Zürich, Switzerland).

(May 23-25)—International Symposium on Polymer Analysis and Characterization. Les Diablerets, Switzerland. (ISPAC Registration, 815 Don Gaspar, Sante Fe, NM 87501).

(June 5-9)—XXIInd FATIPEC Congress and Exhibition. Budapest Convention Centre, Budapest, Hungary.

(June 13-16)—'Science and Technology of Pigment Dispersion." Luzern, Switzerland. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(June 14-17)—Workshop on "Polymer Blends and Alloys." Luzern, Switzerland. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(June 20-22)—16th International Conference on Advances in the Stabilization and Controlled Degradation of Polymers. Luzern, Switzerland. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(June 21-22)—Surfex '94. Exhibition organized by Surfex Ltd., a wholly owned subsidiary of the Oil & Colour Chemists' Association. Harrogate, North Yorkshire. (H. Pooley, Surfex Ltd., Priory House, 967 Harrow Rd., Wembley HAO 2SF, England).

(July 4-8)—20th International Conference on Organic Coatings Science & Technology. Athens, Greece. (A.V. Patsis, State University of New York, New Paltz, NY 12561).

(Sept. 28-30)—"Fluorine in Coatings." Conference organized by the Paint Research Association in conjunction with Chemical-Polymer and Chemserve (UMIST). Salford, England. (Conference Secretary, Paint Research Association, 8 Waldegrave Rd., Teddington, Middlesex TW11 8LD, UK).

(Oct. 4-5)—"Polypropylene '94." Conference sponsored by Maack Business Services. Swissôtel, Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804 AU/Zürich, Switzerland).

(Oct. 25-26)—"Polyethylene '94." Conference sponsored by Maack Business Services. Swissôtel, Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804 AU/Zürich, Switzerland).

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# 'Humbug' from Hillman

Sid Lauren writes: "Dear Humbug-As you know, this faithful correspondent has been an amateur chef for years. In some recent reading on the history of formal cuisine (as opposed to home cooking), I came across some speculation about who originated the idea of salad dressings. I can tell you that the speculation was groundless. It wasn't this or that famous chef; it was some distant precursor of the Association of Dry Cleaners. I spotted that conclusion in my own experience.'

So, now we all know that Sid slobbers when he eats!

Owen Carpenter, a really faithful correspondent keeps Humbug's files on the ready. Here are some of his clips:

Ray Clem of Riyadh, Saudi Arabia, has supplied "a true tale about Tabasco, my cat, and her tail.'

Since arriving in Arabia, Clem writes, "we adopted and nursed back to health a kitten who had lost her mother. Perhaps because of this early separation, she developed a habit of noisily sucking her tail, especially at night."

To break the habit. Clem tried putting a few drops of Tabasco sauce on the cat's tail. It worked for a few days but then she was sucking her tail again. Not only that, she apparently was hooked on the sauce. Whenever they opened the refrigerator, Clem says, she was there meowing, her tail waving wildly, eagerly awaiting her drops of Tabasco.

The cat has brand loyalty, too. They've tried other brands, but she won't settle down until she gets Tabasco. -C&E News, October 8, 1990

Further from Owen were some quotes from John Crosbie's Save the Pun Foundation:

-Most people know the legend of William Tell, but few realize that he and his family were champion bowlers whose team was sponsored by local merchants. Even now, to be able to claim that the Tells once represented your family business would be of great advertising value. Unfortunately, the old records have been lost and today we can't be sure for whom the Tells bowl.

-When the King of Kale first took his young son out to view their great expanse of vegetables and herbs, the lad was impressed and strode on in awe through the fields that would soon be his own ptomaine.

On his father's return to the castle, the queen asked. "Where is our son?" To which the king replied proudly, "I have left my food prince in the stand of thyme."

There were more but I don't think I could stomach any more.

Some time ago, my bashful fellow Lion sent me some clips from Lion Magazines of 1988 and 1989. Some were worth unearthing:

-A fanatic is someone who can't change his mind and won't change the subject.

-Worry is like a rocking chair-it will give you something to do but it won't get you anywhere.

-The class yell of the school of experience is "Ouch!" -People blame fate for other accidents, but feel personally responsible when they make a hole-in-one.

Milt Glaser has been around long enough to relish this quote in the John Hopkins Magazine:

The Bia Lie:

Robert Browning wrote,

"Grow old with me.

The best is yet to be."

That is a big lie. However fortunate we are, the fact remains that the machinery is at its peak at 20 and goes downhill from then on.

-Paul Spear

Reliable Jeff Sturm delivered his perodic copy of the Yetter Letter, from which I usually am able to pluck an amusing quote or two.

-The truck driver stopped at a roadside diner. His waitress brought him a hamburger, a cup of coffee, and a piece of pie.

As the trucker was about to start eating, three men in leather jackets pulled up on motorcycles and came inside. One grabbed the man's hamburger, the second one drank his coffee, and the other one took his pie. The truck driver didn't say a word. He got up, put on his jacket, paid the cashier and left.

One of the bikers said to the cashier, "Not much of a man, is he?"

"He's not much of a driver either," she replied. "He just ran his truck over three motorcycles.

-Do you remember when: a marriage was likely to outlast all three wedding-present toasters? A drug problem meant trying to get a prescription filled on Sunday? The postman not only rang twice but delivered twice? The quality of music wasn't measured in decibels? A whole family could go to the movies for what it now costs for popcorn?

-No matter what happens, there is always somebody who knew it would.

-No man is completely worthless, he can always serve as a bad example.

A man was seen walking down the street with a desk strapped to his back, a typewriter under one arm, and a wastebasket under the other. He was stopped by a policeman, asked what he was doing, and arrested when he replied, "Impersonating an office, sir."

-1978 Farmers' Almanac

-Herb Hillman Humbug's Nest P.O. Box 135 Whitingham, VT 05361

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