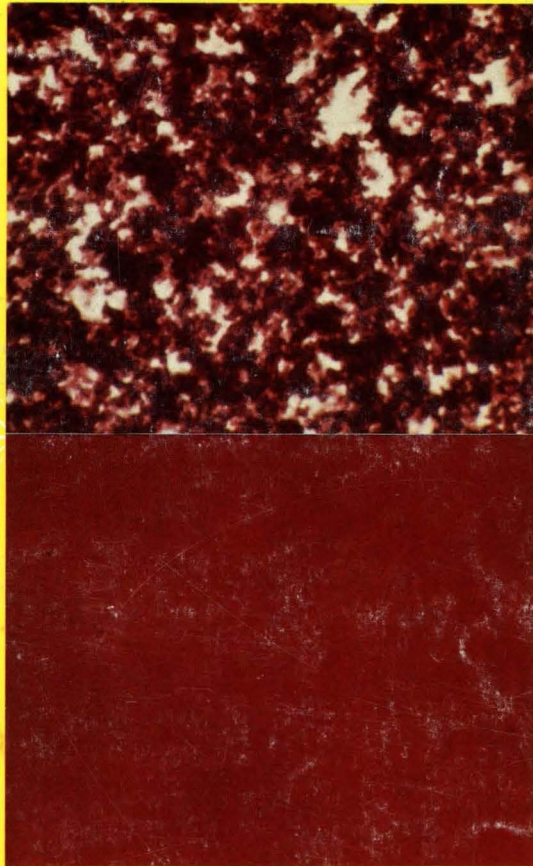




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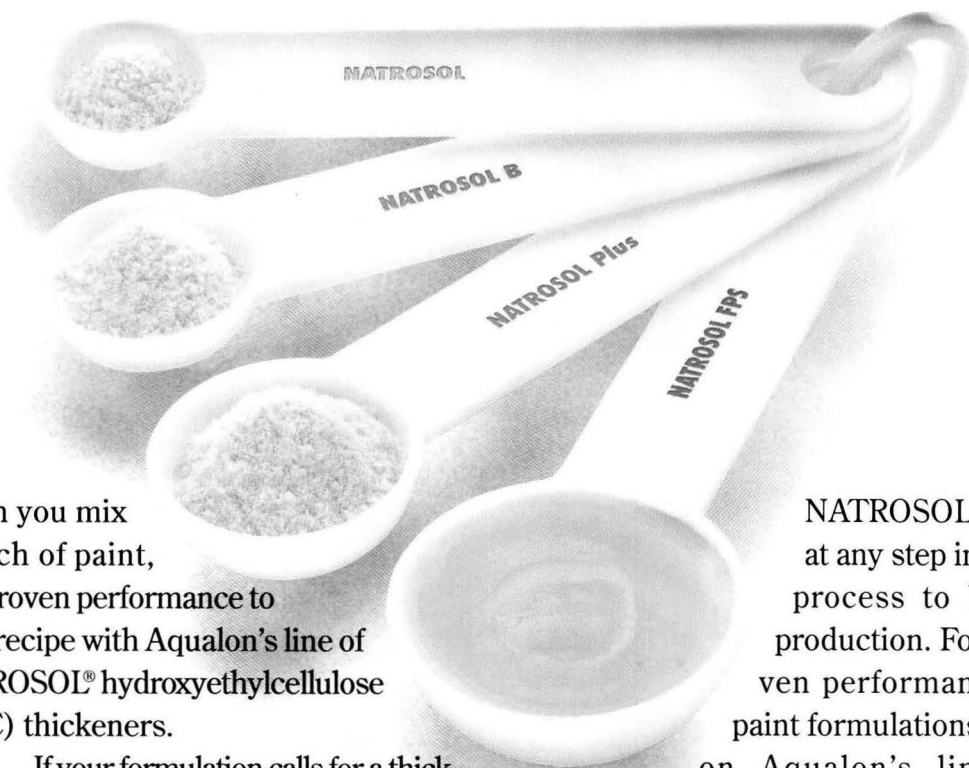
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GENERAL

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 All manuscripts will be assumed to be previously unpublished writing of the authors, not under consideration for publication elsewhere.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.

The JOURNAL OF COATINGS TECHNOLOGY has first right to the publication of papers presented at the Annual Meeting of the Federation and at local regional meetings or symposia of the Constituent Societies.

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

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Four complete copies should be sent to the Editor, JOURNAL OF COATINGS TECHNOLOGY, 492 Norristown Rd., Blue Bell, PA 19422. The cover letter should address copyright, clearance, and release issues discussed above and should specify paper category: *Original Research*, *Reviews*, *Open Forum*, or *Back to Basics*.

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 1993 Roon Awards Committee, Louis J. Sharp, Dexter Corp., 1 E. Water St., Waukegan, IL 60085. (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 repetitious 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 solicited. 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 8½ x 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.

Abstracts

A 75-100 word abstract must be part of the manuscript, and should be a concise description of the key findings or teachings of the work described in the paper. The abstract should not repeat the title or include reference numbers, nor should it duplicate the Conclusion or Summary.

Text

Main headings and sub-headings should be used to improve readability, and to break up typographical monotony. The text should *not* be presented as an alphanumeric outline.

The main headings usually should be INTRODUCTION, EXPERIMENTAL, RESULTS AND DISCUSSION, and SUMMARY or CONCLUSIONS. Sub-headings will be specific to the subject.

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.

Metric System

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.

Tables, Graphs, and Drawings

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 x 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 x 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.

If special nomenclature is used, include a nomenclature table giving definitions and dimensions for all terms.

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.

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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^s and subscripts_s 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

If used, it should follow the summary.

References

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,^{1,2,3} books,⁴ and patents.⁵

- (1) 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

In the Summertime . . .

July . . . hot . . . muggy . . . a time when the slightest movement can seem exhausting. Those "hazy, lazy days of summer" are upon us, right? Not exactly. With the Federation, these summer days are anything but lethargic! Bustling activity occupies every department at FSCT headquarters. Yet, the success of much of this activity is dependent upon the members who volunteer their energy and ideas to make things happen. And, at this time of the year, things are definitely happening!

With three months to go before the FSCT Annual Meeting & Paint Industries' Show, preparations are well underway. Members of the Annual Meeting Program and Host Committees have devoted many hours to guarantee the smooth operation of this much anticipated convention. Booth space has been assigned and programming for the technical sessions is in place—all promising the finest exhibition of coatings materials and services that the industry has to offer.

At the same time, work continues on the FSCT Coatings MSDS System on CD-ROM, which is being produced in cooperation with NPCA. The System was developed by the Chicago Society Technical Committee who sought to assist manufacturers to comply with governmental regulations regarding the 30-year storage of MSDSs. This project has captured the attention of the industry, and MSDSs are swiftly being collected for inclusion in the System.

And—never postponed by the season—another issue of the JCT is being readied for publication. Production on the JCT is an on-going process which depends quite heavily on the contributions of another group of volunteers—the JCT Editorial Review Board.

There are 22 members of this distinguished group whose knowledge spans the wide range of coatings technology. Under the guidance of Chairman Robert F. Brady, of Naval Research Labs, the Editorial Review Board represents a healthy balance of experience and expertise. The overwhelming majority of members are from industry; several are from academia; and some are retired but still extremely active in the industry. All, however, are dedicated individuals committed to maintaining the quality that is the trademark of the JOURNAL OF COATINGS TECHNOLOGY.

Although personal time is a highly treasured commodity, these volunteers give much of it to insure the excellence that readers have come to expect with the JCT. We are grateful to them for their years of service to the JCT and the Federation. In a three-part series, the JCT will profile the members of this distinguished group. In this issue (on page 16), the newest members of the JCT Editorial Review Board are featured.

So, even though it's the "good ol' summertime," activities at the Federation promise to stay "HOT, HOT, HOT!!!"

Patricia D. Viola

Patricia D. Viola,
Editor

Abstracts of Papers in This Issue

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

Electrostatic Charge and Pigment Stabilizing Properties of Fine Particle Sized Barium Sulfates—J. Winkler

JCT, 65, No. 822, 29 (July 1993)

In solvent-based paints, fine particle sized barium sulfates are capable of stabilizing other pigments against flocculation, thereby increasing the gloss, reducing the haze, and improving color strength of the formulations whereas rub-out effects are minimized. Their stabilizing ability is related to the tendency of the barium sulfate particles to associate with other pigment components. The mechanism is shown to have a "steric hindrance" component and a contribution from electrostatic stabilization.

The origin of electrostatic charges on fine barium sulfate particles is studied.

Polymer-Filler Interaction Effects on Coating Properties—C.R. Hegedus and I.L. Kamel

JCT, 65, No. 822, 37 (July 1993)

Previous studies were performed to analyze the surface properties of titanium dioxide (TiO_2) pigments surfaces, the thermodynamics of poly(methyl methacrylate) (PMMA) and methyl methacrylate (MMA) adsorption onto these surfaces from solution, and the resulting adsorbed polymer layer (adlayer) thickness. In the current study, these pigments and PMMA were formulated into coatings. Coating properties were characterized and analyzed with respect to the thermodynamic and physical adsorption results. TiO_2 pigments which had more favorable adsorption free energies and enthalpies with PMMA and MMA resulted in coatings with better dispersion quality and stability, greater resistance to salt spray, and better barrier properties. In contrast, these fillers had detrimental effects on adhesion and flexibility. These results were attributed to extensive interactions between filler and polymer which improved the dispersion, decreased the permeability, and increased the rigidity of the polymer matrix. These extensive interactions are also suspected to create internal strain within the coatings, causing them to fail prematurely as external forces are applied during the adhesion and flexibility tests. It has been demonstrated that a prior knowledge of filler surfaces and filler-polymer affinity can be used to formulate coatings with tailored properties.

Charges Électrostatiques et Propriétés Stabilisatrices de Fines Particules de Sulfates de Baryem.—J. Winkler

JCT, 65, No. 822, 29 (July 1993)

Dans des revêtements à base de solvants, de fines particules de sulfates de baryum sont capables de stabiliser d'autres pigments contre la floculation, d'où l'augmentation du brillant, réduction du voile et amélioration du pouvoir colorant pour les formulations où les effets de frottement sont minimisés. Leur pouvoir de stabilisation est relié à la tendance des particules de sulfate de baryum à s'associer avec d'autres pigments. Le mécanisme proposé comporte un effet d'encombrement stérique ainsi qu'une contribution de stabilisation électrostatique.

L'origine des charges électrostatiques sur les fines particules de sulfates de baryum est étudiée.

Effets des Interactions Polymères—Matière de Remplissage Sur les Propriétés des Revêtements—C.R. Hegedus and I.L. Kamel

JCT, 65, No. 822, 37 (July 1993)

Des études antérieures ont été effectuées pour analyser les propriétés de surface de pigments de bioxyde de titane (TiO_2), la thermodynamique du poly (méthyle méthacrylate) (PMMA) et l'adsorption en solution du méthyle méthacrylate (MMA) sur ces surfaces, ainsi que l'épaisseur de la couche résultante d'adsorption. Dans cette présente étude, ces pigments et le PMMA ont été formulés dans des revêtements. Les propriétés des revêtements ont été caractérisées et analysées en regard des résultats de thermodynamique et d'adsorption physique. Les pigments de TiO_2 possédant des enthalpies et des énergies libres d'adsorption plus favorables avec le PMMA et le MMA ont donné des revêtements possédant une meilleure qualité de dispersion et de stabilité, meilleure résistance au brouillard salin et de meilleures propriétés protectrices. Par contre, ces matières de remplissage ont démontré des effets adverses sur l'adhésion et la flexibilité. Les résultats ont été attribués aux interactions entre les matières de remplissage et le polymère, améliorant ainsi la dispersion, diminuant la perméabilité et augmentant la rigidité du polymère. On croit que ces interactions peuvent créer des tensions internes dans les revêtements, causant ainsi des bris prématurés où les forces externes sont appliquées durant les tests d'adhésion et

Propiedades de Cargas Electrostaticas y Estabilizacion del Pigmento, de las Particulas Finas de Sulfato de Bario—J. Winkler

JCT, 65, No. 822, 29 (July 1993)

En pinturas base solvente, las partículas finas de sulfato de bario son capaces de estabilizar a otros pigmentos contra la floculación, incrementando, de esta manera, el brillo, reduciendo el aspecto lechoso y mejorando la intensidad del color de las formulaciones, mientras que, por otra parte, se minimizan los efectos de frotamiento. Su capacidad de estabilización está relacionada con la tendencia de las partículas de sulfato de bario a asociarse con los componentes de otros pigmentos. Se muestra que el mecanismo tiene un componente de IMPEDIMENTO ESTERICO y una contribución debida a la estabilización electrostática.

Se estudió el origen de la cargas electrostáticas, en las partículas finas de sulfato de bario.

Efectos de la Interaccion Polimero-Particula de Carga, en las Propiedades de los Recubrimientos—C.R. Hegedus and I.L. Kamel

JCT, 65, No. 822, 37 (July 1993)

Se realizaron estudios previos para analizar las propiedades de superficie del pigmento de dióxido de titanio (TiO_2), las propiedades termodinámicas del polimetilmetacrilato (PMMA) y del metil metacrilato (MMA) y la adsorción de sus soluciones sobre estas superficies, así como el espesor resultante de la capa de polímero adsorbido. En el presente estudio se formularon recubrimientos de estos pigmentos y el PMMA. Las propiedades de los recubrimientos se caracterizaron y se analizaron con respecto a los resultados termodinámicos y de adsorción física. Los pigmentos de dióxido de titanio, tuvieron energías libres de adsorción y entalpías mas favorables con el PMMA y el MMA, dando como resultado recubrimientos con mejor calidad de la dispersión y estabilidad, con mayor resistencia a la cámara salina y mejores propiedades de protección. En contraste, estas partículas de carga tuvieron efectos perjudiciales en la adhesión y la flexibilidad. Estos resultados se atribuyeron a las interacciones entre la partícula de carga y el polímero, las cuales mejoraron la dispersión, disminuyeron la permeabilidad e incrementaron la rigidez de la matriz del polímero. Se sospecha, que estas

Two-Component Waterborne Polyurethane Coatings—P.B. Jacobs and P.C. Yu

JCT, 65, No. 822, 45 (July 1993)

Increasingly stringent controls on solvent emissions are forcing the coatings industry to look for alternatives to traditional solvent-borne paints and coatings. One of the approaches which has been taken to reducing solvent levels in polyurethane coatings is the use of water as a carrier. However, when ambient temperature cure is necessary or desirable, commercially available fully reacted waterborne polyurethanes often fall short in terms of chemical and solvent resistance.

In response to the need for ambient temperature curing coatings with low solvent emission levels, we have developed two-component waterborne polyurethane coatings with properties similar to those of two-component solvent-borne polyurethane coatings. In this paper, the hydroxy-functional polyurethane dispersions and the water-dispersible polyurethane crosslinkers that make up this reactive waterborne system are discussed. We also focus on the properties of clear and pigmented films from these formulations as well as the factors which affect film properties.

Studies in the Thermal Diffusion of Copolymers Using Field-Flow Fractionation—M.E. Schimpf et al.

JCT, 65, NO. 822, 51 (July 1993)

Earlier studies of copolymer thermal diffusion are extended here to include several new random and block copolymers of polystyrene and polyisoprene. Thermal diffusion coefficients for these polymers in tetrahydrofuran and cyclohexane were obtained by thermal field-flow fractionation (ThFFF). The results confirm the dependence of thermal diffusion (and therefore ThFFF retention) on the radical distribution of monomeric units in the solvated macromolecule. For random copolymers and block copolymers that assume a random configuration, the thermal diffusion coefficient DT is a linear function of copolymer composition. This relationship provides a basis for obtaining compositional information on such copolymers by ThFFF. For copolymers subject to radial segregation of its monomeric units, the significance of a given unit's role in thermal diffusion increases with the radial distance of the unit from the core of the solvated molecule. The dependence of retention on the radial distribution of monomeric units provides a basis for evaluating bonding arrangements in copolymers.

de flexibilité. Il a été démontré qu'une bonne connaissance des surfaces des matières de remplissage et des affinités avec le polymère peut être utilisée pour formuler des revêtements possédant des propriétés bien spécifiques.

Revêtements Aqueux de Polyuréthane à Deux Composés—Dr. P.B. Jacobs and P.C. Yu

JCT, 65, No. 822, 45 (July 1993)

Des contrôles de plus en plus sévères sur les rejets atmosphériques dus aux solvants forcent les manufacturiers de revêtements à trouver des alternatives aux revêtements traditionnels à base de solvants. Une des approches retenues pour réduire les émissions de solvants dans les revêtements de polyuréthanes est l'utilisation de l'eau. Par contre, quand la température ambiante de durcissement est nécessaire ou désirable, les polyuréthanes aqueux commercialement disponibles ne possèdent pas de bonne résistance aux produits chimiques et aux solvants.

Suivant le besoin pour des revêtements durcissant à la température ambiante avec de bas niveaux d'émission de solvants, nous avons développé des revêtements aqueux de polyuréthane à deux composés et à base de solvants. Dans cette étude, les dispersions de polyuréthane possédant une fonction hydroxy et les agents réticulants de polyuréthane hydro-solubles faisant parti du système réactif aqueux, sont analysés. Nous mettons également l'emphase sur les propriétés des feuillets clairs et pigmentés à base de ces formulations ainsi que les facteurs affectant les propriétés de ces derniers.

Etudes de la Diffusion Thermique de Copolymères Utilisant la Fragmentation Champ-Flux — M.E. Schimpf et al.

JCT, 65, No. 822, 51 (July 1993)

Des études antérieures de la diffusion thermique de copolymères ont été étendues pour inclure plusieurs nouveaux polymères de polystyrène et polyisoprène. Les coefficients de diffusion thermique de ces polymères dans le tétrahydrofurane et le cyclohexane ont été obtenus par fragmentation thermique champ-flux (ThFFF). Les résultats confirment la dépendance de la diffusion thermique (et donc de la rétention (ThFFF) sur la distribution radiale des unités monomériques dans la macromolécule solvatée. Pour des copolymères aléatoires et des copolymères sous forme de blocs qui assument une configuration aléatoire, le coefficient de diffusion thermique D_T est une fonction linéaire de la composition du copolymère. Cette relation procure une base pour l'obtention d'information compositionnelle sur ces copolymères par ThFFF.

interacciones también crean esfuerzos internos dentro de los recubrimientos, ocasionándoles fallas prematuras a medida que se les aplican fuerzas externas durante las pruebas de adhesión y flexibilidad. Se ha demostrado que un conocimiento previo, de las superficies de las partículas de carga y la afinidad polímero-partícula de carga, se puede usar para formular los recubrimientos con propiedades a la medida.

Recubrimientos de Poliuretano Base Agua de dos Componentes—P.B. Jacobs and P.C. Yu

JCT, 65, No. 822, 45 (July 1993)

Los crecientes controles en las emisiones de solventes están forzando a la industria de recubrimientos a buscar alternativas para pinturas y recubrimientos tradicionales base solvente. Una de las tentativas que se han tomado para reducir los niveles de solventes en los recubrimientos de poliuretano es el uso de agua como disolvente. Sin embargo, cuando es necesario o deseable el curado a temperatura ambiente, los poliuretanos base agua disponibles comercialmente, son a menudo insuficientes en términos de resistencia química y resistencia a solventes.

En respuesta a la necesidad de recubrimientos de curado a temperatura ambiente, con bajos niveles de emisión de solventes, se han desarrollado recubrimientos de poliuretano base agua de dos componentes, con propiedades similares a las de los recubrimientos de poliuretano base solvente de dos componentes. En este artículo se discuten las dispersiones de poliuretano hidroxifuncionales y los reticulantes de poliuretano dispersables en agua, que constituyen este sistema reactivo base agua. También se ha hecho énfasis en las propiedades de películas claras y pigmentadas de estas formulaciones así como los factores que afectan las propiedades de la película.

Estudios en la Difusión Térmica de Copolímeros Mediante Fraccionamiento del Campo de Flujo—M.E. Schimpf et al.

JCT, 65, No. 822, 51 (July 1993)

En este trabajo se extienden estudios previos de difusión térmica de copolímeros para incluir varios copolímeros aleatorios y de bloque de poliestireno y poliisopreno. Los coeficientes de difusión térmica de estos polímeros, en tetrahydrofurano y ciclohexano, se obtuvieron mediante fraccionamiento térmico del campo de flujo (ThFFF). Los resultados confirman la dependencia de la difusión térmica (y por lo tanto la retención de ThFFF) en la distribución radial de las unidades monoméricas en las macromoléculas solvatadas. Para los copolímeros aleatorios y de bloque, los

A Silane Primer: Chemistry and Applications of Alkoxy Silanes—G.L. Witucki

JCT, 65, No. 822, 57 (July 1993)

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 resulted in the development of alkoxy functional silanes for use as adhesion promoters, crosslinkers, and hydrophobes. The intent of this paper is to briefly review the unique chemistry of this class of materials and to discuss three areas of product development that have benefitted from the utilization of silanes: surface treatment, additive, and reactive intermediate. This discussion will include recommendations for specific organic/silane combinations.

New Lower-Voltage EB Systems for Curing Polymers and Coatings—P.M. Fletcher

JCT, 65, No. 822, 61 (July 1993)

The diverse uses of electron beam (EB) systems to cure polymers and coatings are reviewed, with consideration given to how appropriate the equipment is for the applications. Recent developments of EB-cured products and their attendant market expansions are described. The new Electro cure™ series of EB systems, designed to operate at a lower voltage than former systems, is presented, and its optimized features for electron curing are highlighted. Anticipation for future growth in the use of EB-curing technology will be discussed.

Pour les copolymères sujets à de la ségrégation radiale de ses unités monomériques, la signification du rôle d'une unité dans la diffusion thermique croît avec la distance radiale de l'unité du cœur de la molécule solvatée. La dépendance de la rétention de la distribution radiale des unités monomériques procure une base pour l'évaluation des arrangements de liens dans les copolymères.

Apprêt à Base de Silane: Chimie et applications des Alkoxy Silanes—G.L. Witucki

JCT, 65, No. 822, 57 (July 1993)

Les formulateurs dans le domaine des revêtements, encres, adhésifs et autres industries connexes, demandent des matériaux qui résistent à l'écaillage et à la pénétration malgré une exposition prolongée à la chaleur, au froid, à l'humidité et aux attaques chimiques. La recherche dans ce domaine a mené au développement de silanes possédant une fonctionnalité alkoxy pour utilisation en tant que promoteurs d'adhésion, agents réticulants et hydrophobes. Le but de cette publication est de réviser brièvement la chimie de cette classe de matériaux et de discuter de trois domaines où le développement de produits a bénéficié de l'utilisation des silanes: traitement de surface, additifs et intermédiaires réactifs. Cette discussion inclut les recommandations pour des combinaisons spécifiques avec le silane.

Nouveaux Systèmes EB à Bas Voltage Pour les Revêtements et Polymères Durcissables—P.M. Fletcher

JCT, 65, No. 822, 61 (July 1993)

Les diverses utilisations des systèmes à bombardement électronique (EB) pour les revêtements et polymères durcissables sont revues en considérant l'équipement approprié pour les applications. Les développements récents de produits durcis au EB ainsi que leurs marchés potentiels sont décrits. La nouvelle série des systèmes EB appétie "Electro cure," désignée pour opérer à un plus bas voltage que les systèmes précédents, est présentée et ses caractéristiques optimales pour le durcissement électronique sont soulignées. Une discussion de l'utilisation de la technologie EB est présentée, en anticipation de son marché futur croissant.

cuales se consideran de configuración aleatoria, el coeficiente de difusión térmica D_T , es una función lineal de la composición del copolímero. Esta relación proporciona una base para obtener información en cuanto a la composición de tales copolímeros mediante ThFFF. Para los copolímeros sujetos a segregación radial de sus unidades monoméricas, el significado del papel de una unidad dada en la difusión térmica aumenta con la distancia radial de la unidad desde el centro de la molécula solvatada. La dependencia de la retención en la distribución radial de las unidades monoméricas, proporciona una base para evaluar arreglos de enlaces en los copolímeros.

Un Primario de Silano. Química y Aplicaciones de los Alcoxy—Silanos—G.L. Witucki

JCT, 65, No. 822, 57 (July 1993)

Los formuladores en las industrias de pinturas, tintas, adhesivos, repelentes al agua y otras industrias relacionadas, requieren de materiales que resistan al desprendimiento y a la penetración a pesar de una exposición prolongada al calor, al frío, la humedad y al ataque químico. Las investigaciones, en cuanto a estos problemas, han dado como resultado el desarrollo de silanos alkoxy funcionales para usarlos como promotores para adhesión, reticulantes e hidrófobos. El propósito de este trabajo es revisar brevemente la química de esta clase de materiales y discutir tres áreas del desarrollo del producto, las cuales han sido beneficiadas con la utilización de los silanos: el tratamiento de la superficie, el aditivo y el reactivo intermedio. La discusión incluirá recomendaciones para combinaciones específicas orgánicas/silanos.

Nuevos Sistemas EB de Bajo Voltaje Para Curar Polímeros y Recubrimientos—P.M. Fletcher

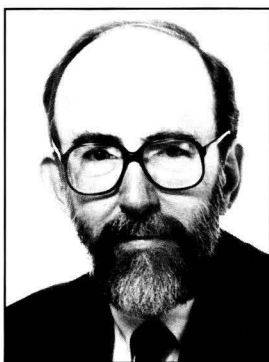
JCT, 65, No. 822, 61 (July 1993)

Se revisan los diversos usos de los sistemas de haces de electrones (EB) para curar polímeros y recubrimientos, considerando que tan apropiado es el equipo para estas aplicaciones. Se describen los desarrollos recientes de los productos curados con EB y su penetración en un mercado creciente. Se presenta la nueva serie de electrocurado Tm de EB, diseñada para operar a un voltaje más bajo que en los sistemas anteriores, a la vez que se destacan las características optimizadas para curado con electrones. Se discutirá la anticipación para el desarrollo futuro en el uso de tecnologías para curado con EB.

1993 MATTIELLO LECTURER

Ray Dickie, Senior Staff Scientist, of Ford Research Lab, To Present Mattiello Lecture at 1993 FSCT Annual Meeting

The Federation of Societies for Coatings Technology is pleased to announce that Ray Dickie, Senior Staff Scientist in the Chemical and Physical Sciences Department of Ford Research Laboratory in Dearborn, MI, will present the Joseph J. Mattiello Memorial Lecture during the 71st Annual Meeting of the Federation. The Annual Meeting will be held at the Georgia World Congress Center in Atlanta, GA, on October 27-29. Dr. Dickie's lecture will be given on Friday, October 29.



The lecture commemorates the contributions of Dr. Mattiello, former President of the Federation (1943-44). Dr. Mattiello was instrumental in expanding the application of the sciences in the decorative and protective coatings fields. He was Vice President and Technical Director of Hilo Varnish Corporation, Brooklyn, NY, when he died in 1948.

The lecturer, chosen from among those who have made outstanding contributions to science, is selected to present a paper on a phase of chemistry, engineering, human relationships or other sciences fundamental to paint, varnish, lacquer, or related protective or decorative coatings.

Career Highlights

Dr. Dickie was graduated from the University of North Dakota with a B.S. in Chemistry. He earned his Ph.D. Degree in Physical Chemistry at the University of Wisconsin, and did postdoctoral research at the University of Glasgow and at Stanford Research Institute. He joined Ford Motor Company in 1968, and is currently Senior Staff Scientist in the Chemical and Physical Sciences Laboratory at Ford.

Dr. Dickie's research interests center on the chemistry of the polymer-metal interface and related areas of surface coating technology and adhesive bonding. The interfacial chemistry of corrosion-induced adhesion failure has been an area of special interest.

He was awarded the Distinguished Alumni Lectureship in Chemistry at the University of North Dakota in 1989. In 1991, he received the Midgley Award of the Detroit Local Section of the American Chemical Society for "outstanding contributions in the field of chemistry related to the automotive industry." In 1992, Dr. Dickie received the prestigious Roy Tess Award in Coatings from the American Chemical Society. To date, he has published more than 70 papers, and has been awarded 36 patents.

Industry-Related Activities

Dr. Dickie is a member of the Detroit Society for Coatings Technology, the Society of Rheology, and the American Chemical Society. He served as Chairman of the ACS Division of Polymeric Materials: Science and Engineering in 1987, and was General Secretary of the ACS Macromolecular Secretariat in 1990. He has organized ACS symposia on composites, crosslinking systems, and corrosion protective coatings. He is currently on the editorial advisory and/or review boards of the *JOURNAL OF COATINGS TECHNOLOGY*, *Progress in Organic Coatings*, and the *Journal of Adhesion Science and Technology*.

FSCT Annual Meeting—Program Highlights

The basis for this year's Annual Meeting technical program theme, "Today's Competitive Coatings: Lean, Mean, and Green," is the understanding that success in

the coatings industry, both now and in the future, belongs to those who take the lead in blending long-term profitability, coatings performance, and environmental protection. The theme recognizes these goals in the terms:

LEAN: as in cost effective; process efficient; and waste free;

MEAN: by being consistent; tough; durable; and resistant; and

GREEN: through being environmentally friendly; renewable; recyclable; and safe.

The following program session themes are being developed:

- Advanced Topics in Coatings Research
- Latex Technology
- Environmental Affairs: Lean, Mean, Green and CLEAN—Innovative Equipment Cleaning Techniques
- Environmentally Compatible Corrosion Inhibitive Coatings
- Radiation Curing
- Characterization of Physical Properties of Coatings

The program also will highlight Room Competition Papers, International Papers, and APJ/Voss Award (FSCT Constituent Society) Competition Papers.

Additional topics to be covered at the event include the following: powder coatings, adhesion, organic pigments, UV-curable coatings, low VOC coatings, formulating, high-solids coatings, and additives.

The Annual Meeting will feature a Poster Session, scheduled to be displayed on Thursday, October 28, from 9:00 am to 5:00 pm.

Program Committee

Clifford Schoff, of PPG Industries, Inc., Allison Park, PA, is serving as Chairman of the Annual Meeting Program Committee. Assisting Dr. Schoff on the steering committee are: Ronda Miles (Vice-Chair), Union Carbide

(Continued on page 12)

We've Come a Long Way!

Sixty-one years ago, history was made as the coatings industry displayed its finest products and services at the first Paint Industries' Show. Held at the Mayflower Hotel in Washington, D.C., this unprecedented event boasted 25 exhibitors. In October of this year, the Paint Industries' Show is celebrating its 58th anniversary and things sure have changed! Now more than 282 exhibitors will share over 88,000 square feet of exhibit space at the Georgia World Congress Center on October 27-29! What hasn't changed, though, is that attendees of the Show will have the opportunity to learn about the best the coatings industry has to offer. The top technical and sales staff of supplier companies will be on-hand to present a wide array of raw materials, produc-

tion equipment, containers and filling equipment, laboratory apparatus, and testing devices for the paint and coatings producer.

The Paint Industries' Show—which boasts the longest and most successful tradition of any coatings-related exhibition—will attract visitors from around the world. It is this tradition which enables the Paint Show to enjoy steady growth as new exhibitors seek to join the ranks of those who participate annually. This year, 20 companies will exhibit for the first time. The Federation of Societies for Coatings Technology—sponsors of the Annual Meeting and Paint Industries' Show—welcomes the following new exhibitors to Atlanta:

Air Quality Sciences
Amherst Process Instruments
Cives Recycling
Coatings Lab., Inc.

Color Communications, Inc.
Cydec, Inc.
Emulsion Systems
Georgia Pacific Resins
Kolon Chemical Corp.
Laidlaw Env. Services
LaQue Center
Micromet Instruments
Ming-zu Chemical
Nan Ya Plastics
Praxair, Inc.
Rohm Tech, Inc.
Ronningen-Petter
Schuller Filtration
Steeltin Can Corp.
U.S. Sack Corp.

(For a full listing of exhibitors, please see page 26 of this issue.)

Ray Dickie to Named Mattiello Lecturer; Additional Annual Meeting & Paint Show Highlights

Continued from page 11

Corp., Garland, TX; Darlene Brezinski, Consolidated Research, Inc., Mt. Prospect, IL; Loren W. Hill, Monsanto Co., Springfield, MA; Richard J. Himics, Daniel Products Co., Inc., Jersey City, NJ; Louis F. Holzknicht, Devoe Coatings Co., Louisville, KY; Louis J. Sharp, Dexter Packaging Products, Waukegan, IL; and Roger Woodhull, California Products Corp., Cambridge, MA.

Hotel Reservations

Eight hotels have reserved blocks of rooms for this event. The Atlanta Marriott Marquis, located in the city's Peachtree Center, will serve as the headquarters hotel. Other hotels include the Hyatt Regency Atlanta, the Westin Peachtree Plaza, Atlanta Hilton and Towers, the Omni Hotel at CNN Center, the Radisson Hotel Atlanta, the Ritz-Carlton Atlanta, and the Comfort Inn. All reservations will be processed through the FSCT Housing Bureau of the Atlanta Convention and Visitors Bureau, using the FSCT Reservation Form. Brochures containing these forms and information regarding hotel accommodations have been mailed to all members, and are included in this issue.

Airline Information

The Federation's Travel Desk has negotiated reduced rates on Delta and Continen-

tal Air Lines. Continental is also offering convention discounts on international flights. To make your transportation arrangements to the Paint Show, you may use the FSCT Official Travel Agency or contact the airline directly.

FSCT Travel Desk: 1-800-448-FSCT
Delta: 1-800-241-6760
(reference file # U0235)
Continental: 1-800-468-7022
(reference file #ZJA35).

Please note that for each airline, certain restrictions apply.

Spouses' Program

Spouses' activities begin on Wednesday, October 27, with a Welcome Social at the Marriott Marquis.

On Thursday, following a continental breakfast in the Marriott Marquis, registered guests will depart on deluxe motor coaches for a visit to Stone Mountain Park which features the world's largest mass of exposed granite. There, spouses will stop at Memorial Hall for a view of the Confederate Memorial—a carving in the granite of Robert E. Lee, Stonewall Jackson, and Jefferson Davis. The carving, even bigger than Mount Rushmore, is the largest work of sculptured art in existence. Participants will have the opportunity to tour the park's authentic antebellum plantation featuring 20 structures dating between 1780 and 1880.

From Stone Mountain, guests will board the motor coaches for the Georgia Freight Depot, a historical building in Atlanta featured in the scenes from the movie "Gone with the Wind." There, a delicious lunch will be served.

After lunch, guests will visit Underground Atlanta, a unique underground shopping district boasting retail shops and restaurants.

Host Committee

Serving as Chairman of the Annual Meeting Host Committee is Jeff Shubert, of Shubert Paints, Inc., Tucker, GA. Assisting on the Committee are: Stan Harshfield, of Watty Paint Corp., Tampa, FL; Philip Aultmann, of Whittaker, Clark & Daniels, Norcross, GA; Thad T. Broome, of J.M. Huber Corp., Macon, GA; Sal Sanfilippo, of SGC Coatings Consultants, Tuscaloosa, AL; and Stephen Cantrell, of Kerr-McGee Chemical Corp., Tucker, GA.

NPCA to Meet Same Week

The National Paint & Coatings Association will hold its annual meeting on October 25-27, in the Hilton Hotel & Towers, in Atlanta.

* * *

(For registration and housing forms for the Annual Meeting and Paint Industries' Show, see pages 23 and 25 of this issue.)

1993 FSCT Spring Week Features Texas Hospitality

"Bigger than the Astrodome and wider than the Rio Grande" describes the welcome given to Federation visitors by the Houston Society members during the 1993 Federation Spring Week meetings, held in the Houston suburb of League City, Texas. The site for the meetings, South Shore Harbour Resort and Conference Center, presented an idyllic setting for the four-day Spring Week, which featured the meetings of the Board of Directors, on May 16, and Incoming Society Officers, on May 17. The Spring Symposium, "Influence of Substrates and Application Methods/Techniques on Coatings Performance," was sponsored by the FSCT's Professional Development Committee on May 17-18.

Board of Directors Highlights

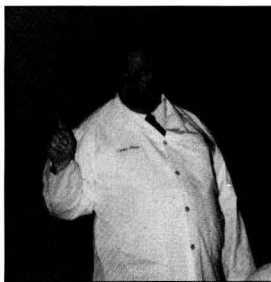
Attendance (53): Thirty-five members of the Board, plus 18 guests (including one FSCT Past-President and six Society Officers).

Financial Report: 1992 Statement of Income and Expense and 1993 Operating Budget were reviewed in detail by staff. The First Quarter 1993 Statement showed income and expense well within the budget set at \$2.75 million.



Annual Meeting and Paint Show: The FSCT experienced a record-setting Paint Show in 1992, with 295 companies exhibiting in over 94,000 sq. ft. of booth space. Attendance of 8,404 was the third highest ever. Over 97% of exhibit space has been contracted for the 1993 Paint Show and all plans are proceeding according to schedule. The theme for the Annual Meeting, "Today's Competitive Coatings: Lean, Mean and Green," will be reflected in the selection of the Keynote Address by Jean-Michel Cousteau, noted marine environmentalist. Technical programming, under the direction of Chairman Clifford Schoff, will feature nearly 60 presentations over the three-day event. Housing and registration information have been sent to all members.

Officer/Board Nominations: The slate for 1993-94, presented by the Nominating Committee, is:



President-Elect—Joseph P. Walton, of Cleveland Society.

Secretary-Treasurer—Darlene Brezinski, of Chicago Society.

Executive Committee—Forest Fleming, of Piedmont Society (3 years).

Board (at-Large)—Rose A. Ryntz, of Detroit Society, and Thomas Hill, of Western New York Society (2 years); Freidun Anwari, of Cleveland Society (1 year).

Board (Past-President)—Milton A. Glaser, of Chicago Society (2 years).

By-Laws: Approved revisions to Standing Rules affecting method of election of membership in Societies; passed first reading of By-Laws revision re-defining Associate Membership. Discussed Society-requested provisions to By-Laws allowing Associate Members to hold Society Representative office. By-Laws Committee draft proposal will be discussed at Fall Meeting of Board. (See page 14 for draft proposal.)

Society Business:

Brenda Carr, FSCT Member Services Chair, presented Certificates of Appreciation to Chicago, Birmingham, and Rocky Mountain Societies in recognition of their outstanding gains in membership during the year.

A membership promotional video, produced by the FSCT, was shown to the Board. The video will be used by the FSCT and Societies in gaining managerial support for increased participation in Society membership activity.

The New York Society presented a training video on VOC Determination. Produced by the Society, with FSCT support, the video is the first in a series of training video presentations.

Society Officers Meeting

The 17th annual orientation meeting for Incoming Society Officers was attended by representatives of 25 Societies. Informal

round-table sessions featured discussions on topics of importance to both the FSCT and Society operations: Administration and Committee Structure; Membership Retention and Recruitment Programs; Education and Program Development; Publicity and Public Relations; and, Finances and Budgeting. Led by Federation Officers and Staff, the discussions were interesting and informative to all participants.

FSCT Spring Seminar

Developed by the FSCT Professional Development Committee (Roger Woodhull, Chair), the two-day seminar featured presentations focused on the many factors which come into play in the process of coating a substrate, including the method of application, the substrate, the coatings, and other conditions. Attended by 68 persons, the seminar featured the following presentations: "Coating of Concrete/Masonry"; "Sheet Rock"; "History of Paint Applicators"; "Application Methods"; "Basic Properties and Surface Preparation of Wood"; "Finishing Alternatives for Exterior Wood Products"; "Successful Coating of Pressure-Treated Wood"; "Finishing Characteristics of Plywood, OSB, and Com-Ply Panels"; and "Hardboard Siding as a Substrate." Open Forum Sessions completed each day's presentations.

* * *

We sincerely thank the members of the Houston Society for their generous hospitality and support of the Spring Week events, and for sponsoring the tour of Houston's NASA facility. The Society's assistance in all aspects of Spring Week was invaluable. Also gratefully acknowledged is Eastman



Chemical, Inc.'s sponsorship of the Board of Directors reception. The FSCT sincerely appreciates the efforts of the Professional Development Committee and, especially, Dan Dixon, in the development of the seminar and their assistance on-site.

Proposed Amendments to FSCT By-Laws (for first reading)

I. NPCA Representative on FSCT Board

WHEREAS the Federation of Societies for Coatings Technology (FSCT) and the National Paint and Coatings Association (NPCA) have each agreed to provide the other with a seat on their respective Board of Directors, be it

RESOLVED that the first paragraph of By-Laws Article IV, Section B, be amended to read as follows:

ARTICLE IV Organization

B. BOARD OF DIRECTORS

The Board of Directors shall consist of the President, President-Elect, Secretary-Treasurer, four members-at-large, the immediate Past-President or most recent available Past-President, two additional Past-Presidents, all of the Society Representatives, and a representative appointed by the National Paint and Coatings Association (NPCA). Active membership shall be required for all members of the Board of Directors, except (1) the Past-President members who may hold any class of membership in the Federation and (2) the representative of the NPCA, who need not be a member of the FSCT.

AND be it further RESOLVED that By-Laws Article VII, Section C, be amended by adding a new Paragraph (9):

Nominations and Elections

C. TERMS OF OFFICE

(9) The NPCA Representative on the Board of Directors shall be appointed annually by the NPCA.

II. Society Representatives— Eligibility for Associate Members

WHEREAS the FSCT Board of Directors has requested that the By-Laws Committee consider the eligibility for Associate Members to serve as Society Representatives on the Federation Board of Directors rather than the current practice of limiting these positions to Active Members, be it

RESOLVED that the first paragraph of By-Laws Article IV, Section B, be amended as follows:

B. BOARD OF DIRECTORS

The Board of Directors shall consist of the President, President-Elect, Secretary-Treasurer, four members-at-large, the immediate Past-President or most recent available Past-President, two additional Past-Presidents, and all of the Society Represent-

tatives. At least two of the three officers and all four members-at-large must be Active Members. The Society Representatives must be Active or Associate members and the three Past-President members may hold any class of membership in the Federation.

Be it further RESOLVED that the following amendments be made to be consistent with the above amendment:

BY-LAWS ARTICLE IV, Section C

The Officers of the Federation shall consist of a President, President-Elect, and Secretary-Treasurer. At least two Officers shall at all times be Active Members of the Federation. One Officer may be an Associate Member.

STANDING RULES ARTICLE SRIII, Alternate Society Representative Section A

A. APPOINTMENT

(1) The President of each Constituent Society may appoint an Active or Associate Member as the Alternate Society Representative to serve during the term of office of the said President.

(2) In case the President of the Constituent Society does not choose to appoint an Alternate Society Representative to serve during the term of office of the said President, or if this appointee ceases to be an Active or Associate Member, or for any reason is unable to serve, then the President of the Constituent Society shall appoint an Active or Associate Member to serve as Alternate Society Representative during any regular or special meeting of the Federation Board.

The Executive Vice President of the Federation shall certify that the appointee is a

duly-accredited Alternative Society Representative when these terms are met:

(1) The appointee is an Active or Associate Member of the Constituent Society which he is to represent.

Note: Standing Rules amendments requires only one reading for approval, so this would not be presented to the Board until the second reading of any proposed By-Laws change on this matter.

COMMENTS OF THE BY-LAWS COMMITTEE:

The admission of Associate Members to the Board of Directors, as proposed by the above amendments, could bring to the Board qualified individuals who currently are not eligible to serve. However, it could also create the following situations:

1. A quota limiting the number of Associate Members as Society Representatives would not be practical since each Society should have equal choice in their selection. It would be possible for all 26 Societies to elect Associate Members as their Representatives. The 36-member Board could contain as many as 30 Associate Members:

26 Society Representatives
1 Officer
3 Past-Presidents.

While it can be assumed that the above situation would not likely occur, it could be quite possible that in a few years the majority of the Board could be Associate Members.

2. While the Officers could be limited to one Associate Member of the three, if desired, the Executive Committee could have five of its seven members as Associate Members: one Officer, a Past-President and three Society Representatives.

THEREFORE, the By-Laws Committee unanimously recommends **against** adoption.

Raw Materials Suppliers—Participate Now!

The FSCT is currently accepting coatings manufacturing-related Material Safety Data Sheets for the Federation's Coatings MSDS on CD-ROM System. Endorsed by the NPCA, the System will include the NPCA Raw Material Index, as well as the MSDSs used by the coatings industry.

For more information on how to participate, contact FSCT Headquarters at 492 Norristown Rd., Blue Bell, PA 19422; (215) 940-0777. To submit MSDSs, contact Michele Wollheim at Accu-Mem, 3105 N. Wilke Rd., Suite D, Arlington Heights, IL 60004; (708) 670-7030.

FSCT Publications Order Form



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JOURNAL OF COATINGS TECHNOLOGY

Editorial Review Board

David R. Bauer

Principal Research Scientist for Ford Motor Company, Dearborn, MI. Dr. Bauer has been in the coatings industry for 16 years. He graduated from Cal Tech in 1971 with the B.S. Degree in Chemistry. In 1975, he received the Ph.D. Degree in Chemistry from Stanford University.

Dr. Bauer is a member of the American Chemical Society Division of Polymeric Materials Science and Engineering for which he has served as the Newsletter Editor, Treasurer, and Vice Chair Elect. He was named the Best Speaker at the Cleveland Society for Coatings Technology Conference in 1982. Dr. Bauer's interests focus on the physical chemistry of coatings, including cure, rheology, durability, photodegradation, and stabilization.

Juergen H. Braun

Dr. Braun is a Research Associate for DuPont Chemicals, Wilmington, DE. He has been with DuPont for 37 years and has provided service to the coatings industry for 30 years. Dr. Braun received his undergraduate degree in 1948 and the Diplom-Ingenieur in 1951 from the Technische Universitaet in Berlin, Germany. In 1956, he received the Ph.D. Degree from the University of Texas. He is affiliated with North Dakota State University as a guest lecturer. Dr. Braun was awarded the New York Society for Coatings Technology Award in 1986 and was a recipient of a Roon Foundation Award in 1989. Dr. Braun is the author of the "Introduction to Pigments" monograph for the *Federation Series on Coatings Technology*. His special interests include white and color pigment technologies, fine particle technology, pigment optics, and crystallography.

John L. Massingill, Jr.

Dr. Massingill is the Director of the Coatings Research Institute at Eastern Michigan University, in Ypsilanti, MI. He graduated with the B.S. Degree from Texas Christian University in 1963, where he also received the M.S. (1965) and Ph.D. (1968) Degrees. Prior to his new appointment, Dr. Massingill

was employed with Dow Chemical Resins for 18 years. During his tenure with Dow, he was granted 10 patents for his developments on acrylates, novel epoxies, and epoxy phosphate esters. Dr. Massingill's professional activities include: the American Chemical Society Books Department Advisory Board (1988-1992); ACS Counselor for the Industrial and Engineering Chemistry Division; Container Technical Committee Chairman (1991-1992) for the National Coil Coaters Association; and Technical Program Co-Chairman (1992) for the Second North American Conference on Coatings Science and Technology. Dr. Massingill's special interest areas are epoxy coatings, container and coil coatings, epoxy resin advancement, and epoxy resin modifications.

George R. Pilcher

A graduate of the College of Wooster in 1970, Mr. Pilcher has been in the coatings industry for 23 years, and currently is the Technical Director, Coil and Extrusion Business Unit, Akzo Coatings, Inc., Columbus, OH.

He is a member of the CDIC Society and was recognized by the Society with an award for his "outstanding contributions." A member of the FSCT Board of Directors from 1988-90, Mr. Pilcher currently serves on the Federation's Roon Foundation Awards and Mattiello Memorial Lecture Committees. Additional contributions to the FSCT include having served as Chairman of the Professional Development and Program Committees and as a member of the PDC, APJ/Voss Award, Finance, and Nominating Committees. He is the President of the Coatings Industry Education Fund and has been a member of its Board of Trustees since 1987. As a former member of the Cleveland Society, he served as a member of the Educational and Technical Committees. In addition, he is Past-Chairman of the Gordon Research Conference on Coatings and Films (1991) and Chairman of the American Chemical Society Division of Polymeric Materials Science and Engineering. The author of various journal articles and book

The JOURNAL OF COATINGS TECHNOLOGY has achieved worldwide recognition as a leading publication of the coatings industry. No group has done more to insure the contribution of that reputation than the JCT Editorial Review Board. Comprised of 22 highly qualified members, the Board operates under the general direction of Chairman Robert F. Brady. The Board is charged with the responsibility of reviewing manuscripts prior to acceptance for publication and its members assist authors by providing professional critiques.

In a three-part series, the Journal will highlight the accomplishments of this respected group. In this issue, the newest members of the Review Board are featured.

chapters, Mr. Pilcher was elected a Fellow of the American Institute of Chemists in 1988. He is listed in several current or planned volumes of *Who's Who in America*.

Clifford K. Schoff

Dr. Schoff has been with PPG Industries, Inc., Allison Park, PA, since 1974 and currently is a Scientist in the Automotive Coatings Division. A Chemistry major at the University of Idaho, Dr. Schoff received the B.S. Degree and M.S. Degree in 1962 and 1964, respectively. Upon graduation, he served the Peace Corps as a volunteer teacher and coach in Nigeria from 1964 to 1967. Dr. Schoff attended St. Andrews University in Scotland, where he received the Ph.D. Degree in Polymer Chemistry in 1971. After postdoctoral research at Glasgow University and at Princeton, he joined the Physical Chemistry Group at the Coatings and Resins Research Center of PPG Industries.

Dr. Schoff is a member of the Pittsburgh Society. He has held the offices of Treasurer, Secretary, President-Elect, and President (1984-85) of the Society, as well as the Chairman of the Technical Committee. Dr. Schoff has been active in the Federation as well. He is the 1993 Chairman of the Annual Meeting Program Committee. In addition, he serves on the Roon Foundation Awards, Mattiello Memorial Lecture, and Professional Development Committees. Dr.

Schoff authored the Federation booklet on "Rheology" and coauthored the "Coating Film Defects" monograph for the *Federation Series on Coatings Technology*. He has also published more than 30 papers and articles and has lectured extensively.



D.R. Bauer



J.H. Braun



J.L. Massingill, Jr.



G.R. Pilcher



C.K. Schoff

Regulatory UPDATE

JULY 1993

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

Environmental Protection Agency April 26, 1993—58 FR 24996 Semiannual Agenda of Regulations Action: Notice

The U.S. Environmental Protection Agency (EPA) has published in the Federal Register its Semiannual Regulatory Agenda for the upcoming year. The purpose of the agenda is to inform interested parties of the progress of EPA regulations and to encourage effective public participation in the regulatory process. To be placed on the mailing list for further agendas, please contact Bridgette Dent, Regulatory Development Branch, U.S. EPA, PM-223Y, Washington, D.C. 20460, (202) 260-5475. For general information about the agenda, contact Angela Suber, Regulatory Development Branch, (202) 260-7205.

The following items under the listed statutes are among those identified by EPA for regulatory activity between April 1993 and April 1994.

Toxic Substances Control Act (TSCA)

PRE-RULE STAGE

1. Policy Statement Implementing the Prior Informed Consent Procedures for the Export/Import of Industrial Chemicals.
2. Environmental Hazard Communication Rule.

PROPOSED RULE STAGE

1. Addition of Air Toxics to Toxic Release Inventory.
2. Emergency Planning and Community Right-to-Know Act Section 313 Expanded Reporting Requirements.
3. Responses to Petitions Received to Add to or Delete Chemicals from the List of Toxic Chemicals Under Section 313 of SARA.
4. Lead Exposure Reduction: Legislative Mandates.
5. SARA Section 110 Chemicals Generic Test Rule.
6. Regulatory Investigation Under the Toxic Substances Control Act (TSCA) to Reduce Lead Consumption and Use.
7. Regulatory Investigation of Formaldehyde.
8. Polychlorinated Biphenyls (PCBs) Disposal Amendments.
9. Amendment to the TSCA Section 8 (a) Comprehensive Assessment Information Rule (CAIR).

10. Proposed follow-up Rules on Existing Chemicals.

FINAL RULE STAGE

1. Mandatory Pollution Prevention Reporting for Toxic Release Inventory (TRI).
2. Final Follow-up Rules on Existing Chemicals.
3. Premanufacture Notification (PMN) Rule Amendments.
4. Polychlorinated Biphenyls (PCBs): Applications for Exemptions from the Ban on Manufacturing, Processing, and Distribution.
5. Procedures and Criteria for Termination of PCBs Disposal Permits.
6. Section 8 (d) Health and Safety Data Reporting Rules.
7. Export Notification Requirements; Changes to Reporting Requirements.

COMPLETED ACTIONS

1. Master Testing List.

Clean Water Act (CWA)

PRE-RULE STAGE

1. Water Quality Standards Revisions.

PROPOSED RULE STAGE

1. Effluent Guidelines and Standards for the Waste Treatment Category.
2. NPDES Application Regulations for Storm Water Discharges and Municipal Separate Storm Water Sewer Systems Affected by the Results of the 1990 Census.
3. NPDES Permit Application Standard Form A and Short Form A (Revision).
4. Denial or Restriction of Disposal Sites (Revision).
5. Clean Water Act Section 404 State Program Regulations.

FINAL RULE STAGE

1. Effluent Guidelines and Standards for the Organic Chemicals, Plastics, and Synthetic Fibers Category.
2. Amendments to the NPDES Surface Water Toxics Control Program.

COMPLETED ACTIONS

1. Water Quality Standards for Toxic Pollutants.

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.

2. Revisions to Regulations for Implementation of Section 403 of the Federal Water Pollution Control Act.

Resource Conservation and Recovery Act (RCRA)

PRE-RULE STAGE

1. Modifications to the Definition of Solid Waste and Regulations of Hazardous Waste Recycling: General.

PROPOSED RULE STAGE

1. Causes for Permit Modifications to Hazardous Waste Management Facilities.
2. Hazardous Waste Management System: Post-Closure Requirements.
3. Spent Solvents Listing Determination and Study.
4. New and Revised Testing Methods Approved for RCRA Subtitle C Hazardous Waste Testing Manual SW-846, Third Edition, Update II.
5. Chlorinated Aliphatics Listing Determination Under RCRA Subtitle C (HSWA).
6. Identification and Listing of Hazardous Wastes: Hazardous Waste Identification Rule.
7. Identification and Listing of Hazardous Waste: Wood Surface Protection Chemicals.
8. RCRA Fees: Handler Notifications and Waste Export Notifications.
9. Amendments to Biennial Reporting Requirements.
10. Corrective Action for Releases to Ground Water from Regulated Hazardous Waste Units.
11. Hazardous Waste Sump Requirements.
12. Hazardous Waste Management System: Ground Water Monitoring Constituents (Phase II) and Methods.
13. Streamline Permitting for Mixed Waste.
14. Clarify Lender Liability for Underground Storage Tanks.
15. Underground Storage Tanks Containing Hazardous Substances—Financial Responsibility Requirements.

FINAL RULE STAGE

1. Modifications of the Hazardous Waste Recycling Regulations: Universal Wastes.
2. No-Migration Variance for Prohibited Hazardous Waste Land Disposal.
3. Suspension of the Toxicity Characteristic Rule for Non-Underground Storage Tank Petroleum Contaminated Media.
4. Amendments to Ground water Monitoring Requirements at Hazardous Waste Facilities.
5. Treatment, Storage, Disposal Facility—RCRA Air Emission Standards.
6. Extension of States Interim Authorization Option to Carry Out Post-HSWA Regulations.

COMPLETED ACTIONS

1. Disposal of Containerized Liquids in Hazardous Waste Landfills.
2. Corrective Action Management Units (CAMUs) and Temporary Units; Corrective Action Provisions Under Subtitle C.

Clear Air Act (CAA)

PRE-RULE STAGE

1. Report to Congress and Regulatory Agenda for VOCs from Consumer and Commercial Products.
2. Accelerated Phaseout of Class I Chemicals.

PROPOSED RULE STAGE

1. Enhanced Monitoring Program.
2. New Source Review Nonattainment Requirements.

3. National Ambient Air Quality Standards (NAAQS): Lead.
4. NESHAP: Chromium—Electroplating.
5. NESHAP: Organic Solvent Degreasing.
6. General Provisions for Major and Area Sources of Air Toxics.
7. Protection of Stratospheric Ozone: Safe Alternatives.
8. NESHAP: Polymers and Resins, Group I.
9. NESHAP: Polymers and Resins.
10. NESHAP: Surface Coating Operations in Shipbuilding and Ship Repair.
11. Establishment of Guidance for Implementing Clean Air Act, Section 112 (j) Provisions for Making MACT Determinations when EPA Fails to Promulgate a Federal Standard.
12. Approval and Delegation of Federal Air Toxics Programs to State and Local Agencies.
13. NESHAP for Solid Waste Treatment, Storage, and Disposal Facilities.
14. Protection of Stratospheric Ozone: Listing of Class I Chemicals.
15. Regulations Governing Prior Notice of Citizen Suits Brought Under Section 304 of the Clear Air Act.
16. Individual Constituents Standards—Phase III of RCRA Air Emission Standards.

FINAL RULE STAGE

1. Protection of Stratospheric Ozone; Recycling.
2. Conformity of General Federal Actions to State Implementation Plans.
3. Designation of Areas for Air Quality Planning Purposes.
4. NESHAP: Hazardous Organic.
5. Economic Incentive Program Rules Authorized Under Title I of the CAA.
6. Control Technique Guidelines.
7. Development of a Schedule for Regulating Source Categories of Hazardous Air Pollutants Subject to Section 112 of the Clean Air Act Amendments of 1990.
8. Treatment, Storage, and Disposal Facility—RCRA Air Emission Standards.

COMPLETED ACTIONS

1. Clarification of Best Available Control Technology Regulatory Definition.
2. Approval and Promulgation of Implementation Plans; Partial Disapproval of New Jersey Implementation Plan for Ozone.
3. Compliance Extensions for Early Reduction of Hazardous Air Pollutants.
4. Statement of Policy and Procedures Regarding Petitions Under Section 112 of Title III of the Clear Air Act Amendments of 1990.
5. Protection of Stratospheric Ozone: Product Ban.
6. Protection of Stratospheric Ozone: Labeling.

Superfund (CERCLA)

PROPOSED RULE STAGE

1. Designation Under CERCLA and Reportable Quantity Adjustments of New Clean Air Act Hazardous Air Pollutants.
2. National Priorities List for Uncontrolled Hazardous Waste Sites: Proposed Rules.
3. Procedures for Reimbursement Petitions Under Section 106 (b) of CERCLA.
4. Amendments to the Extremely Hazardous Substances List Under Section 302 of the Emergency Planning and Community Right-to-Know Act.

FINAL RULE STAGE

1. List of Regulated Substances and Thresholds for Accidental Release Prevention: Requirements for Petitions Under Section 112 (r) (3) of the CAAA of 1990.
2. Reporting Exemptions for Federally Permitted Releases of Hazardous Substances.
3. Reportable Quantity Adjustments of Lead, Lead Compounds, Lead-Containing Hazardous Waste Streams, and Methyl Isocyanate.
4. Comprehensive Environmental Response Compensation and Liability Act (CERCLA) Cost Recovery.
5. Administrative Hearing Procedures for Class II Penalties Under CERCLA and Emergency Planning and Community Right-to-Know Act (EPCRA).
6. Prior Notice of Citizen Suits Under CERCLA.

COMPLETED ACTIONS

1. Designation of Extremely Hazardous Substances as CERCLA Hazardous Substances.
2. Reportable Quantity Adjustments of Extremely Hazardous Substances.
3. National Priorities List (NPL) for Uncontrolled Hazardous Waste Sites—Updates.
4. NPL for Uncontrolled Hazardous Wastes Sites—Proposed Update XII.
5. Response Claims Procedures of the Hazardous Substances Superfund.
6. Administrative Hearing Procedure for Superfund Claims.
7. Addition of Chemicals to the List of Extremely Hazardous Substances Based on Their Physical Properties.

Department of Labor

April 26, 1993—58 FR 24562

Semiannual Agenda of Regulations

Action: Notice

The Department of Labor has announced its semiannual agenda of regulations. The agenda has been selected for review or development for the upcoming year. For further information, contact the Office of the Assistant Secretary for Policy, Department of Labor, 200 Constitution Ave., N.W., Room S-2312, Washington, D.C. 20210, (202) 219-9058.

The following regulations are among those scheduled for activity by the Department of Labor's Occupational Safety and Health Administration.

Occupational Safety and Health Administration (OSHA)

PRE-RULE STAGE

1. Exposure Assessment Programs for Employees Exposed to Hazardous Chemicals.
2. Indoor Air Quality in the Workplace.
3. Comprehensive Occupational Safety and Health Programs.

PROPOSED RULE STAGE

1. Respiratory Protection.
2. Fall Protection (Part 1926).
3. Glycol Ethers: 2-Methoxyethanol, 2-Ethoxyethanol and Their Acetates.
4. Hazardous Materials (Part 1910).
5. Recording and Reporting Occupational Injuries and Illnesses.
6. Control of Hazardous Energy (Lockout/Tagout)—Construction (Part 1926).
7. Ergonomic Safety and Health Standards.

8. Retention of Markings and Placards.
9. Hazard Communication (MSDS).

FINAL RULE STAGE

1. Methods of Compliance.
2. Scaffolds (Part 1926).
3. Fall Protection Systems (Personal Protective Equipment) (Part 1910).
4. Face, Head, Eye, and Foot Protection (Personal Protective Equipment) (Part 1910).
5. Methylene Chloride.
6. Hazard Communication.
7. Walking and Working Surfaces (Part 1910).
8. Accreditation of Training Program for Hazardous Waste Operations (Part 1910).
9. Lead in Construction.
10. Reporting of Fatality or Multiple Hospitalizations.

COMPLETED ACTIONS

1. Confined Space (Part 1910).

Department of Transportation

April 26, 1993—58 FR 24618

Semiannual Regulatory Agenda

Action: Notice

The Department of Transportation (DOT) has announced its semiannual summary of current and projected rulemakings, oversight of existing regulations, and completed actions for the coming year. By publishing the agenda, it is DOT's intention to increase public awareness of its regulatory activity. For further information, contact the Office of the Assistant General Counsel for Regulation and Enforcement, DOT, 400 7th St., S.W., Washington, D.C. 20590, (202) 366-4723.

The DOT's Research and Special Programs Administration (RSPA) has identified the following items for regulatory activity within the coming year.

Research and Special Programs Administration (RSPA)

PROPOSED RULE STAGE

1. Hazardous Materials in Intrastate Commerce.
2. Improvements to Hazardous Materials Identification Systems.
3. Detection and Repair of Cracks, Corrosion, Lining Flaws, Thermal Detection Flaws, and Other Defects of Tank Car Tanks.
4. Transportation of a Hazardous Liquid at 20% or Less of Specified Minimum Yield Strength.
5. Cargo Tanks; Miscellaneous Requirements.

FINAL RULE STAGE

1. Oil and Hazardous Substances; Spill Prevention, Containment, and Response Plans.
2. Transportation of Hazardous Materials; Miscellaneous Amendments.
3. Leakage Surveys.
4. Passage of Internal Inspection Devices.
5. Intermediate Bulk Containers for Hazardous Materials.
6. Tank Cars and Cargo Tank Motor Vehicles: Attendance Requirements.

COMPLETED ACTIONS

1. Training for Hazardous Materials Transportation.
2. Marine Pollutants.
3. Electronic Filing of Property and Passenger Tariffs.
4. Incorporation by Reference of Voluntary Standards.

Department of Housing and Urban Development
April 26, 1993—58 FR 24382
Semiannual Agenda of Regulations
Action: Notice

The Department of Housing and Urban Development (HUD) has published its semiannual regulatory agenda. The agenda consists of proposed regulations already issued or expected to be issued and of currently effective rules that are under review. For further information, contact the Office of the Assistant General Counsel for Regulations, HUD, Room 10276, 451 Seventh St., S.W., Washington, D.C. 20410, (202) 708-3055.

The following regulations are among those scheduled for activity by the Office of the Secretary during the coming year.

PROPOSED RULE STAGE

1. Lead-Based Paint Poisoning Prevention in Certain Residential Structures.
2. Regulations Implementing New Lead-Based Paint Disclosure and Warning Requirements for Sale and Rental of Housing.
3. Regulations Implementing New Lead-Based Paint Program Requirements Under the Housing and Community Development Act of 1992.

FINAL RULE STAGE

1. Lead-Based Paint Poisoning Prevention Act—Stewart B. McKinney Homeless Assistance Amendments of 1988—Section 1088.

Short-Term Environmental Legislative Forecast—

While several hearings on environmental statutes have been scheduled, sources on Capitol Hill have indicated that only the Clean Water Act (CWA) and the Safe Drinking Water Act (SDWA) are likely to see significant action over the next year.

Scheduled for reauthorization, in addition to the CWA and the SDWA, are the Comprehensive Environmental Re-

sponse, Compensation, and Liability Act (CERCLA-Superfund), the Resource Conservation and Recovery Act (RCRA), and the Endangered Species Act. The two "water bills" are considered the least controversial of the five, and therefore easier to pass.

Throughout the month of June, hearings have been scheduled for four out of the five environmental statutes. The Senate Environment and Public Works Committee will consider legislation to reauthorize the Clean Water Act, where the state revolving loan fund appears to be in jeopardy; the Senate Subcommittee on Superfund, Recycling, and Solid Waste will hold a hearing on legislation to encourage states to develop voluntary toxic waste site cleanups; the House Energy and Commerce Subcommittee on Transportation will hold a hearing on Superfund remedy selection; the House Subcommittee on Health and Environment will hear testimony on the Safe Drinking Water Act lead rule; and the Merchant Marine and Fisheries Subcommittee on the Environment and Natural Resources will hold a hearing on provisions for habitat conservation plans under the Endangered Species Act.

No hearings have been scheduled on the reauthorization of RCRA.

Transportation—On May 25, the Senate Commerce Committee approved legislation addressing back-billing claims against shippers. The Undercharge Equity Act of 1993 (S. 412), sponsored by Sen. James Exon (D-NE), would block trucking firms and collection agents from holding shippers liable for rates on file at the ICC as opposed to the discounted rates negotiated with carriers. The liability covers claims made prior to September 30, 1990.

S. 412 establishes a settlement procedure where shippers would pay significantly less than they owe under current law.

Rep. Norman Mineta (D-CA) has introduced similar legislation in the House. The House Surface Transportation Subcommittee is scheduled to hold hearings on the bill (H.R. 2121) in June.

States Proposed Legislation and Regulations

California

Spray Paint—CA A. 839 (Baca) authorizes the furnishing of aerosol containers of paint or related substances for use in school-related activities that are part of the instructional program when used under controlled and supervised situations within the classroom or on the site of a supervised project, as specified. The bill passed the Assembly on June 1 and was referred to the Senate Committee on Judiciary.

Environmental Marketing—CA A. 1112 (Sher) revises the definition of "recyclable" as it relates to advertising; defines "recyclable" as capable of being recycled and meeting the following conditions: the article is collected, separated, or otherwise recovered from the solid waste stream for use in the form of raw materials in the manufacture of a product or package in more than 65% of the curbside collection programs operating in the state; or the article is accepted for recycling wherever it is sold. The bill passed the Assembly on June 9 and was sent to the Senate.

Graffiti—CA A. 2240 (McDonald) creates the state Graffiti Clearinghouse in the Office of Planning and Research and would vest specified responsibilities in the clearinghouse relating to graffiti abatement. The bill passed the

Assembly June 1 and was referred to the Senate Committee on Governmental Organization.

Containers—CA S. 466 (Boatwright) revises the findings and declarations concerning rigid plastic packaging containers; defines the terms "beverage container" and "curbside collection program" for purposes of those provisions. The bill passed the Senate on May 27 and was referred to the Assembly Committee on Natural Resources.

Lead—CA S. 617 (Hayden) states legislative intent that the state comply with the training and certification requirements contained in the Federal Residential Lead-Based Reduction Act of 1992. Prohibits a contractor, on or after July 1, 1994, from removing lead from residential real property unless the contractor has passed an approved lead removal certification examination. The bill passed the Senate on June 8 and was sent to the Assembly.

Paint Recycling—CA S. 734 (Rosenthal) requires all state agencies to purchase re-refined recycled solvents and recycled paints as defined by this bill. The purchase of the listed materials is required only when they are available, of a fitness and quality equal to their nonrecycled counterparts, and are not more costly than 5% of the lowest price quoted

by suppliers. The bill passed the Senate on May 27 and was sent to the Assembly.

Colorado

Air Quality—CO H. 1340 (Schauer) revises the state air program to comply with requirements of the Federal Clean Air Act Amendments of 1990. The bill was signed by the Governor on June 8.

Occupational Safety and Health—CO H. 1354 (Foster) concerns premium adjustments for implementation of workplace safety programs required by workers' compensation insurance policies. The bill was signed by the Governor on June 9.

Connecticut

Air Quality—CT H. 6843 (Committee on Environment) concerns fees to implement the Clean Air Act Amendments of 1990. The bill passed the House on May 27 and passed the Senate on June 3.

Illinois

Household Hazardous Waste—IL H. 1896 (Giglio) amends Household Hazardous Waste Collection Program Act; changes the definition of household hazardous waste to include hazardous waste as listed by the U.S. EPA or waste that exhibits certain properties. Includes waste oil, petroleum distillate-based solvents, oil-based liquid paint, paint strippers, paint thinners, herbicides and pesticides, except antimicrobial and disinfectant products, in the definition. The bill passed the House in April and the Senate on May 13.

Louisiana

Occupational Safety and Health—LA H. 846 (Anding and Murray) relates to safety and health of employees; grants to current or former employees and their representatives a right of access to records or analyses of employees' exposure to toxic substances or harmful physical agents; provides for attorney fees and exemplary damages. The bill was sent to the Governor on June 9.

Environmental Crimes—LA H. 1150 (Sam Theriot) relates to environmental crimes; provides for violating fee or filing requirement; deletes notification requirements. The bill was signed by the Governor on May 26.

Lead—LA H. 1978 (Carter) relates to lead abatement; creates the Louisiana Abatement Commission within the Department of Health and Hospitals; provides for its membership and sets forth its duties and responsibilities; provides with respect to certification, training, and licensing of persons engaged in environmental lead reduction; provides penalties for violations of rules or statutes relevant to environmental lead. The bill was reported from the House Committee on Health and Welfare on May 25, and was amended on the House floor on May 26.

LA S. 427 (Cravins) relates to environmental health; provides for lead abatement; provides for lead hazard reduction; provides for technician licensure and certification; provides for the promulgation of rules and regulations no less stringent than the federal law; provides for funding. The bill was sent to the Governor on June 1.

Maine

Toxics-in-Packaging—ME H. 756 (Marsh) revises the toxics reduction in packaging laws to require that manufac-

turers furnish certificates of compliance to purchasers instead of to the agency; establishes a six-year exemption for packaging that cannot meet the statutory concentration levels because of the addition of post-consumer materials; amends the Voluntary Waste Reduction and Recycling Labeling Program to include the terms "compostable" and "biodegradable." The bill was signed by the Governor on June 11.

Massachusetts

Automotive Paint—MA H. 2082 (Angelo) prohibits the sale of automotive paint to any person not registered pursuant to chapter 100A. The bill was withdrawn from the Joint Committee on Public Safety on May 19 and is currently in the Joint Committee on Natural Resources and Agriculture.

MA H. 2349 (Valianti and Durand) regulates the sale of automotive paint products. The bill was released from the Joint Committee on Commerce and Labor on May 24.

MA S. 43 (Durand) relates to the illegal use of certain automotive paint and paint by-products. The bill was released from the Joint Committee on Commerce and Labor on May 24.

Hazardous Products—MA H. 2543 (Cahir) establishes a Retail Hazardous Products Identification Program. The bill was released from the Joint Committee on Commerce and Labor on May 24.

MA H. 2755 (Hodgkins) regulates the sale of certain hazardous products in retail establishments. The bill was released from the Joint Committee on Commerce and Labor on May 24.

Toxics-in-Packaging—MA H. 3403 (Angelo) prohibits a package or a packaging component to be offered for sale or for promotional purposes by its manufacturer or distributor in the Commonwealth that includes in the package itself or in any packaging component inks, dyes, pigments, adhesives, stabilizers, or any other additives, or any lead, cadmium, mercury, or hexavalent chromium which has been intentionally introduced as an element during manufacturing or distribution as opposed to the incidental presence of any of these elements. The bill was released from the Joint Committee on Natural Resources and Agriculture on May 18 and is in the House Committee on Ways and Means.

Lead—MA S. 38 (Local Sponsor) relates to further regulating the removal of lead paint. The bill was released from the Joint Committee on Commerce and Labor on May 24.

Michigan

Environmental Marketing—MI S. 25 (Ehlers) provides for the use of the terms recyclable, recycled, and degradable. The bill passed the Senate on June 3 and was referred to the House Committee on Conservation, Environment and Great Lakes Affairs.

MI S. 187 (Bouchard) requires labeling for degradable, biodegradable, or photodegradable bags or containers to meet standards for decomposition. The bill passed the Senate on June 3 and was referred to the House Committee on Conservation, Environment and Great Lakes Affairs.

Air Quality (Regulation)—The Michigan Air Pollution Control Commission has proposed rules that would update definitions applying to air pollution and emissions, such as "secondary emissions," "actual emissions," "air-cleaning device," "major nonattainment air contaminant," "particulate matter," and "coatings"; includes regulations for the construction of major offset sources and major offset modifications proposed for locations within nonattainment areas,

and air use approval and permitting. For further information, contact the Air Pollution Control Commission, Department of Natural Resources, (517) 373-7069.

Missouri

Toxics-in-Packaging—MO S. 100 (Goode) prohibits the selling of packages, packing material, or components containing specified concentrations of lead, cadmium, mercury, or hexavalent chromium. The bill was sent to the Governor on May 28.

MO S. 232 (Banks and Wiggins) requires the Department of Health to develop a program to train and license lead abatement contractors and others in order to prevent and control lead poisoning from the presence of lead in dwellings. The bill was sent to the Governor on May 28.

Nevada

Aerosol Lockup—NV A. 605 (Augustine) relates to the defacement of property; requires a business to keep aerosol containers of paint in a locked cabinet or display case in larger cities; makes it unlawful for a person to furnish a minor with an aerosol container of paint in larger cities; makes it unlawful for a minor to purchase an aerosol container of paint in larger cities; makes it unlawful to place graffiti on or otherwise deface the property of another; details other requirements. The bill was introduced in May and was referred to the Assembly Committee on Commerce. An identical bill (A. 615—Toomin) was introduced at the same time and also referred to the Commerce Committee.

Air Quality (Regulation)—The Nevada Environmental Commission has proposed rules relating to New Source Performance Standards and National Emission Standards. The proposal adds standards for small industrial-commercial-institutional steam generating units, municipal waste combustor, VOC emission from polymer manufacturing, VOC emissions from synthetic organic chemical manufacturing, and standards for benzene emissions from transfer and waste operations. For further information, contact the Environmental Commission at (702) 687-4670.

New Hampshire

Lead—NH S. 231 (Shaheen) relates to lead poisoning and control and continually appropriates a fund to the Director of Public Health Services. The bill was sent to the Governor on May 25.

New York

Lead—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 was introduced in May and referred to the Assembly Committee on Health. An identical bill (S. 5159—Volker) was introduced in the Senate and referred to the Senate Committee on Health.

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

introduced on June 3 and referred to the Assembly Committee on Environmental Conservation.

Packaging—NY A. 2573 (Brodsky) enacts the Environmentally Sound Packaging Act; requires packaging to be reusable or recyclable; provides exceptions and makes related provisions. The bill was released from the Assembly Committee on Environmental Conservation on June 2 and was referred to the Committee on Ways and Means.

Hazardous Products—NY S. 5267 (Leichter) requires retailers to provide consumers with information on hazards and environmentally safe alternatives to household hazardous products at the point of retail sale, by labels and pamphlets; requires the Department of Environmental Conservation to establish a hazardous products list. The bill was introduced on May 5 and referred to the Senate Committee on Environmental Conservation.

Cadmium (Artists' Colors)—NY S. 5834 (Seward) allows manufacturers of artists' supplies to use a small amount of cadmium on a label so as to display the color of the materials within the package. The bill was introduced on June 3 and referred to the Senate Committee on Rules.

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 rent housing because it will be occupied by a young child or pregnant woman. The bill was introduced on May 27 and referred to the Senate Committee on Health and Human Services.

Pennsylvania

Toxics-in-Packaging—PA H. 337 (Vitali) regulates toxic materials used in packaging and components thereof; provides for additional duties of the Department of Environmental Resources for certain procedures, for remedies and for enforcement and for civil and criminal penalties; prohibits packaging that includes inks, dyes, pigments, adhesives, stabilizers, or any other additives containing lead, cadmium, mercury, or hexavalent chromium which has been intentionally introduced as an element during manufacturing. The bill was released with amendment from the House Committee on Appropriations on June 7.

Rhode Island

Graffiti—RI H. 7413 (Simonian) provides for a fine and/or community service for any minor who has in his or her possession or under his or her control aerosol spray paint containers. The bill was introduced in May and referred to the Joint Committee on Environment and Energy.

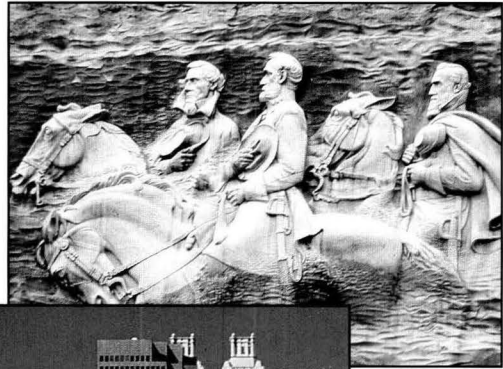
Virginia

Hazardous Waste (Regulation)—The Virginia Waste Management Board has proposed regulations that would incorporate changes in the hazardous waste management rules as they apply to wood preservers. For further information, contact William Gilley, Regulation Consultant, Waste Management Board at (804) 225-2966.

Federation of Societies for Coatings Technology

1993 Annual Meeting & Paint Industries' Show

Hotel Information/Reservation Application
◆ Advance Registration Form ◆



*"Today's
Competitive
Coatings:
Lean,
Mean and
Green"*



Georgia World Congress Center
Wednesday, Thursday, Friday ◆ October 27-28-29, 1993
Atlanta, Georgia

From the President:

The combined Annual Meeting and Paint Industries' Show, to be held at the Georgia World Congress Center, is a major educational activity of the Federation of Societies for Coatings Technology. This international coatings manufacturing industry event consists of three days of technical program sessions and exhibits, running concurrently. Registration is required for admission.

The whole world is coming to Atlanta! We expect that representatives from 60 countries will be in attendance at the Federation's 71st Annual Meeting & 58th Paint Industries' Show. It is recognized internationally as the coatings industry's premier showcase for both Raw Material and Equipment Suppliers and the end users. In addition, the technical sessions are unrivaled in quality and variety. And if that isn't enough, Atlanta's mild climate, ambiance and southern hospitality will delight you—not to mention its wonderful array of restaurants and stores.

Together, the combination is unbeatable! Take a few minutes to review this outstanding program and make your reservations early.

Looking forward to seeing y'all in Atlanta!



Colin D. Penny
Colin D. Penny
President, FSCT

"Today's Competitive Coatings: Lean, Mean and Green"

The basis for this year's Annual Meeting Technical Program theme is the understanding that success in the coatings industry both now and in the future belongs to those who take the lead in blending long-term profitability, coatings performance and environmental protection.

The theme recognizes these goals in the terms:

- LEAN, as in cost effective, process efficient, and waste free
- MEAN, by being consistent; tough; durable; and resistant; and
- GREEN, through being environmentally friendly; renewable; recyclable; and safe.

The following program session themes are being developed:

- ◆ Advanced Topics in Coatings Research
- ◆ Environmental Affairs
- ◆ Latex Technology
- ◆ Lean, Mean, Green and CLEAN — Innovative Equipment Cleaning Techniques
- ◆ Environmentally Compatible Corrosion Inhibitive Coatings
- ◆ Radiation Curing

- ◆ Characterization of Physical Properties of Coatings
- ◆ Roon Award Competition Papers
- ◆ International Papers
- ◆ API/Voss Award (Society) Competition Papers

Papers presented at the event will cover the previously mentioned topics and also include the following:

- ◆ Powder Coatings
- ◆ Adhesion
- ◆ Organic Pigments
- ◆ UV-Curable Coatings
- ◆ Low VOC Coatings
- ◆ Formulating
- ◆ High-Solids Coatings
- ◆ Additives

The Keynote Address will be delivered on Wednesday morning to kick off the event. Highlighting the technical program will be the Mattiello Memorial Lecture, scheduled for Friday morning.

A Poster Session, featuring non-commercial work covering new ideas and techniques in coatings research, will be held all day Thursday.

World's Premier Paint Show to Feature Products of Over 267 Companies

The largest coatings-related exhibition in the world—the FSCT Paint Industries' Show—will be held in conjunction with the Annual Meeting at the Georgia World Congress Center. Over 267 supplier companies to the coatings manufacturing industry will be present to discuss their newest products and services. In over 90,000 sq. ft. of exhibits will be displayed a wide variety of raw materials, production equipment, containers and filling equipment, laboratory apparatus, and testing devices for the paint and coatings producer.

Key personnel from the top technical and sales staff of supplier companies will be on-hand to provide attendees with an opportunity to learn of the latest developments in their products and services.

Exhibit hours will be:

Wednesday, October 27 12:00 Noon-5:00 p.m.
Thursday, October 28 9:00 a.m.-5:00 p.m.
Friday, October 29 9:00 a.m.-12:00 Noon

Hotel Reservation Instructions

Whether you wish the value of a moderately priced hotel or the luxury of an upscale property, the choice is yours. The FSCT has arranged for convention rates at eight official Paint Show hotels. To obtain these rates, requests for accommodations must be placed through the FSCT Housing Bureau of the Atlanta Convention and Visitors Bureau, using the FSCT Housing Form. The reservation cut-off date is **September 24**.

Send your form to the FSCT Housing Bureau for processing. Be sure to include a phone number and keep a copy of the form for your records. Phone calls and faxes will not be accepted. The Housing Bureau will mail an acknowledgment of the reservation and the hotel assigned will then forward a confirmation. Allow two weeks for receipt of acknowledgment.

All hotels require a room deposit or credit card guarantee. If a credit card number has been given, a deposit is not required. Otherwise, please send the deposit amount indicated on the hotel confirmation **directly** to the hotel within two weeks of receipt of confirmation.

International attendees only may fax their request on the official housing form to (404) 521-6392.

All changes/cancellations must be placed in writing to the Housing Bureau. After September 24, changes and cancellations must be made directly with the hotel.

Participating Hotels

Atlanta Marriott Marquis (FSCT Headquarters)

The Marriott Marquis, located in the city's Peachtree Center, features a 50-story interior atrium and glass-enclosed bubble elevators as well as an abundance of greenery and artwork. The guest rooms offer climate control, AM/FM radios, color TVs with in-room movies and sports, in-room video check-out, and a separate desk area. Concierge level guest rooms are also available. The hotel operates ten restaurants and lounges, an indoor/outdoor pool, a health club, a sauna and a shopping level.

(404) 521-0000

(Requests for rooms limited to 10 per company.)

Hyatt Regency Atlanta

This 23-story atrium hotel includes luxury guest rooms and suites, a landscaped outdoor pool, a whirlpool, and a fully equipped health and fitness center. The Hyatt is located in Peachtree Center, just across the street from the FSCT headquarters hotel. Available are three restaurants, including Polaris,

a 327-foot high revolving rooftop restaurant accessible by a glass elevator.

(404) 577-1234

Westin Peachtree Plaza

The Westin Peachtree Plaza is America's tallest hotel, boasting 73 stories, three restaurants, four lounges, an indoor/outdoor pool, 24-hour room service and a fully-equipped health club.

(404) 659-1400

Atlanta Hilton and Towers

Eight restaurants and lounges, including the four-star "Nikolai's Roof," are housed by this hotel, which also provides a fully equipped health club, tennis courts, and jogging trail. (NPCA headquarters)

(404) 659-2000

The Omni Hotel at CNN Center

The Omni is located in downtown Atlanta, adjacent to the Omni Coliseum, the Georgia World Congress Center and the Georgia Dome. The rooms and suites feature in-room movies, complimentary HBO, hair dryers, irons and ironing boards. Eighteen-hour room service is available, Bugatti for fine Northern Italian dining, and The Cafe for traditional American fare. The Take Two Lobby Lounge offers entertainment. Health Club facilities are also available.

(404) 659-0000

(Requests for rooms limited to 10 per company.)

The Radisson Hotel Atlanta

Guest services at this hotel include dry cleaning and laundry services, a hair salon, and gift shop. The garden setting pool, surrounded by trees, flowers, and a fountain, is covered by a sun roof. A restaurant, lounge, and fitness club are also available in the hotel.

(404) 659-6500

Ritz-Carlton Atlanta

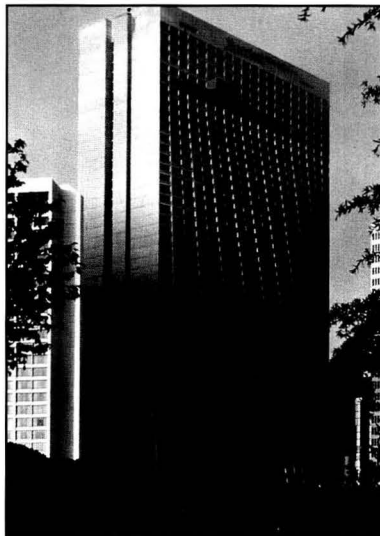
The only four-star, four-diamond downtown property features a small, intimate club-like atmosphere. Award-winning cuisine is served in four restaurants and lounges. A health club facility is available.

(404) 659-0400

The Comfort Inn

The convenient location of the Comfort Inn places guests two blocks from the Georgia World Congress Center, Peachtree Center, the CNN Center, and the MARTA Rapid Transit System. The hotel offers spacious guest rooms and suites, a restaurant and lounge, and a courtyard/pool reception area.

(404) 524-5555



The Marriott Marquis—FSCT Headquarters Hotel

Hotel Room and Suite Rates

Property	Single	Double	1 BR Suite	2 BR Suite
Marriott Marquis*	\$131	\$146	\$450-900	\$550-1050
Concierge Level	\$175	\$175		
Hyatt Regency	\$128	\$143	\$325-800	\$400-875
Westin Peachtree	\$120	\$135	\$350-1150	\$500-1350
Atlanta Hilton & Towers	\$122	\$135		
Omni Hotel at CNN Center*	\$139	\$154	\$650-800	\$800-950
Radisson Hotel	\$ 99	\$115	\$260-480	\$365-585
Ritz-Carlton	\$140	\$155	\$385-985	\$580-1165
Comfort Inn	\$ 89	\$ 99		

*A limit of 10 rooms per company will be placed at the Marriott and also at the Omni Hotel. A parlor counts as one room.

Shuttle Service

Shuttle Bus service will be provided between the cooperating hotels and the Georgia World Congress Center.

Route 1

Marriott Marquis Courtland Street Entrance
 Atlanta Hilton Courtland Street @ Marquis
 Comfort Inn International Blvd.

Route 2

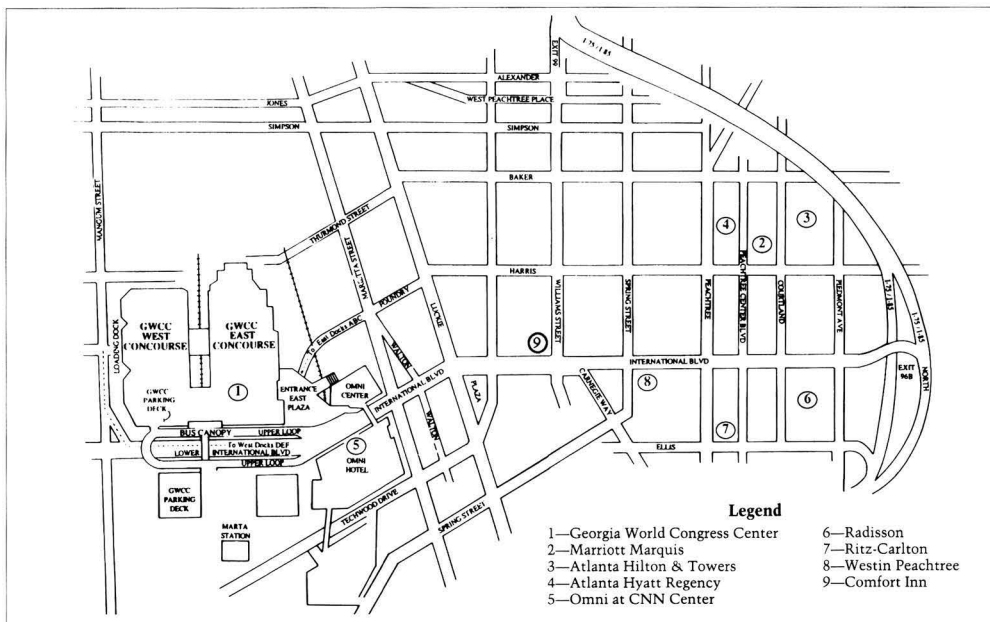
Westin Peachtree Spring Street - Motor Lobby Entrance
 Hyatt Regency Harris Street - Clock of Five Entrance

Route 3

Ritz-Carlton Ellis Street
 Radisson International Blvd. - Ballroom Entrance

Hours of Operation

Tuesday, October 26—
 8:00 a.m. - 6:00 p.m.
 Wednesday, October 27—
 7:30 a.m. - 6:00 p.m.
 Thursday, October 28—
 7:30 a.m. - 6:00 p.m.
 Friday, October 29—
 7:30 a.m. - 3:00 p.m.



Registration Information

The Advance Registration fees include three days of admission to the Paint Industries' Show and the Opening Session, and all concurrent program sessions of the Annual Meeting. To register, simply complete the Advance Registration Form and forward it with payment to FSCT. The Advance Registration prices will be available until **October 1**. The form with accompanying payment must be received at FSCT by October 1. Registration options are listed below:

Full Time	Advance	On-Site
Member	\$ 75	\$ 90
Non-member	\$100	\$125
Guest	\$ 60	\$ 70

Method of Payment

Acceptable types of payments include checks in U.S. funds made payable to FSCT, as well as credit cards: VISA, MasterCard, and American Express. Payment is due with registration form. Forms received without payment will not be processed. Please note: **if payment is made with a credit card, the form may be faxed to FSCT Headquarters Office. If faxing, please do not mail original form.**

The Registration Services Area will be located at the Georgia World Congress Center and will be open over the following days and times for you to pick up your badge and registration materials.

Day	Time
Tues., Oct. 26	8:00 a.m. - 5:00 p.m.
Wed.-Thurs., Oct. 27-28	7:30 a.m. - 5:00 p.m.
Fri., Oct. 29	7:30 a.m. - 12 Noon

On-site registration will also be available during the times noted above.

Cancellation and Refund Policy

All cancellations must be submitted in writing to the FSCT Headquarters Office. Cancellations received by October 15 will be subject to a \$10 handling charge. A \$25 charge will apply after that date. All cash refunds will be processed after November 1. Credit card cancellations received after October 1 will not be processed until after November 1.

Airport and City Transportation*

From Hartsfield Atlanta International Airport:

Airport Shuttle (service to downtown hotels, provided by Atlanta Airport Shuttle) is \$8.00 one way, \$14.00 round trip. The trip takes approximately 30 minutes.

Taxi Service from the airport to downtown hotels is \$15.00 for one person, \$8.00 per person with two passengers, and \$6.00 per person with three passengers in the taxi.

Public Transportation from the airport to the downtown area nearby the official hotels is available via MARTA (rapid transit). The fee is \$1.00 and the ride takes approximately 35 minutes.

* Prices are subject to change.

Airline Information

Convention discounts of up to 10% on domestic flights are available from Delta and Continental Air Lines.* Continental is also offering convention discounts on international flights. To make your transportation arrangements to the Paint Show, you may use the Federation's Official Travel Agency or contact the airlines directly.

FSCT Travel Desk 1-800-448-FSCT
Delta 1-800-241-6760 (ref. file # **U0235**)
Continental 1-800-468-7022 (ref. file # **ZJA35**)

*For each airline, certain restrictions apply.

Guest Program

Guest Activities begin on Wednesday, October 27, with a Welcome Social at the Marriott Marquis.

On Thursday, following a continental breakfast in the Marriott Marquis, registered guests will depart on deluxe motorcoaches for a visit to Stone Mountain Park which features the world's largest mass of exposed granite. There, guests will stop at Memorial Hall for a view of the Confederate Memorial—a carving in the granite of Robert E. Lee, Stonewall Jackson, and Jefferson Davis. The carving, even bigger than Mount Rushmore's, is the largest work of sculptured art in existence. Guests also will have the opportunity to tour the park's authentic antebellum plantation featuring 20 structures dating between 1780 and 1880.

From Stone Mountain, guests will board the motorcoaches for the Georgia Freight Depot, a historical building in Atlanta featured in scenes from the movie "Gone with the Wind." There, a delicious lunch will be served.

After lunch, guests will visit Underground Atlanta, a unique underground shopping district boasting retail shops and restaurants.

Making Your Arrangements

(1) To place airline reservations, call the FSCT Travel Desk at **1-800-448-FSCT** or (215) 628-2549 and mention **Paint Show '93**. To contact the carriers directly, call the following numbers and reference the file numbers provided:

Delta 1-800-241-6760 (ref. file # U0235)
Continental 1-800-468-7022 (ref. file # ZJA35)

(2) To make hotel reservations, mail your Hotel Reservations Form to the FSCT Housing Bureau. The cut-off date for reservations is **September 24**.

(3) Register in advance for the Annual Meeting and Paint Industries' Show by filling out the Registration Form and forwarding it to FSCT with payment. The deadline for Advance Registration is **October 1**.

(4) To register a spouse or guest, fill out the Guest portion of the Registration Form and provide the proper payment.

(5) Dates to keep in mind:

October 25-27—NPCA Annual Meeting, Hilton Hotel and Towers, Atlanta.

October 26—FSCT Board of Directors Meeting, 9:00 a.m., Marriott Marquis Hotel.

October 27-29—FSCT Annual Meeting & Paint Industries' Show, Georgia World Congress Center.

1993 Advance Registration

FEDERATION OF SOCIETIES FOR COATINGS TECHNOLOGY
ANNUAL MEETING & PAINT INDUSTRIES' SHOW
ATLANTA, GA • OCTOBER 27-29, 1993

C	Office Use Only
U	Auth. Code _____ Date Received _____ Amount \$ _____ Check No. _____
V	

BADGE INFORMATION: This is how your badge will read. Please print clearly!

NICKNAME

FIRST NAME LAST NAME

COMPANY

STREET (or P.O. Box)

CITY

STATE/PROV.

COUNTRY (OTHER THAN U.S.)

POSTAL CODE

TELEPHONE NO.

FAX NO.

Please name the Federation Society in which you are a paid-up member:

Registration Fees:

- A FSCT Member \$75.00
 B Non-Member \$100.00
 D Guest \$60.00
 G Special Fee for Retired Members \$25.00
 H Special Fee for Spouse of Retired Members \$25.00

GUEST BADGE INFORMATION:

NICKNAME

FIRST NAME LAST NAME

CITY

STATE/PROV.

POSTAL CODE

Luncheon Tickets:

- NUMBER REQUIRED: _____
\$25.00 EACH.

Method of Payment:

Payment is due with registration form.

Total Amount Due \$ _____

Please Check One:

- Enclosed is Check # _____ payable in U.S. Funds to FSCT

- Charge to the following card:

___MC ___VISA ___AMEX

Card No. _____

Expiration Date: ___ Mo. ___ Yr.

Signature (Credit card registrations only)

Please print cardholder's name

BUSINESS CLASSIFICATION DATA FOR INDUSTRY REGISTRANT:

YOUR COMPANY (CHECK ONE ONLY)

- AA Manufacturers of Paints, Varnishes, Lacquers, Printing Inks, Sealants, Adhesives
 BB Manufacturers of Raw Materials
 CC Manufacturers of Equipment and Containers
 DD Sales Agents for Raw Materials and Equipment

YOUR POSITION (CHECK ONE ONLY)

- EE Government Agency
 FF Research/Testing/Consulting
 GG Educational Institution/Library
 HH Paint Consumer
 YY Environmental Services
 JJ Other
 KK Management/Adm.
 LL Mfg. & Engineering
 MM Quality Control
 NN Research & Development
 PP Technical Sales Service
 QQ Sales & Marketing
 RR Consultant
 SS Educator/Student/Librarian
 TT Other

DEADLINE DATE FOR ADVANCE REGISTRATION IS **OCTOBER 1**. NONE WILL BE ACCEPTED AFTER THAT DATE. If paying by check, please fill out form and mail with a check in the correct amount (made payable to the FSCT) to the Federation address shown below. All checks must be payable in U.S. Funds. Any that are not will be returned. We are pleased to accept faxes on credit card charges only. A \$10.00 charge will be made for cancellations received prior to October 15. A \$25.00 charge will be made for cancellations received after that date.

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1993 PAINT INDUSTRIES' SHOW

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SC Johnson Polymer
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Sun Chemical Corp.
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U.S. Sack Corp.
U.S. Silica Co.
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United States Testing Co.

Van Waters & Rogers Inc.
R.T. Vanderbilt Co., Inc.
Versa-Matic Pump Co.
Vorti-Siv Div., of M&M Ind., Inc.

Wacker Silicones Corp.
Warren Rupp, Inc., a Unit of Idex
Wilden Pump & Engineering Co.
Witco Corp.

X-Rite, Inc.
ZENECA Biocides, Zeneca Inc.
ZENECA Resins

CPC Challenges Architectural Coatings "Fees"; NPCA Reports on Latest Reg-Neg Efforts

The National Paint and Coatings Association (NPCA) along with the California Paint Council (CPC), in addition to two paint manufacturing companies, challenged the legality of "fees" assessed on California manufacturers and distributors of architectural coatings to pay for that state's lead screening program by filing a lawsuit in a California Superior Court on Thursday, April 29.

The paint industry contends that the fees authorized by amendments to California's Childhood Lead Poisoning Act of 1991 are invalid because they are actually taxes passed in violation of the state's constitution and Proposition 13. (According to Proposition 13, tax measures require two-thirds approval by both the Assembly and the Senate of the California legislature. Amendments to the Childhood Lead Poisoning Prevention Act were approved by simple majority.)

The industry also contended that the regulations adopted by the California Department of Health Services (DHS) failed to follow the law's direction to impose "fees" upon all those engaged "... in the stream of commerce of lead or products containing lead." Instead, under emergency regulations adopted by DHA, the state chose to collect almost 100% of the fees from the paint and petroleum industries only. A fraction of the fees were to be collected from California facilities reporting releases of lead into ambient air under Title III of the Superfund Amendments and Reauthorization Act.

The paint and coatings industry is encouraging representatives to file claims for refunds of the fees with the California State Board of Equalization (BOE), alleging that the fees were illegally assessed. Once the claim for refund is denied, or six months have passed with no response from BOE, the company filing the claim can file an appeal in a Sacramento County court. The CPC is in the process of preparing a model "claim for refund" form to be used by industry members.

Wood Furniture Reg-Neg

Representatives from NPCA and other groups met on March 25-26 to examine and refine the scope of a possible regulatory negotiation (reg-neg) for the wood furniture manufacturing industries.

If chartered, the reg-neg will address the development of either a control technique guideline (CTG) or a National Emission

Standard for Hazardous Air Pollutants (NESHAP), or both, for the wood furniture manufacturing industries and their coatings operations. The Environmental Protection Agency is currently required to publish a CTG for this industry by November 1993, and a NESHAP by November 1994.

New Groups Formed at AIM Meeting

Two new work groups were formed at the architectural and industrial maintenance (AIM) coatings reg-neg meeting on April 22-23, in Arlington, VA, in the latest effort

to draft a consensus national regulatory program to limit volatile organic compound emissions for AIM coatings.

The new work groups—one to address regulatory structures and the other to focus on data collection and categories—will consist of representatives of NPCA and other parties involved in the AIM reg-neg, including the Paint Industry Caucus and the Environmental/State Caucus.

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

"Women in Coatings" Accepting Nominations for 1993 Award Presentations

Women in Coatings (WIC) is accepting names of women who have made a significant contribution in support of paint and coatings and/or related industries, for their 1993 WIC Awards. The presentation will take place during the Federation of Societies for Coatings Technology's Annual Meeting on October 27-29, 1993, in Atlanta, GA.

Contributions can include the publication of technical or non-technical papers, presentations of information, or any significant accomplishment which benefits the industry in general.

The award categories are as follows:

COMMUNICATIONS—Overall contributions such as product information, promotions, advertising, and general public relations.

MANAGEMENT—Overall management of products, projects, customer accounts, department, or staff.

LEADERSHIP—Ability to lead within the industry as in actively participating in professional and trade associations.

RESEARCH AND TECHNOLOGY—Overall contribution by way of research and development such as product innovation and processes.

SALES AND MARKETING—Overall contribution by way of sales and marketing as evidenced by increased recognition by customers and business associates within the industry, significant increase

in sales and development of a certain market segment.

PURCHASING—Overall contribution resulting in cost saving of purchased materials, improvement of product quality by purchasing from quality conscious suppliers, and JIT inventory.

INDUSTRY SUPPORT—Other branches within the companies that are not included in the preceding categories. Examples of such groups are the laboratory technicians, secretarial and clerical help, customer service and order desk, shipping and receiving, and computer operators.

The WIC Awards are designed to bring recognition to those who have contributed to the advancement of paint and coatings and provide incentive to those women striving for excellence in their fields.

The group attempts to unite women in the paint and coatings and related industries in a forum where support can be derived and common experiences can be shared in overall pursuit of creating a stronger and more versatile industry.

All nominations for the 1993 WIC Awards are due no later than September 17. Send the nominee's name, award category, and accomplishment(s) and appropriate date(s), to Eve De La Vega-Irvine, c/o J.M. Huber Corp., Clay Div., One Huber Rd., Macon, GA 31298.

Valspar's McWhorter Resin Subsidiary to Acquire Resin Products Division of Cargill, Incorporated

The Valspar Corporation, Minneapolis, MN, has announced that its wholly owned resin subsidiary, McWhorter, Inc., has reached a definitive agreement with Cargill, Incorporated, to purchase certain assets of Cargill's Resin Products Division.

The sale is contingent upon approval by the board of directors of both firms and completion of due diligence and other review procedures.

Cargill's Resins Products Division produces resins for architectural, special purpose coatings, and original equipment manufacturing (OEM), as well as polyesters for reinforced fiberglass and other specialty applications. Divisional plants are located in Lynwood, CA; Forest Park, GA; Carpentersville and Chicago Heights, IL; and Ennis, TX. Personnel involved in administration and research and development activities are also located in Minneapolis. Revenues for the division were \$190 million for the year ended May 31, 1992.

SC Johnson Polymer to Open New Site in The Netherlands

SC Johnson Polymer Worldwide, Racine, WI, plans to expand its European operations by constructing a business center in Friesland, Holland, and relocating its Polymer Coatings and Graphic Arts business there. Groundbreaking for the new business center is slated for spring 1994 and will be constructed in phases over five years. The manufacturing facilities are scheduled for startup in September 1995 beginning with emulsion polymer, eventually to be followed by resin production. Other construction phases will include warehouse and distribution facilities, laboratories, and administrative offices.

Contract Negotiations Underway for U.S. Filter To Construct a Wastewater Treatment Plant in Mexico

United States Filter Corporation, Palm Desert, CA, announced that it has been selected to enter into contract negotiations to design, build, and operate a wastewater treatment plant for the City of Cuernavaca, located in Morelos, Mexico. The project is developed to treat wastewater at a rate of 13.8 million gallons per day with clean water being discharged directly to the Yautepec River. Designed for a population service area of 550,000, the facility will provide clean water for agricultural irrigation with sludge from the plant being used for soil conditioning.

In addition to designing and building the treatment facility, U.S. Filter will own the

Valspar is a manufacturer of paint and coatings. Products produced include industrial, consumer, and packaging coatings, as well as specialty products such as resins, colorants, and industrial maintenance coatings. The company has 24 manufacturing plants plus warehouse facilities located throughout the United States and Canada, with approximately 2,500 employees.

Cargill is a privately held merchandiser, processor, transporter, and warehouse of agricultural and other bulk commodities, based in Minnetonka, MN. Its major businesses include merchandising of a wide range of agricultural and other bulk commodities. The company employs more than 66,000 individuals in 58 countries worldwide.

Drakenfeld Colors and Ceramic Colors and Special Products Div. of Degussa, Form Joint Venture: Cerdec

The Drakenfeld Colors Division of CIBA-GEIGY Corporation, headquartered in Washington, PA, has formed a joint venture with the Ceramic Colors and Special Products Division of Degussa AG, Frankfurt, Germany. The newly formed corporation, called Cerdec Corporation, also headquartered in Frankfurt, will globally market ceramic and glass decorating products.

CIBA-GEIGY and Degussa will represent 30 and 70% ownership of the new company, respectively. Additionally, the joint venture will provide the combined research and development resources, manufacturing efficiencies, and a global customer service network.

Four areas of Cerdec specialization include: the ceramics business; the decorating and special products business involving decorating and precious metals; the glass business including automotive products; and the mixed metal oxides area serving the plastics and coating industries.

The board of directors of the new company will include two representatives from each of the parent companies.

Board members will include: Gerhard Wiesmann and Andreas Wagner, of Degussa

AG; David Brearly, of CIBA-GEIGY Pigments Division; and Robert Martel, of Drakenfeld Colors Division of CIBA-GEIGY. Joe Sullivan, of CIBA-GEIGY, and Messrs. Wiesmann, Wagner, and Martel will also serve on the local board of Cerdec.

Cerdec will have locations and operations in the Americas, Europe, and the Far East, including production plants in Germany, United States, France, Italy, Spain, Brazil, and Mexico.

The new venture employs over 1,800 in their combined four divisions, and has expanded itself further through joint ventures with Kemin in South Korea, T&D Ceratec in Japan, and Ceracolor in Bangkok, Thailand.

Powder Coating Resins Expansion Announced by RUCO

RUCO Polymer Corporation, Hicksville, NY, will increase its production of powder coating resins by 30%. The expansion, which will be completed by June, will add an additional 15 million pounds of resins.

RUCO Polymer Corporation is a manufacturer of specialty polyester polyols for polyurethanes (coatings, elastomers, adhesives, castables), solid polyester resins for powder coating, and polyurethane latexes.

Union Carbide to Build Butanol Facility in Taft, LA

Union Carbide Corporation, Danbury, CT, has announced plans for a 300 million pound-per-year butanol facility at the company's Taft, LA, petrochemicals complex. The new unit, scheduled for completion by the end of 1995, will employ the next generation of Union Carbide/Davy McKee low-pressure oxo technology. The facility will supplement the company's existing production at its Texas City, TX, plant.

Butanol is widely used in the production of chemical intermediates, primarily for the paint and coatings industry.

Electrostatic Charge and Pigment Stabilizing Properties of Fine Particle Sized Barium Sulfates

Jochen Winkler
Sachtleben Chemie GmbH*

In solvent-based paints, fine particle sized barium sulfates are capable of stabilizing other pigments against flocculation, thereby increasing the gloss, reducing the haze, and improving color strength of the formulations whereas rub-out effects are minimized. Their stabilizing ability is related to the tendency of the barium sulfate particles to associate with other pigment components. The mechanism is shown to have a "steric hindrance" component and a contribution from electrostatic stabilization.

The origin of electrostatic charges on fine barium sulfate particles is studied.

INTRODUCTION

Precipitated barium sulphates (chemical formula BaSO_4), also called blanc fixe, are common ingredients in a variety of paint formulations. They are appreciated for their lightness, their low tint, and their chemical inertness. Their extremely low solubility, even in acidic environments, makes them completely safe physiologically. BaSO_4 is commonly used as a contrast medium in X-ray diagnostics of the digestive tract. For this application, amounts of up to several hundred grams are ingested by patients.

Formerly, blanc fixes with mean particle sizes down to approximately $1 \mu\text{m}$ were commercially available. Newly developed ultrafine blanc fixe types have mean particle sizes of $0.2 \mu\text{m}$ (blanc fixe HP) and $0.1 \mu\text{m}$ (blanc fixe HU). The specific surface areas¹ of these products are listed in Table 1 along with the data of an experimental product, HV, which is even finer.

*Duisburg, Germany.

This paper deals with some application aspects of these materials in paints. One of the features of fine blanc fixe grades is their ability to stabilize other pigments against flocculation. The mechanism of this stabilization was investigated² and it was found to depend upon an association of the blanc fixe with the other pigments. Furthermore, electrostatic charges appear to play an important part. This was the reason for a more detailed study of the charging behavior of blanc fixe. The results are reported here.

EXPERIMENTAL

Paints were prepared with state of the art procedures using commercially available raw materials. In the formulations with blanc fixes, nonvolatile resin parts were partly substituted by blanc fixe, thus increasing the overall pigment volume concentration [(PVC); volume of pigments divided by volume of total solid contents].

Application paint properties were measured according to procedures described in DIN Standards (gloss according to DIN 67 530 with Micro-Tri-Gloss, BYK-Gardner, Geretsried; color measurements according to DIN 53 234 with Elrepho, Zeiss, Oberkochen; color differences Δa^* , Δb^* , ΔL^* according to ISO 7724/1). The haze was measured with a

Table 1—Properties of Blanc Fixes Used

Blanc Fixe	Specific Surface Area m^2/g	Mean Particle Diameter μm
HP ^a	12	0.2
HU ^b	28	0.1
HV (experimental)	45	0.05

(a) Sachtperse HP, Sachtleben Chemie GmbH, Duisburg, Germany.

(b) Sachtperse HU, Sachtleben Chemie.

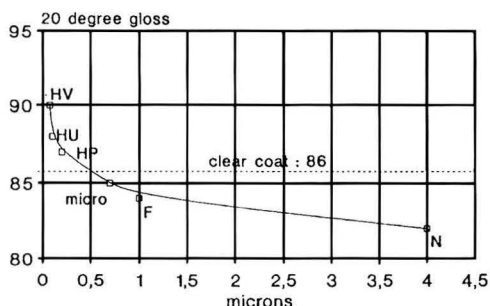


Figure 1—Gloss of acrylic/isocyanate clearcoat and influence of 10% FVC of different blanc fixe. (Blanc fixe N, F, and micro from Sachtleben Chemie GmbH, Duisburg)

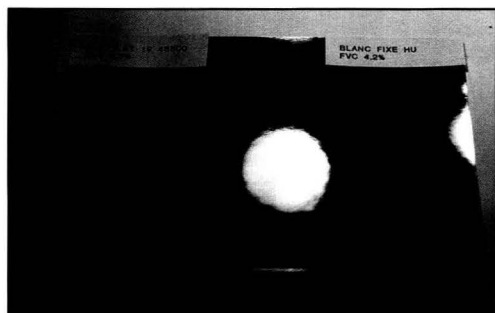


Figure 2—Reflection of a lamp on the surface of an alkyd/melamine topcoat with C.I. Pigment Violet 19 46500 (Cinquasia Red YRT 759 D). Left: without blanc fixe HU. Right: with 4.2% FVC of blanc fixe HU

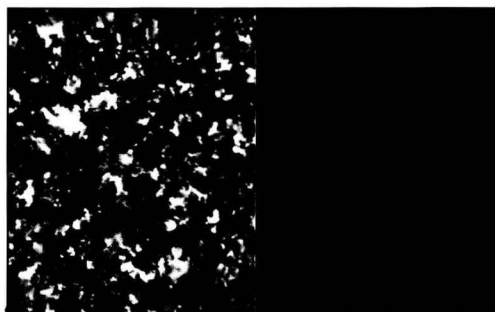


Figure 3—Microscopic view of flocculated (left) and stabilized Cinquasia Red YRT 759 D (right). Stabilization by blanc fixe HU

Goniophotometer, Zeiss, Oberkochen, according to a published procedure³ on cured films of paints that were diluted to spray application viscosity and poured on slanted glass plates. A higher haze number indicates less gloss.

The solvents used for the examination of electrophoretic mobilities of blanc fixes were analytical grades purchased by Merck, Darmstadt, and Fluka, Neu-Ulm. They were used without further purification. The physical data of these solvents were taken from literature⁴ and from data published by the manufacturers. The viscosities of several solvents were not available and were therefore measured by capillary viscosimetry. Donor and acceptor numbers were taken from literature.⁵⁻⁷

High-frequency electrophoretic mobilities were measured with the Electrokinetic Sonic Amplitude (ESA) instrument from Matec Instruments, Hopkinton, MA.

The ESA signal is defined as the quotient of a pressure amplitude P that is generated by electrostatically charged colloidal particles moving in a high frequency AC electrical field, divided by the field strength E . It is related to the high frequency electrophoretic mobility μ by the formula.⁸

$$ESA = \frac{P}{E} = \phi c \Delta\rho \mu \quad (1)$$

with ϕ = volume fraction of particles
 c = sonic velocity in the suspension
 $\Delta\rho$ = density difference between colloidal particles and medium

The electrophoretic mobilities were further used to calculate zeta potentials using the formulas given in the following.

In cases of doubt as to whether the electrostatic charge was positive or negative, and for calibration purposes, an electrodeposition experiment on copper electrodes at maximum field strengths of 150 V/cm was performed.

APPLICATION PROPERTIES

Dispersing

Regardless of the application, the blanc fixes should be properly dispersed. For this, bead milling is essential. For laboratory trials, a paint shaker may be used. Millbase compositions normally consist of 50 to 70 wt % of $BaSO_4$ in 50 to 30 wt % of a resin solution. The resin solution should have a solids content of 25 to 35 wt %. Dispersion should be carried out to a fineness of better than 7.5 on the Hegman gauge.⁹ In this sense, the handling is comparable to that of other inorganic "transparent" pigments like iron oxide red¹⁰ or micronized titanium dioxide.¹¹

Rheology and Gloss

Not surprisingly, fine sized $BaSO_4$ particles affect the rheology of paints in the sense of a viscosity increase and the onset of a yield point, thus reducing the sagging tendency. More detailed information has been given elsewhere¹² that is in accordance with the findings of other workers.^{13,14} Due to the low refractive index ($n_D = 1.64$) of $BaSO_4$, blanc fixe has little light scattering effect. The 0.1 μm material is next to transparent even at filler volume concentrations (FVCs) of 10%. Figure 1 shows the gloss of an acrylic/isocyanate two-

component system filled with 10% FVC of different blanc fixes with mean sizes between 4 and 0.05 μm . It is observed that the gloss increases as the particle size of the blanc fixe gets smaller and that the gloss exceeds the value for the unpigmented clearcoat when the fine grades of less than 0.7 μm are used. This is because, as any pigmentation, they improve the leveling of the paint but do not disturb the surface. The combination of rheology control and gloss retention is of technical interest.

Stabilizing Effect

In many cases,¹² fine particle-sized blanc fixes are capable of stabilizing other pigments against flocculation, leading to higher gloss, less haze,³ and "cleaner," more brilliant, colors. An example for the reduction in haze is shown in *Figure 2*, drawdowns of a Quinacridone Pigment (Cinquaasia Red YRT 759 D, du Pont de Nemours) in an alkyd/melamine system without and with blanc fixe HU. The drawdown on the right side has a PVC of 9.2% and additionally 4.2% FVC of HU. *Figure 3* compares the pigment flocculation state of the unstabilized paint (left) and the stabilized formulation with HU. Both photographs were taken under a light microscope.

The mechanism of the stabilizing effect is best demonstrated with the aid of transmission-electron-microscopic images of paint film cross sections. *Figure 4* shows as larger light gray particles of lower contrast a Diketo-pyrrolo-pyrrole pigment (Irgazin Red DPP-BO, CIBA-GEIGY, Basel), 7% PVC and blanc fixe HU, 5% FVC, as smaller and darker particles in an alkyd/melamine topcoat. Clearly, the organic pigment particles are intimately surrounded by the blanc fixe. The 20° angle gloss of the formulation was 80 compared to 45 for the formulation containing only 7% PVC of Irgazin Red DPP-BO. The association between the blanc fixe and the pigment is crucial for stabilization. *Figure 5* shows a different organic pigment of the Isoindoline type (Paliogen Red L 3585 HD, BASF, Ludwigshafen) at a PVC of 7% with 3% FVC of HU in the same binder system. It is evident that in this particular formulation there is no tendency of association between the HU and the Paliogen Red and thus, compared to the original formulation, the gloss was not improved.

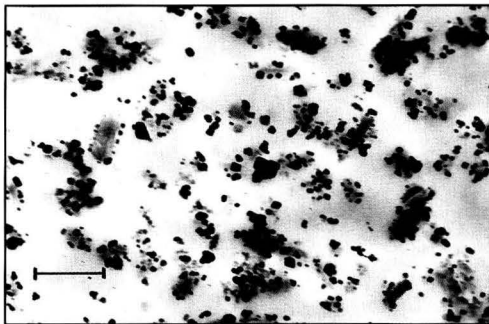


Figure 4—TEM photo of blanc fixe HU (dark particles) and organic pigment (lighter and larger particles) in a cured paint film. (Scale length: 0.5 μm)

Table 2—Gloss and Tint of Cinquaasia Red YRT 759 D in Combination with Different Blanc Fixes in an Alkyd/Melamine Topcoat

	20° Gloss	60° Gloss	ΔL^*	Δa^*	Δb^*
Reference without					
blanc fixe	65	87	—	—	—
HP	79	92	0.52	1.512	2.414
HU	87	93	0.361	1.819	3.437
HV (experimental)	86	93	0.441	2.755	4.213

When an identical FVC of blanc fixe is incorporated into a formulation, the number of particles introduced increases when their particle size is smaller. For this reason, the coverage of the pigment particle surfaces meant to be stabilized is increased when using a finer blanc fixe. This leads to improved stabilization efficiency as is seen from *Table 2* where gloss and color values are presented for Cinquaasia Red YRT 759 D in combination with HP, HU, and the experimental HV. The reduction in particle size from HU (0.1 μm) to HV (0.05 μm) affects the color values but has no further significant effect on the gloss.

The stabilizing effect for a given blanc fixe increases with increased loading amounts. Depending upon the severity of the flocculation problem, an FVC similar to the PVC of the colored pigment may be necessary. A combination of blanc fixes with organic dispersing agents is, however, possible and is sometimes chosen for rheological reasons.

The antiflocculating properties of fine particle sized blanc fixes may also be used to reduce or even eliminate rub-out phenomena^{15,16} found in flocculated systems. The stabilizing effect is more pronounced in combination with hiding pigments because of their larger particle size.

Stabilizing Mechanism

A number of different attractive and repulsive forces acting on colloidal particles, such as pigments and fillers in paints, determine their stability against flocculation. Leaving magnetic forces aside, these are: (1) the London-van der

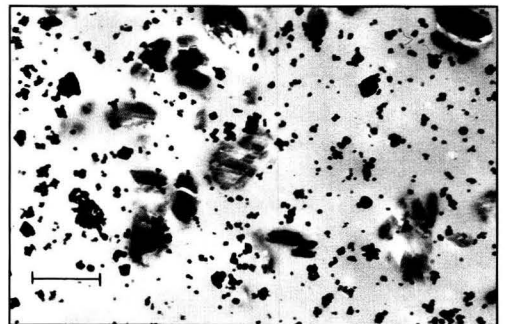


Figure 5—TEM photo comparable to *Figure 4*, however, using a different organic pigment. (Scale length: 0.5 μm)

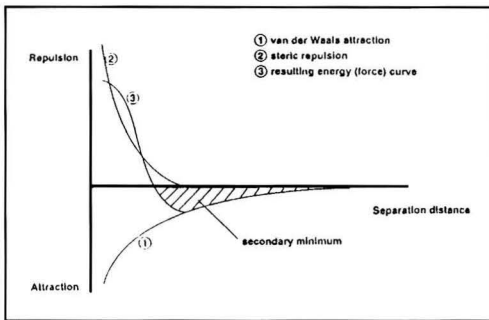


Figure 6—Schematic representation of a distance dependent potential energy curve between two particles with a secondary minimum

Waals attractive force¹⁷; (2) steric repulsion by adsorbed polymers¹⁷; (3) repulsion by electrostatic charges of the same sign¹⁷; and (4) attraction by electrostatic charges of the opposite sign.

The attractive force by charges of the opposite sign is reported by Franklin¹⁸ in one instance to be the cause for severe flocculation. We have also encountered examples for this behavior.

As these forces have different spatial dependencies, the resulting potential energies and thereby attractive and repulsive forces between pigment particles are distance-dependent. Pigments are stabilized against irreversible flocculation if a potential energy barrier of 5 to 15 times kT (k = Boltzmann’s constant and T = temperature in Kelvin) separates the particles from direct contact.¹⁹⁻²¹ Flocculation as encountered in paints normally occurs in the so-called secondary minimum of the potential energy curve (Figure 6).

In the case of steric stabilization alone, a secondary minimum is found if the London dispersive force of attraction reaches beyond the layer of adsorbed polymers. London energies are considered to be long-range energies that decay with the sixth or seventh power of the separation distance.¹⁹ Direct measurements of attraction forces between quartz lenses and a glass plate carried out by Derjaguin et al.²² showed an onset of attraction at distances of approximately 400 nm when air filled the gap between the surfaces. The attractive force is reduced if a medium of higher Hamaker constant fills the gap. For curved mica platelets in toluene, Luckham et al.²³ determined a distance of 10 nm for the beginning of a measurable London dispersive force.

Table 3—Electrostatic Charge of HU/Irgazin DPP-Red-BO in Wet Paint (ESA Signal) and Gloss, Haze, and Tint of Cured Paint Film

Sample	ESA Signal μ Pa · cm/V	Gloss		Haze	Δ a*	Δ b*
		20°	60°			
Without HU	-0.36	49	83	1.603	Reference	Reference
With HU #1	0.37	77	91	0.308	0.79	1.90
With HU #2	0.46	81	92	0.286	1.07	2.41
With HU #3	1.00	85	94	0.190	0.98	2.50

Theoretical calculations based on equations proposed by Hamaker and Vold,²⁰ respectively, show that appreciable attraction occurs at distances between 10 and 50 nm separation distance, depending upon particle size and the Hamaker constants of the media involved.²¹ Depending upon the molecular weight, the degree of branching, the nature of adsorption and, most important, the thermodynamic interaction between the adsorbed polymer and the solvent, stabilizing polymer layers may have different thicknesses varying from a few nm to approximately 60 nm.²² For pigments in binder solutions, it is therefore reasonable to assume a thickness of up to 40 nm.

In comparison, adsorbed particles of blanc fixe HU with a mean particle size of 100 nm will effectively prevent the larger pigment particles from obtaining a close side-by-side approach by steric hindrance. They will thereby reduce the London attractive forces acting between them. The use of small particles as a spacer between larger particles of powdered material to diminish their cohesiveness is well known.²⁴ The attraction will then be governed either by the London forces between the spacer particles or between the spacer particles and the pigment instead of between the pigment particles alone.

In both cases, the overall attraction is expected to be reduced since the attraction force decreases appreciably with decreasing particle size,²¹ whereas the Hamaker constant has very little influence.²⁵

An additional stabilizing action, however, is generated by electrostatic charges of the blanc fixe spacer. Table 3 demonstrates the influence of differently prepared blanc fixe HU samples on the ESA signals of the wet paints formulated with Irgazin DPP Red BO and the corresponding gloss and haze values of the cured paint films. Furthermore, the influence of HU on the green-red and the blue-yellow tint of the paint films is shown. As the Irgazin DPP Red BO becomes more finely distributed, the color tint becomes redder and more yellow. In the starting formulation (“reference”) in Table 3, the red pigment had a negative charge. The pigment was not stabilized as can be seen from the poor gloss values and the high haze. With “HU 1,” the charge was changed to a positive sign and stabilization was coming into effect.

With “HU 2” and “HU 3,” the charge, and hence the stabilizing effect, was further increased. The increase of gloss from the reference to the formulation “HU 1” is believed to be largely the result of steric stabilization of the HU particles acting as a spacer since the measured ESA signal is just reversed in sign. A quantitative discussion is nevertheless not quite simple since, according to equation (1), the ESA signal is linearly dependent upon the density difference between the particles and the medium. Blanc fixe has approximately twice the density of the organic pigment, but as seen from Figure 4, flocs are formed with effective hydrodynamic densities that cannot be measured. It was shown²⁶ that even the adsorption of polymeric material will lower the effective density of colloidal particles and thereby lower their ESA signal.

The effects of electrostatic charges can also be seen by viewing the coalescence pattern of a drop of paint containing HU and a drop of flocculated colored pigment paste under a microscope. This is shown in Figure 7 with Cinquasia Red YRT 759 D. The increase in color strength at the boundary

between the two phases shows a dispersing effect of the HU without any mechanical influence. Apparently, the positively charged HU particles associate with the uncharged Cinquasia Red YRT 759 D particles. The repulsive forces between the charged HU particles on the outskirts of the flocs then makes them break at their weakest interface, which evidently seems to be in between the colored pigment particles.

Electrostatic Repulsion in Solvent-Based Coatings

Electrostatic charges on colloidal particles in organic media may be generated in the same way as in water. The mechanisms are: dissociation of surface groups; adsorption of ions; reaction with liquid components (e.g., acid-base type reaction with functional groups of resins); and isomorphic substitution (particularly common in clay minerals, e.g., substitution of Si^{4+} by Al^{3+} , thus leading to a negative charge of the particle).

The fact that electrostatic charges may play an important part in the stabilization of pigments in organic systems has received attention in literature.²⁷⁻²⁹ For a spherical particle surrounded by an electrostatic double layer, the total charge Q on the particle surface may be approximated by equation (2):

$$Q = \frac{\epsilon a \psi_0}{1 + \kappa a} \quad (2)$$

with ϵ = dielectric constant. Product of ϵ_r , the relative dielectric constant and ϵ_0 , the permittivity of vacuum
 a = particle radius
 ψ_0 = surface potential

For a symmetrical electrolyte, κ is given by

$$\kappa = \left(\frac{8 \pi e^2 N_A c z^2}{\epsilon k T} \right)^{1/2} \quad (3)$$

with e = elementary charge
 N_A = Avogadro's Number
 k = Boltzmann Number
 z = valency of electrolyte ions
 T = absolute temperature
 c = electrolyte concentration in moles per volume unit

The reciprocal value of κ is known as the "double layer thickness." At a distance of $1/\kappa$ away from the surface, the potential drops to the $(1/e)$ th part of the surface potential.

The characteristic feature of organic systems is their low dielectric constant, that is low dipole moment and low polarizability in comparison to water. For this reason, organic solvents are normally not efficient in stabilizing ions (clear exceptions are crown ethers and the lower alcohols).

A typical ionized electrolyte concentration in organic media would be approximately 10^{-9} moles/liter. Using equation (3) to compare this with aqueous slurries of pigments with typical ionized electrolyte concentrations in the range between 10^{-6} to 10^{-3} moles/liter leads to the conclusion that in organic media, κ obtains very small values in spite of the lower value of the dielectric constant. Consequently, the double layer thickness $1/\kappa$ is very much larger in organic media than in water.

From this discussion, two results may be stated that are relevant in view of the electrostatic stabilizing action of fine blanc fixes in organic systems:

(1) Electrostatic double layers in media of low dielectric constant have a low capacitance. Only few charges lead to appreciable potentials [equation (2)].

(2) The electrostatic double layer becomes very thick [equation (3)]. The potential is far ranging and therefore helpful in preventing flocculation into the "secondary minimum."

[For a detailed discussion of electrostatic charging in nonaqueous media, see pages 89 to 92 of reference (25)].

Adsorption of Electrolytes

In a former publication,² the mechanism by which blanc fixe obtains an electrostatic charge in different organic solvents was studied. For this, the organic solvents were described with respect to their Lewis-acidity and -basicity by their acceptor- and donor-numbers (AN and DN, respectively) according to Gutmann.^{5,6} It was found that blanc fixe HU carries only positive charges which is in contrast to the behavior of amphoteric oxides such as MgO , TiO_2 , or SiO_2 which become negatively charged in basic solvents due to the dissociation of terminal OH-groups.³⁰ Titration experiments led to the conclusion that adsorbed electrolytes, namely Na_2SO_4 , dissociated, and whereas the NaSO_4^- -anion preferentially went in solution, the remaining Na^+ -ion became potential determining. It was further demonstrated that there was a relationship between $(\text{AN DN})^{0.5}$ as a measure for the ability of the solvent to stabilize anions and cations and the quantity of

$$Z = \text{ESA } \eta \epsilon_r^{-1} \quad (4)$$

where η is viscosity. In reference (2), Z was assumed to be proportional to the zeta potential. The exact relationship between the ESA signal and the zeta potential U_z in the case of small particles with large double layer thicknesses is⁸

$$U_z = \frac{3 \text{ESA } \eta}{2 \epsilon \phi \Delta \rho c} (x^2 + y^2)^{1/2} \quad (5)$$



Figure 7—Light microscopic view of a drop of flocculated paint (right) coming into contact with a drop of paint containing blanc fixe HU (left)

Table 4—Physical Properties of Solvents and Zeta Potentials of 1 Vol% of Blanc Fixe HU (0.34% Moisture) in Them

No.	Medium	Relative DK ^a	Viscosity mPa · s	DN	AN	ESA $\mu\text{PA} \cdot \text{m} \cdot \text{V}^{-1}$	(AN-DN) ^{0.5}	U_z mV
1	Acetaldehyde	21.80	0.22	18.8	13.8	40.718	16.11	1.9
2	Acetone	22.00	0.32	16.8	13.8	36.754	15.23	2.2
3	Aniline	6.89	4.40	33.4	17.1	10.532	23.90	24.8
4	Carbon tetrachloride	4.81	0.58	0.0	22.8	-0.528	0	-0.4
5	Diethylether	43.00	0.23	18.1	5.0	0.858	9.51	2.2
6	Dimethylsulfoxide	48.90	2.30	29.6	20.6	85.338	40.47	17.5
7	Dioxane	2.20	1.52	14.7	5.9	0.394	9.31	1.0
8	Acetic acid	6.20	1.22	10.1	52.1	6.155	22.94	4.6
9	Ethanol	24.30	1.22	6.4	37.1	30.276	15.41	5.1
10	Formamide	109.00	3.30	23.9	40.0	108.158	30.92	13.2
11	Hexamethylphosphoric acid amide	29.60	3.42	38.0	10.7	3.753	20.16	1.9
12	Methanol	32.63	0.55	11.9	41.3	42.659	22.17	2.8
13	N,N-Dimethylformamide	37.60	0.92	25.1	16.2	95.390	20.16	10.7
14	Nitromethane	38.60	0.62	4.7	21.0	3.506	9.93	0.9
15	Piperidine	5.80	1.43	48.6	5.5	0.532	16.35	0.5
16	Pyridine	12.30	0.97	33.6	16.6	26.592	23.62	9.8
17	Carbon tetrachloride	2.24	0.97	0.0	8.5	-0.430	0	-1.1
18	Tetrahydrofuran	7.60	0.48	20.7	8.0	0.517	12.87	0.1
19	Triethylamine	2.40	0.68	53.5	3.0	-0.505	12.67	-0.6
20	Water	81.00	0.98	17.9	54.9	26.800	31.35	1.5

(a) Dielectric constant.

In equation (5), $\Delta\rho$ is the difference between the density ρ_p of the particle and that of the liquid ρ_L and x , y , and α are given by

$$x = 1 + \alpha^{1/2} \quad (6)$$

$$y = \alpha^{1/2} + \frac{2\alpha\rho_p}{9\rho_L} \quad (7)$$

$$\alpha = \frac{\omega a^2 \rho_L}{\eta} \quad (8)$$

In equation (8), ω is the angular frequency of the electric field.

Table 4 lists the physical data of the organic solvents, the quantity of (AN DN)^{0.5}, the ESA signal found for a blanc fixe HU at a concentration of 1 vol % and the zeta potential calculated from these data. Figure 8 is a plot of the high frequency zeta potential versus the ion stabilizing capability

(AN DN)^{0.5}. There is a definite trend toward higher zeta potentials with increasing ion stabilizing capability. Water (substance number 20) lies outside the trend. Evidently, water stabilizes ions so well that no ion adsorption will occur, thus leaving the blanc fixe without any charge.

Aniline, number 3, is also interesting since it is capable of mesomerism with charge separation within the molecule. It is assumed that the high potential found in that solvent has to do with this resonance stabilization. Pyridine, number 16, with a basic nitrogen atom within the aromatic ring leads to an intermediate zeta potential. It therefore seems that rather subtle changes in the molecular structure of the organic phase may have a large influence on electrolyte dissociation and the adsorption of the resulting ions on blanc fixes. It is always the ion with the higher charge density which becomes potential determining.

The principle that ions with higher charge densities are preferentially adsorbed was also found to be valid when adding ionic surfactants to blanc fixe dispersed in resin solutions (viz. the following section on Adsorption of Ionic Surfactants in Resinous Dispersions). These experiments demonstrate that this principle may be applied to paint formulations.

Effect of Moisture

It is reported in literature²⁵ that impurities in the liquids, especially water, will affect the zeta potential. Moderate amounts of adsorbed moisture on the blanc fixes had no influence in our measurements. Higher amounts have an effect in extremely unpolar solvents as can be seen from the following measurements.

The blanc fixe HU used in Table 4 had 0.34% of adsorbed moisture. Table 5 compares the zeta potentials from this material before and after drying at 120°C. There is literally

Table 5—Comparison of Zeta Potentials of Blanc Fixe HU (Compare Table 1) in Various Organic Solvents in Dependence of its Moisture Content

Solvent	Moisture content		
	Dried at 120°C	0.34%	2.5%
Carbon tetrachloride	-0.9 mV	-1.1 mV	21.6 mV
Acetone	2.2	2.2	1.4
Methanol	3.0	2.8	4.2
Ethanol	5.20	5.10	—
Pyridine	9.2	9.8	—
Aniline	25.7	24.8	—
NN-Dimethyl formamide	11.6	10.7	—

no effect from 0.34% moisture. Storing the blanc fixe HU over a saturated $\text{CuSO}_4 \cdot 5 \text{H}_2\text{O}$ solution (relative humidity 98%) led to the adsorption of 2.5% moisture. The zeta potentials in acetone and methanol are hardly changed whereas that in carbon tetrachloride is greatly increased. Presumably, the existence of water on the blanc fixe increases its lyophobicity in CCl_4 . The adsorbed water appears to increase the number of potential determining ions in the inner Helmholtz plane whereas the bulk liquid CCl_4 determines the potential drop.

When comparing these zeta potentials with others published in literature, it should be kept in mind that they are calculated from high frequency electrophoretic mobility data using a correction term for particle inertia. We are not aware of any comparative studies with, for example, microelectrophoresis.

On the other hand, the particle size used in equation (8) largely affects the calculated zeta potential. U_p increases with increasing particle radius. For the calculations in Tables 4 and 5, an effective particle diameter of 0.1 μm was assumed.

Adsorption of Ionic Surfactants in Resinous Dispersions

The electrostatic charging of blanc fixes in paint media is not restricted to the adsorption of ionized electrolyte atoms. A mechanism by which polymers ionized through a proton transfer reaction with the solvent are adsorbed²⁷ is also likely to happen.

Since blanc fixe has no ionizable terminal groups at its surface, it must preferentially adsorb ions from the solution in order to obtain an electrostatic charge. As stated earlier, if the ions are from adsorbed electrolyte remaining from the production of the blanc fixes, then the cation Na^+ will be potential determining.² The principle behind this appears to be that the ion with a higher charge density is adsorbed whereas the counter-ion with a lower charge density is thermodynamically better stabilized in the liquid phase. Examples for this behavior have been reported.^{31,32}

Titration of ionic surfactants to blanc fixe HU in 1:1 mixtures of alkyd resin (Alkydal F 300, Bayer, Leverkusen) with mineral spirit (Solvesso 100, Esso Chemie, Cologne) showed that this process will reliably occur even in the presence of binder. Figure 9 shows an ESA titration with a 0.4% solution of calcium octoate, $(\text{CH}_3-(\text{CH}_2)_6-\text{COO})_2\text{Ca}$, in Solvesso 100.

This ionic surfactant will dissociate to yield $(\text{CH}_3-(\text{CH}_2)_6-\text{COO})\text{Ca}^+$ and $\text{CH}_3-(\text{CH}_2)_6-\text{COO}^-$. As can be seen from Figure 9, the smaller ion $(\text{CH}_3-(\text{CH}_2)_6-\text{COO}^-)$ is adsorbed. The ESA curve goes through an isoelectric point at the addition of 3 ml of calcium octoate solution and obtains progressively larger negative values during the course of the titration.

At the addition of 6 ml of calcium octoate-solution, the HU surface area is saturated with ions.

Figure 10 shows a similar experiment using sodium laurylsulfate ($\text{C}_{12}\text{H}_{25}-\text{O}-\text{SO}_3\text{Na}$). In this case, starting from a slightly positive potential, there is an increase in positive charge during the course of the titration due to Na^+ adsorption. The change in the ESA signal is less pronounced, presumably because the degree of dissociation of the sodium laurylsulfate in mineral spirit is only low.

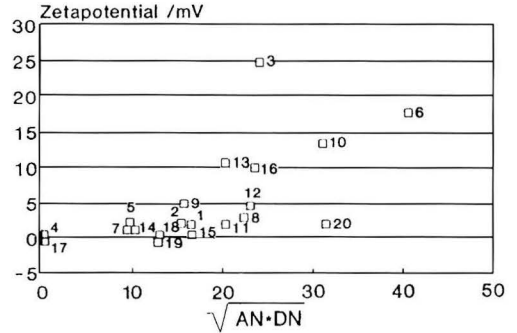


Figure 8—Dependence of the zeta potential of blanc fixe HU (0.34% moisture content) from $(\text{AN DN})^{0.5}$ of the different solvents from Table 4

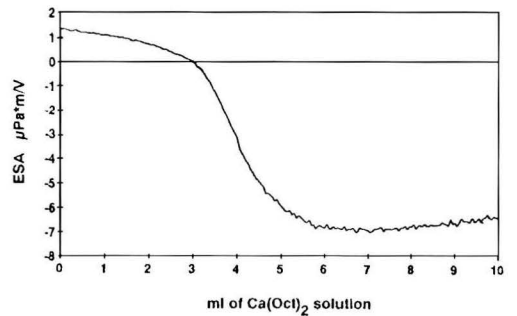


Figure 9—Change of ESA signal upon the addition of a 0.4% calcium octoate solution in mineral spirit to a dispersion of blanc fixe HU in an alkyd resin

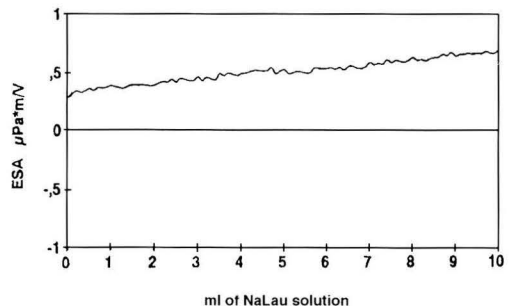


Figure 10—Experiment as in Figure 9 using a sodium laurylsulfate solution

CONCLUSIONS

Finely divided blanc fixes are capable of stabilizing larger pigments against flocculation. In solvent-based paints, the mechanism was found to depend upon the blanc fixe particles associating with the pigment particles, thus acting as a spacer that prohibits the side-by-side approach of the pigments to distances close enough where the attractive van der Waals force prevails. Secondly, the blanc fixe particles may contribute additionally by adding an electrostatic component to the repulsive forces.

Since organic media have low dielectric constants, electrostatic double layers have low capacitances. This means that a small amount of charges will lead to appreciable surface potentials.

Next, the surface potential decays slowly with distance into the solution because of the low ionic strength in organic media (less shielding of counter ions).

Blanc fixes obtain electrostatic charges solely by an ion adsorption mechanism. Therefore, the surface charge of blanc fixes depends largely upon the capability of the surrounding fluid to stabilize ions. One source of potential determining ions is adsorbed electrolyte already present on the surface of the blanc fixe from its production, generally Na_2SO_4 . From this, the sodium ion as a dissociation product will be adsorbed due to its higher charge density in comparison to the NaSO_4^- anion. It was shown elsewhere² that the ability of solvents to generate charges from adsorbed electrolytes was best described by $(\text{AN} \cdot \text{DN})^{0.5}$, the geometric mean of their acceptor- and donor-numbers. The influence of moisture becomes more pronounced with decreasing solvent polarity. This is consistent with the findings reported for amphoteric oxides.²⁵

In resinous dispersions, the electrostatic charge of blanc fixes may be controlled by the addition of ionic surfactants. In addition, the dissociation product with the higher charge density becomes potential determining.

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References

- (1) Haul, R. and Dübgen, G., *Chem. Ing. Techn.*, **32**, 349 (1960).
- (2) Winkler, J., *Farbe + Lack*, **97**, No. 10, 859 (1991).
- (3) Becker, H., Noven, H., and Rechmann, H., *Farbe + Lack*, **74**, No. 8, 145 (1968).
- (4) *Handbook of Chemistry and Physics*, 56th Edition, Weast, R.C. (Ed.), CRC Press, Cleveland, OH (1975-76).
- (5) Mayer, U. and Gutmann, V., *Adv. Inorg. Chem. Radiochem.*, **17**, 189 (1975).
- (6) Soukup, R.W., *Chemie in unserer Zeit*, **17**, No. 4, 129 (1983).
- (7) Soukup, R.W., *Chemie in unserer Zeit*, **17**, No. 5, 163 (1983).
- (8) O'Brian, R.W., *J. Fluid Mech.*, **190**, 71 (1988).
- (9) German Standard DIN 53 203.
- (10) Kelch, W., *Defazet*, **29**, 119 (1975).
- (11) Kettler, W.H. and Richter, G., *Farbe + Lack*, **98**, No. 2, 93 (1992).
- (12) Machunsky, E. and Winkler, J., *Plaste und Kautschuk*, **37**, No. 12, 421 (1990).
- (13) Hauser, P., Hermann, M., and Honigmann, B., *Farbe + Lack*, **76**, No. 6, 545 (1970).
- (14) Hauser, P., Hermann, M., and Honigmann, B., *Farbe + Lack*, **77**, No. 11, 1097 (1971).
- (15) Kaluza, U., *Defazet*, **33**, No. 10, 355 (1979).
- (16) Kaluza, U., *Defazet*, **33**, No. 11, 399 (1979).
- (17) Vincent, B., *Advan. Colloid Interface Sci.*, **4**, No. 213, 193 (1974).
- (18) Franklin, M.J.B., *J. Oil Colour Chem. Assoc.*, **51**, 499 (1968).
- (19) Verwey, E.J.W. and Overbeek, J.Th.G., *Theory of the Stability of Lyophobic Colloids*, Elsevier, Amsterdam, 1948.
- (20) Vold, M.J., *J. Colloid Sci.*, **16**, 1 (1961).
- (21) Crowl, V.T. and Malati, M.A., *Discuss. Faraday Soc.*, **42**, 301 (1966).
- (22) Derjaguin, B.V., Abrikosova, I.I., and Lifshitz, E.M., *Quart. Rev. (London)*, **10**, 295 (1956).
- (23) Luckham, P.F. and Ansarifar, A., *Chem. Eng. Sci.*, **42**, No. 4, 799 (1987).
- (24) Krupp, H., *Advan. Colloid Interface Sci.*, **1**, 79 (1967).
- (25) Lyklema, J., *Advan. Colloid Interface Sci.*, **2**, 65 (1968).
- (26) Maier, H., Baker, J.A., and Berg, J.C., *J. Colloid Interface Sci.*, **119**, No. 2, 512 (1987).
- (27) Fowkes, F.M., Jinnai, H., Mostafa, M.A., Anderson, F.W., and Moore, R.J., *ACS Symposium Series 200*, Goddard, E.D. and Vincent, B. (Eds.), American Chemical Society, Washington, D.C., 307 (1982).
- (28) Cooper, W.D. and Marsden, R.S., *J. Chem. Soc. Faraday Trans. 1.*, **74**, 1583 (1978).
- (29) Müller, B.W., Lucks, J.S., Stampa, B., and Müller, R.H., *Pharm. Ind.*, **52**, No. 6, 789 (1990).
- (30) Labib, M.E. and Williams, R., *Coll. & Polym. Sci.*, **264**, No. 6, 533 (1986).
- (31) Perreira, H.C., *J. Electrochemical Chem.*, **25**, 69 (1970).
- (32) Koelmans, H. and Overbeek, J.Th.G., *Discuss. Faraday Soc.*, **18**, 52 (1954).

Polymer-Filler Interaction Effects on Coating Properties

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Previous studies were performed to analyze the surface properties of titanium dioxide (TiO_2) pigments surfaces, the thermodynamics of poly(methyl methacrylate) (PMMA) and methyl methacrylate (MMA) adsorption onto these surfaces from solution, and the resulting adsorbed polymer layer (adlayer) thickness. In the current study, these pigments and PMMA were formulated into coatings. Coating properties were characterized and analyzed with respect to the thermodynamic and physical adsorption results. TiO_2 pigments which had more favorable adsorption free energies and enthalpies with PMMA and MMA resulted in coatings with better dispersion quality and stability, greater resistance to salt spray, and better barrier properties. In contrast, these fillers had detrimental effects on adhesion and flexibility. These results were attributed to extensive interactions between filler and polymer which improved the dispersion, decreased the permeability, and increased the rigidity of the polymer matrix. These extensive interactions are also suspected to create internal strain within the coatings, causing them to fail prematurely as external forces are applied during the adhesion and flexibility tests. It has been demonstrated that a prior knowledge of filler surfaces and filler-polymer affinity can be used to formulate coatings with tailored properties.

INTRODUCTION

Traditionally, organic coatings and paints have been formulated and developed with a trial and error, empirical approach. In this approach, a large formulation-testing plan, containing a number of pigments and polymers, is established and the formulator mixes and tests a large number of

combinations. This is a time consuming and costly approach which provides little understanding as to why the optimum formulation out-performs others.

Filler materials and their interactions with polymers play a significant role in determining the properties of coatings and other composite materials. Reference (1) provides a thorough review of this subject. Nonetheless, there are deficiencies and misconceptions in current theories and models addressing filler-polymer interactions in particulate-filled composite properties, rendering these models unsuitable for application in paint formulation. The objective of this research was to determine the contributions of filler-polymer interactions to coating properties. This information should set an example for the understanding and utilization of polymer-pigment adsorption phenomena in the selection of paint components to achieve the desired properties. In this paper, the formulation and characterization of model paint systems, containing poly(methyl methacrylate) (PMMA) and titanium dioxide (TiO_2) will be presented. The coating properties tested will be discussed in light of thermodynamic and physical adsorption data presented in previous papers.²⁻⁴

EXPERIMENTAL

Coating Formulation and Specimen Preparation

A commercially available grade of PMMA was used in organic coating formulations. Its molecular weight and glass transition properties are listed in *Table 1*. This material was mixed with methyl ethyl ketone (MEK) and propylene glycol monomethyl ether (PM) acetate to obtain a 20% solution (*Table 2*). Different portions of this solution were mixed with one of the titanium dioxide pigments (TIO-1, TIO-2, TIO-3) to obtain pigment volume concentrations (PVC) of 6.4%, 17.0%, and 28.0% in the applied (dry) coatings. These TiO_2 pigments varied in surface chemistry. TIO-1 and TIO-2 have alumina and silica surface treatments while TIO-3 is untreated. The physical and chemical characteristics of these

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fillers are presented in references (1) and (2). References (2-4) describe surface characteristics of these materials and PMMA adsorption phenomena.

The pigment-resin mixtures were milled by vigorously agitating them in a 1 L jar half-filled with glass shot for approximately 30 min on an industrial paint shaker. Immediately after milling, these dispersions had a Hegman fineness-of-grind (ASTM D 1210) greater than 7. The unpigmented polymer solution and the milled coatings were applied to steel and aluminum test specimens (Q Panel Company, Cleveland, OH) using conventional air spray. The steel specimens were AISI 1020 with no surface preparation other than cleaning with reagent grade MEK. Aluminum specimens were 2024-T3 clad aluminum alloy meeting Federal Specification QQ-A-250/4. These specimens were cleaned and treated with materials conforming to Military Specification MIL-C-81706 to produce a chemical conversion coating conforming to Military Specification MIL-C-5541. This is a commonly used chromate conversion coating for aluminum to enhance adhesion and corrosion inhibition of subsequent coatings and paints. Additional specimens, used for coating flexibility characterization, were 2024-O temper aluminum alloy, sulfuric acid anodized in accordance with specification MIL-A-8625 Type 1.

The coatings were also applied to opacity charts (Leneta Form 2A, Paul N. Gardner Laboratory, Pompano Beach, FL) in order to determine their "hiding power." The dry film thickness of all applied coatings was $15.2 \pm 2.5 \mu\text{m}$.

Following application, the coatings were allowed to air dry for 7 days at $24 \pm 3^\circ\text{C}$ in order to remove residual solvent. They were subsequently characterized for opacity, adhesion, flexibility, resistance to salt spray exposure, and salt water immersion. The latter was performed using electrochemical impedance spectroscopy (EIS).

Procedures

Table 3 is a listing of the test methods used to characterize the formulated coatings. A brief description of these methods is presented in the following. Specific details are provided in the American Society for Testing and Materials (ASTM) procedures and reference (5).

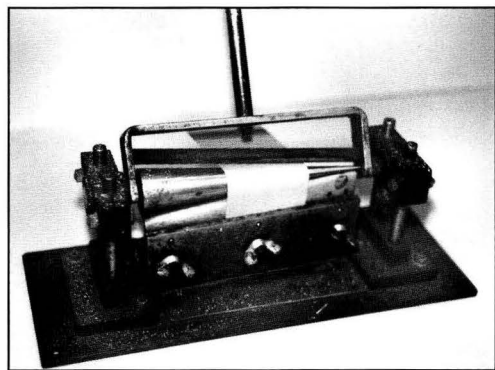


Figure 1—Conical mandrel test apparatus and specimen

Table 1—Molecular Weight and T_g of PMMA

M_w	41,900
M_n	19,000
M_w/M_n	2.21
T_g	70°C

Filler dispersion stability in the coating was determined by evaluating pigment settling characteristics according to ASTM D 869. After milling, a 100 mL portion of each coating was stored in a can. After remaining undisturbed in this condition for 50 days, the can was opened and the entire volume of paint was probed with a square-end spatula weighing 45 g. The following scale was used to evaluate the condition of the paint and any pigment sediment.

- 10 — No change from original condition. Pigment well dispersed throughout the paint sample.
- 8 — Spatula easily reaches bottom of paint sample. Although some sediment may exist, it offers no significant resistance to sideway movement of the spatula. Only a slight deposit of pigment clings to spatula.
- 6 — Spatula descends through pigment settlements under its own weight. Definite resistance to sideway movement of the spatula. Portions of sediment caked and clung to spatula.
- 4 — Spatula does not descend through cake under its own weight. Pigment sediment is heavily caked. Difficult to move spatula sideways.
- 2 — All pigment is caked on the bottom of the paint sample. Very high resistance to sideways movement.

Hiding power (opacity) characteristics were determined by measuring the coating "Y" reflectance values from the tristimulus color scale. These values were determined over the black (Y_b) and white (Y_w) sections of the opacity paper using a D25-PC2 $45^\circ/10^\circ$ colorimeter manufactured by Hunter Laboratories, Reston, VA. Contrast ratios (CR) were calculated according to:

$$\text{CR} = \frac{Y_b}{Y_w} \quad (1)$$

Adhesion of the coatings to their substrate was measured by the wet tape (ASTM D 3359, Method A) and scrape adhesion (ASTM D 2197, Method B) tests. In the former, the test specimen was immersed in distilled water at $24 \pm 3^\circ\text{C}$ for 24 hr. Immediately upon removal, two parallel cuts were made 2.54 cm apart through the coating and into the substrate. Another set of incisions was made in an "X" pattern, connecting the two parallel lines. Using firm pressure, a 2.54 cm wide strip of 3M-250 masking tape (3M Company, Minneapolis, MN) was placed on the coating, over and parallel to the initial incision lines. Following this, the tape was removed in a quick and steady pull. The coating was inspected and evaluated in accordance with the following criteria:

- 5A — No peel or removal of coating.
- 4A — Trace peeling or removal along the cuts.
- 3A — Jagged removal along cuts up to 1.6 mm on either side.

- 2A — Jagged removal along most of cuts up to 3.2 mm on either side.
- 1A — Removal from over 50% of the area under the tape.
- 0A — Removal of all the coating under the tape or beyond the tape.

The scrape adhesion test was performed using an SG-1605 apparatus manufactured by Paul N. Gardner Laboratory. The specimen used in this test had both coated and uncoated sections. The testing was performed by guiding a weighted stylus at a 45° angle to the specimen along the uncoated section into the coated section. As the stylus reaches the edge (or lip) of the uncoated-coated section, it applies a force to the coating-substrate interface. The scrape adhesion was recorded as the maximum load that could be applied to the stylus without debonding the coating from the substrate.

Flexibility of the coatings on the O-temper aluminum specimens previously described was evaluated using two methods: the conical mandrel bend (ASTM D 522) and the Gardner impact resistance (ASTM D 2794). The former was performed by clamping a specimen, coated side out, into the conical mandrel apparatus (Paul N. Gardner Laboratories) as in Figure 1. The specimen was then bent 180° about the mandrel in approximately one second. The coating was immediately examined under 10× magnification for cracking along the bend. The distance between the large end of the mandrel (diameter = 4 cm) and the coating crack tip was recorded. This data was then converted to ultimate coating elongation (in percent) using a relationship provided by Shurr.⁶

The impact flexibility test was performed by placing a specimen, coated side down, on a panel support with a 16.3 mm diameter opening. The hemispherical indenter (15.9 mm diameter), which sits at the bottom of a hollow guide cylinder (Figure 2), was placed on the back side of the specimen over the opening. A 100 g weight was dropped down the guide tube from various heights onto the indenter, thereby deforming the substrate and coating. After each impact, the coating was immediately examined for cracks using a microscope at 10× power. The impact flexibility was determined in terms of the highest point from which the impact produced no detectable cracks in the coating. This height and the weight of the impact instrument were used to calculate the impact energy (in mJ) which the coating could withstand.

The coatings were also evaluated for their resistance to corrosive, high humidity conditions by exposing them to a 5% salt spray (ASTM B 117). Steel specimens were exposed for 24 hr while aluminum specimens were exposed for 500 hr. Immediately upon removal of the specimens from the chamber, they were examined for blistering and uplifting of the coating, and corrosion of the metal substrate.

EIS characterizations during immersion in NaCl solution were performed using a Model 388 Electrochemical Imped-

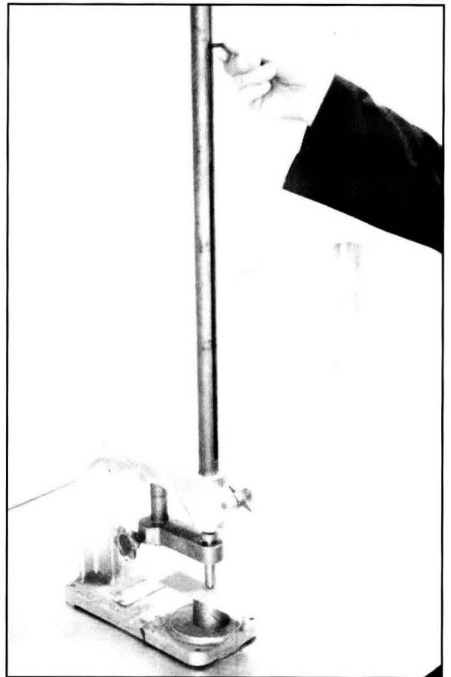


Figure 2—Gardner impact test apparatus and specimen

ance System (EG&G Princeton Applied Research Corporation, Princeton, NJ). The EIS test cell consisted of a Pyrex glass o-ring joint clamped onto a coated aluminum substrate. The electrolyte solution exposed to the coatings was 3.5% NaCl with a pH of 6.0. This test cell design created a coating surface immersion area of 7.5 cm². Exposures were performed at room temperature. EIS measurements were performed on the 6.4% PVC TIO-1 and TIO-3/PMMA coatings at intervals up to 336 hr of immersion. EIS data was obtained in the frequency range of 10⁻² to 10⁵ Hz and subsequently analyzed in the form of Bode plots which consist of impedance magnitude and phase angle versus frequency.

RESULTS AND DISCUSSION

The results of the coating characterization studies are presented in Tables 4-8, and summarized in Table 9. These results were analyzed relative to both pigment type and concentration. Related studies on the thermodynamic and physical properties of PMMA adsorption on these pigments have been previously reported.²⁻⁴ The trends in coating performance found in the current study have been identified and explained in terms of the previously identified pigment-polymer interactions within the coatings. These cause and effect relationships are discussed in the following.

The results of the pigment settling evaluation after 50 days of storage are presented in Table 4. It should be noted that this type of evaluation is usually performed after several

Table 2—PMMA Solutions Used in Coating Formulations

Component	Percent by Weight
PMMA	20
Methyl ethyl ketone	30
Propylene glycol monomethyl ether (PM) acetate	50

Table 3—Standard Test Methods Used to Evaluate Coating Performance

Property	ASTM Method
Pigment dispersion/settling	D 869
Opacity	D 2805
Wet tape adhesion	D 3359, A
Scrape adhesion	D 2197, B
Conical mandrel flexibility	D 522
Gardner impact flexibility	D 1737
Salt spray exposure	B 117

Table 4—Rating for Pigment Dispersion for TiO₂ Coatings Following 50 Days of Storage

Pigment	Pigment Volume Concentration (%)		
	6.4	17.0	28.0
TIO-1	10	8	6
TIO-2	10	10	10
TIO-3	8	6	6

See text for rating description.

Table 5—Contrast Ratio for TiO₂-Filled PMMA Coatings

Pigment	Pigment Volume Concentration (%)		
	6.4	17.0	28.0
TIO-1	0.68	0.83	0.93
TIO-2	0.71	0.91	0.95
TIO-3	0.61	0.84	0.90

Table 6—Wet Tape and Scrape Adhesion Properties of TiO₂ Coatings on Aluminum Substrate

WET TAPE ADHESION

Pigment	Pigment Volume Concentration (%)		
	6.4	17.0	28.0
TIO-1	4A	4A	4A
TIO-2	3A	3A	3A
TIO-3	4A	5A	4A

The unpigmented PMMA coating had a wet tape value of 5A.

SCRAPE ADHESION (KG)

Pigment	Pigment Volume Concentration (%)		
	6.4	17.0	28.0
TIO-1	1.0	0.75	0.75
TIO-2	0.5	0.75	0.75
TIO-3	1.5	0.75	1.5

The unpigmented PMMA coating had a scrape adhesion value of 0.75 kg.

Table 7—Conical Mandrel and Impact Flexibility of TiO₂ Coatings on Aluminum Substrate

CONICAL MANDREL (% ELONGATION)

Pigment	Pigment Volume Concentration (%)		
	6.4	17.0	28.0
TIO-1	10.0	5.7	4.6
TIO-2	9.0	4.9	4.4
TIO-3	9.5	5.7	4.1

The unpigmented PMMA coating had an elongation greater than 30%.

IMPACT RESISTANCE (mJ)

Pigment	Pigment Volume Concentration (%)		
	6.4	17.0	28.0
TIO-1	273	192	192
TIO-2	244	133	148
TIO-3	229	148	148

The unpigmented PMMA coating had an impact resistance of 27 mJ.

Table 8—Results of Coated Specimen Exposure to 5% Salt Spray

Steel Specimens, 24 Hr Exposure

Pigment	Pigment Volume Concentration (%)		
	6.4	17.0	28.0
TIO-1	coating intact no corrosion	coating intact slight corrosion	coating cracked slight corrosion
TIO-2	coating intact no corrosion	coating cracked moderate corrosion	coating cracked moderate corrosion
TIO-3	coating cracked slight corrosion	coating cracked moderate corrosion	coating cracked moderate corrosion

Steel specimens coated with the unpigmented PMMA exhibited no coating defects and no corrosion of the substrate.

Table 9—General Effects of Pigment Chemistry and Concentration on Coating Properties

Pigment reactivity (ΔH_f and ΔG_f) with PMMA: TIO-2 > TIO-1 >> TIO-3 (from IGC and calorimetry)^{2,3}

PMMA adlayer thickness: TIO-1 > TIO-2 > TIO-3 (from viscosity data applied to the Einstein model)⁴

Coating Property	Pigment Chemistry	Pigment Concentration
Dispersion quality	TIO-2 > TIO-1 > TIO-3 (resistance to settling)	28.0 > 17.0 > 6.4
Opacity	TIO-2 > TIO-1 = TIO-3	28.0 > 17.0 > 6.4
Adhesion	TIO-3 > TIO-1 > TIO-2	No effect
Flexibility	TIO-3 > TIO-1 > TIO-2	6.4 > 17.0 > 28.0
Corrosion	TIO-1 > TIO-2 > TIO-3	6.4 > 17.0 > 28.0
Permeability	TIO-3 >> TIO-1 (as determined from EIS)	

months or years of storage and longer duration will magnify the observed dispersion quality. Therefore, even minor differences after 50 days of storage are interpreted as having significant implications. The results in Table 4 illustrate that the trend for pigment suspension stability is:

TiO-2 > TiO-1 > TiO-3
Decreasing dispersion stability →

It is widely accepted that as the filler-polymer interaction increases, pigment particles are less likely to settle. This is caused by the bonding between particles and polymer, allowing the particles to remain suspended throughout the matrix. In addition, the formation of the polymer adlayer by these interactions minimizes the potential for particle-particle interactions which may lead to re-agglomeration and hard compaction of the filler. Since IGC and calorimetry results^{2,3} have illustrated that the general interaction trend of these pigments with PMMA and methyl methacrylate (MMA) is: TiO-2 > TiO-1 > TiO-3, the results of the pigment settling evaluation agree with the thermodynamics of polymer-pigment interactions.

The contrast ratios (CR) of the TiO₂ pigmented coatings are presented in Table 5. CR values are a measure of the coating's ability to mask the underlying substrate and these values increase as coating opacity improves. The results in Table 5 clearly indicate that increasing PVC results in higher contrast ratio and opacity. This is expected since TiO₂ pigments scatter and reflect light, thereby obscuring the substrate.⁷ Increasing TiO₂ concentration will enhance this effect as their concentration increases up to their critical pigment volume concentration. The results also indicate that at all pigment concentrations tested, the TiO-2 pigment provides better hiding. The general trend is:

TiO-2 > TiO-1 > TiO-3
Decreasing opacity →

It has been demonstrated that improved pigment dispersion generally enhances coating opacity due to more efficient light scattering. In fact, opacity characterization has been used as a precise and accurate technique to evaluate pigment dispersion quality within a coating.^{8,9} One requirement for high quality dispersion is that pigment particles remain in a nonagglomerated and suspended state. This is usually caused by strong filler-matrix interactions. Considering IGC and calorimetry results showed that TiO-2 and TiO-1 have stronger interaction with PMMA than TiO-3, better dispersion and opacity are expected in coatings with these pigments. These expectations are supported by the dispersion stability and CR test results previously presented.

Both wet tape and scrape adhesion tests illustrated that adhesion of all coatings to steel was extremely poor and no distinction could be made between coatings with different fillers on this substrate. Results on aluminum are presented in Table 6, with higher values in both tests indicating better adhesion. Comparison of these results did not indicate a dominant trend relative to PVC. However, a previous report recommended a PVC range (35 to 55%) for optimum adhesion of emulsion-based acrylics to steel.¹⁰ This apparent contradiction may be due to the limited PVC range used in the current study. However, one must keep in mind that the adhesion evaluation tests previously discussed are strongly

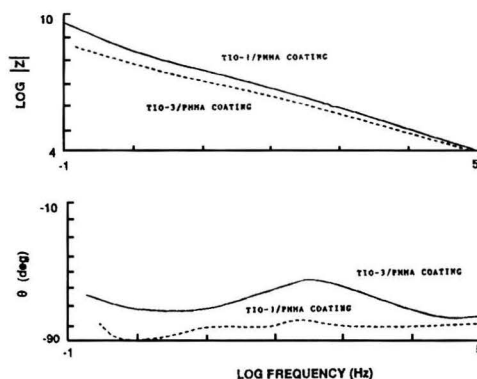


Figure 3—EIS response for coatings after 1 hr immersion in 3.5% NaCl solution

influenced by other coating properties, including strength and pigment-resin interaction. This relationship is illustrated in the following.

Comparing the effect of pigment type on both wet tape and scrape adhesion on aluminum substrate, the general trend appears to be:

TiO-3 > TiO-1 > TiO-2
Decreasing adhesion →

It has been reported,¹¹ that glassy-type polymer coatings follow a general trend of improved adhesion with increasing flexibility. In addition, other reports^{12,13} have indicated that coatings with higher internal stresses exhibit lower adhesion to their substrate. These internal stresses cause the coating to be less flexible and to fail (adhesively and/or cohesively) when external forces are applied during adhesion test experiments. Within the same resin-substrate system, it is suspected that increased pigment-polymer interactions will reduce observed substrate adhesion. The polymer chains which firmly attach to the filler surface may increase the internal stress within the polymer matrix, resulting in reduced adhesion to the substrate as observed earlier.^{11,12} The adhesion results presented herein follow this general trend, adhesion decreases with increasing pigment-polymer affinity. Results of flexibility tests which will be discussed also follow this trend.

Results from the conical mandrel and impact tests are presented in Table 7 and these results indicate a general trend identical to that observed from the adhesion tests:

TiO-3 > TiO-1 > TiO-2
Decreasing flexibility →

Based on the arguments presented, these results are expected. Increased pigment-polymer interaction increases the overall rigidity of the matrix and reduces the flexibility of the composite. In addition to this effect, there is also an obvious effect of reduced flexibility with increasing filler volume concentration.

None of the coated aluminum specimens exhibited any coating or substrate abnormalities after 500 hr exposure in

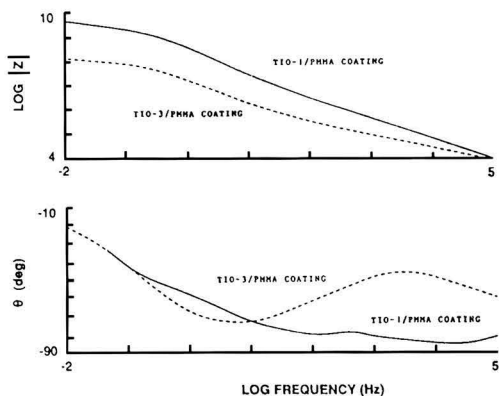


Figure 4—EIS response for coatings after 336 hr immersion in 3.5% NaCl solution

salt spray. In contrast, the steel specimens exhibited differences in coating performance after 24 hr exposure. These results are presented in Table 8. The coatings were evaluated for blistering and uplifting; the underlying steel substrates were inspected for corrosion. These results indicate the presence of both pigment type and volume effects. Coating performance decreases with increasing PVC and decreasing pigment-polymer interactions:

TIO-1 > TIO-2 > TIO-3
Decreasing coating performance →

In the related salt water immersion results, Figures 3 and 4 illustrate the EIS response of the 6.4% PVC TIO-1 and TIO-3 coatings on aluminum after 1 hr and 336 hr, respectively. References (14-16) discuss theory, analytical approach, and practical applications for investigating the performance of organic coatings on metal substrates with EIS. These references provided the basis for the analysis performed in the current study. After 1 hr of exposure (Figure 3), the TIO-1 and TIO-3 coatings had low frequency ($< 10^0$ Hz) impedance values of greater than 10^9 and 10^8 ohms, respectively. In addition, the impedance responses in the mid- to high-frequency range ($> 10^0$ Hz) are linear with a slope of approximately -1 . These results indicate low conductivity coatings which are providing good barrier protection to their substrate. However, in general lower impedance values indicate poorer barrier properties and therefore this data indicates that even after a mere 1 hr immersion, the TIO-3 coating has greater permeability than the TIO-1 coating. This effect is magnified in Figure 4 where the TIO-3 impedance value at 10^0 Hz drops to nearly 10^7 ohms while the TIO-1 coating response is nearly unchanged.

The phase angle data in Figures 3 and 4 provide supporting information on coating performance. The TIO-1 mid/high-frequency phase angles were initially between -80° and -90° , again indicating good barrier properties, where -90° is indicative of a perfect barrier. In contrast, the TIO-3 phase angles range from -50° to -80° , indicating poorer barrier properties. After 336 hr the TIO-1 coating has an increase in phase angle in the lower frequency range but remains at

nearly -90° above 10^1 Hz. The TIO-3 coating-substrate interface seems to have totally broken down after 336 hr as evidenced by high phase angles over nearly the entire spectrum analyzed.

The EIS data and the salt spray exposure results previously presented provide strong evidence that even though TIO-1 and TIO-3 were formulated in the same binder, at the same concentration, and under the same conditions, the TIO-1 coating is a better barrier. It is suspected that this contribution is provided by the enhanced pigment-binder interactions exhibited by TIO-1 as reported previously.^{2,3} These interactions give rise to a thicker adsorbed layer which is suspected to be more rigid and less permeable. In fact, a previous study⁵ indicated that the PMMA adlayer thickness trend for these pigments follows: TIO-1 > TIO-2 > TIO-3, thereby confirming that this should be the order for decreasing effective filler volume and increasing permeability. This explanation is consistent with the effect of TIO-1/PMMA coatings being less permeable than their counterpart TIO-3/PMMA coatings.

The general coating performance trends relative to pigment type and concentration are presented in Table 9. From the discussions presented earlier, they appear to agree with each other, as well as with previously presented data in both this and other work.

SUMMARY

The practical contributions of pigment-polymer interactions to coating properties have been demonstrated. Titanium dioxide pigments with more favorable adsorption free energies and enthalpies with PMMA and MMA result in coatings with better dispersion quality and stability, greater resistance to salt spray, and improved barrier properties. In contrast, these fillers had detrimental effects on adhesion and flexibility. These results are attributed to extensive interactions between filler and polymer which improves the dispersion and reduces permeability. The resulting polymer adlayer which was found to be tightly bound, caused an improvement in barrier properties as determined from EIS. These extensive pigment-polymer interactions caused the coating to prematurely fail as external forces were applied during adhesion and flexibility tests. It is believed that the enhanced interaction between polymer and pigments may create internal strain within the coating similar in effect to localized shrinkage due to a crosslinking reaction. Therefore, a more brittle coating is expected to be caused by the polymer interaction.

References

- Hegedus, C.R., "Pigment-Resin Interactions in Coating Systems," Ph.D. Dissertation, Drexel University, Philadelphia, PA, June 1991.
- Hegedus, C.R. and Kamel, I.L., "Thermodynamic Analysis of Pigment and Polymer Surfaces Using Inverse Gas Chromatography," *JOURNAL OF COATINGS TECHNOLOGY*, 65, No. 820, 31 (1993).
- Hegedus, C.R. and Kamel, I.L., "Thermodynamic Analysis of Pigment-Polymer Interactions and Their Effects on Coating Properties," Naval Air Warfare Center Aircraft Division, Warminster, PA, June 1992.
- Hegedus, C.R. and Kamel, I.L., "Adsorption Layer Thickness of Poly(methyl methacrylate) on Titanium Dioxide and Silica," *JOURNAL OF COATINGS TECHNOLOGY*, 65, No. 821, 49 (1993).
- Sward, G.G. (Ed.), *Paint Testing Manual*, American Society for Testing and Materials, Philadelphia, 1972.

- (6) *Ibid.* reference 5, Chapter 5.4.
- (7) Mitton, P.B., "Opacity, Hiding Power, and Tinting Strength," *Pigment Handbook, Volume III: Characterizations and Physical Relationships*, Patton, T.C. (Ed.), John Wiley and Sons, New York, 1973, p 289.
- (8) Montreal Society for Coatings Technology, "Quantifying Pigment Dispersion," *JOURNAL OF COATINGS TECHNOLOGY*, 61, No. 770, 73 (1989).
- (9) Steig, F.B., "Ending the 'Crowding/Spacing Theory' Debate," *JOURNAL OF COATINGS TECHNOLOGY*, 59, No. 748, 96 (1987).
- (10) Kambanis, S.M. and Chip, G., "Polymer and Paint Properties Affecting Wet Adhesion," *JOURNAL OF COATINGS TECHNOLOGY*, 53, No. 682, 57 (1981).
- (11) Payne, H.F., *Organic Coating Technology: Volume I*, John Wiley and Sons, 1954, p 17.
- (12) Croll, S.G., "Atmospheric Gases and the Hardening of an Amine-Cured Epoxy Coating," *JOURNAL OF COATINGS TECHNOLOGY*, 52, No. 665, 35 (1980).
- (13) Nate, K. and Kobayashi, T., "Adhesive Characteristics of Ultraviolet Curable Resins," *JOURNAL OF COATINGS TECHNOLOGY*, 52, No. 668, 57 (1980).
- (14) Skully, J.R., "Electrochemical Impedance Spectroscopy for Evaluation of Organic Coating Deterioration and Underfilm Corrosion—A State of the Art Technical Review," David Taylor Research Center Report DTNSRDC/SME-86/006, Annapolis, MD, September 1986.
- (15) "Evaluation of Organic Coatings by Electrochemical Impedance Measurements," EG&G Princeton Applied Research, Electrochemical Instruments Division, Application Note AC-2, Princeton, NJ.
- (16) "Basics of AC Impedance Measurements," EG&G Princeton Applied Research, Electrochemical Instruments Division, Application Note AC-1, Princeton, NJ.

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Two-Component Waterborne Polyurethane Coatings

P.B. Jacobs and P.C. Yu
Miles, Inc.*

Increasingly stringent controls on solvent emissions are forcing the coatings industry to look for alternatives to traditional solvent-borne paints and coatings. One of the approaches which has been taken to reducing solvent levels in polyurethane coatings is the use of water as a carrier. However, when ambient temperature cure is necessary or desirable, commercially available fully reacted waterborne polyurethanes often fall short in terms of chemical and solvent resistance.

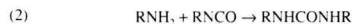
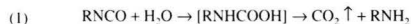
In response to the need for ambient temperature curing coatings with low solvent emission levels, we have developed two-component waterborne polyurethane coatings with properties similar to those of two-component solvent-borne polyurethane coatings. In this paper, the hydroxy-functional polyurethane dispersions and the water-dispersible polyurethane crosslinkers that make up this reactive waterborne system are discussed. We also discuss the properties of clear and pigmented films from these formulations as well as the factors which affect film properties.

INTRODUCTION

Polyurethane coatings have gained a reputation of high performance in the coatings industry. Key properties associated with these coatings are abrasion resistance, hardness, flexibility, chemical and solvent resistance, low temperature curability, and, with aliphatic polyurethane coatings, light stability. Chemists have taken advantage of the versatility of polyurethane chemistry to produce coatings which meet very demanding performance requirements. To date, the best film properties have been obtained from reactive two-component solvent-borne polyurethane coatings.

Historically, rigorous efforts have been made to keep water out of two-component polyurethane formulations due to the reaction of isocyanate with water. In this reaction,

unstable carbamic acid is formed. The carbamic acid immediately decomposes to carbon dioxide and amine (Reaction 1).¹ The carbon dioxide can form bubbles in the film and amine, once formed, reacts rapidly with other isocyanate groups to form polyureas (Reaction 2). If the reaction with water predominated, the polyol would not be crosslinked and resulting films would have very poor properties.



Prior to current developments with waterborne, two-component polyurethane coatings, it was not unreasonable to make the assumption that such reactive polyurethane systems were unworkable. In a two-component waterborne system, there is no *a priori* reason to expect that the isocyanate group will react with the active hydrogen of the hydroxyl group on a polyol component instead of the much more abundant water. However, in spite of the potential problems associated with the water/isocyanate reaction, we have been able to develop reactive two-component waterborne polyurethane coatings. These coatings provide the high gloss and performance of two-component solvent-borne coatings with low solvent emissions and ambient temperature curability.

THEORY OF TWO-COMPONENT WATERBORNE COATINGS

Films with good properties can be made from reactive two-component waterborne polyurethane coatings formulations even though water is in excess. Our theory is that the polyisocyanate reacts only slowly in the aqueous two-component formulation. When a thin film is formed from the two-component waterborne formulation, the water evaporates rather rapidly. In unpigmented films, the initial drawdowns are opaque white, but become transparent as the water evaporates within 20-60 minutes depending on the thickness

*Mobay Rd., Pittsburgh, PA 15205.

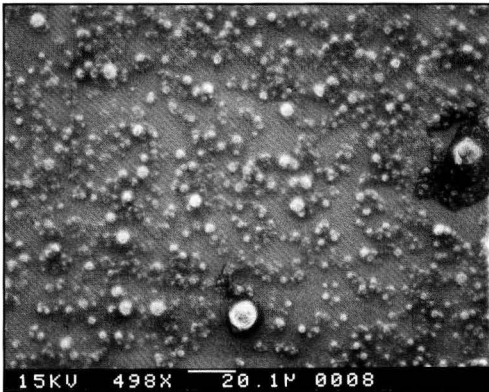


Figure 1—Scanning electron micrograph of a water dispersed polyisocyanate crosslinker. 1 cm = 20 μm

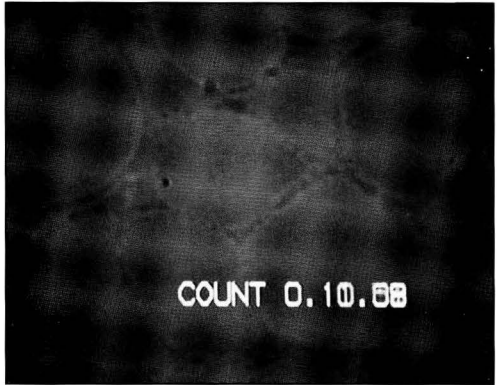


Figure 2—Light micrograph of clear film microstructure. 1 cm = 25 μm

of the films. The dispersed polyisocyanate particles coalesce with the "polyol" particles and the crosslinking reaction begins as the isocyanate groups come into contact with the oligomer bound hydroxyls.

The reaction of water with aliphatic di- or polyisocyanates used in polyurethane coatings is slow. Seneker and Potter² studied the kinetics of the catalyzed reaction of reduced diphenylmethane diisocyanate (rMDI) with water in homogeneous solution at 40 and 60°C. They reported that no significant reaction with water took place in the 15 minutes it took them to heat the solution to temperature before adding catalyst.² Dieterich states that, particularly for aliphatic isocyanate-terminated prepolymers at low temperatures, a large portion of the isocyanate groups remains stable for a relatively long time in the aqueous two-phase system.³ To further study this phenomenon, a water dispersible polyisocyanate was reacted with a stoichiometric amount of water (two equivalents of isocyanate to one equivalent of water) in a homogeneous N-methylpyrrolidinone solution. After four hours at 24°C, only five percent of the isocyanate had been consumed and, after 20 hours, only 25% had been consumed. It is clear that in a two-component system, where water is present not in stoichiometric amounts but in vast excess, some limited reaction with water does occur. We have found that optimal properties are obtained from two-component waterborne polyurethane coatings at NCO to OH ratios of 2.0 or greater, presumably because of this reaction with water.

Table 1—Property Development vs Time

Days Elapsed	1	2	3	5	12
König pendulum hardness (sec)	36	129	123	130	130
MEK 2X rubs	150	200+	200+	200+	200+
Tensile strength (psi)	1625	3193	4608	5543	5491
Reverse impact (in. lb)	160	160	160	160	160

We propose that in the formulation consisting of a water dispersible polyisocyanate and a hydroxy-functional polyurethane dispersion, polyisocyanate is dispersed in water but not dissolved in it and must coalesce with the "polyol" dispersion particles for crosslinking to occur. In dispersions with built-in hydrophilic centers, the hydrophilic portion is thought to be located on the surface of the dispersed particle.³ The bulk of the hydrophobic material is inside the particle. We used the electron microscope to demonstrate the particulate nature of the polyisocyanate crosslinker. *Figure 1* is an electron micrograph of stabilized particles from a five percent solids dispersion of a water dispersible polyisocyanate.* Light microscopy of the cured unpigmented two-component films (*Figure 2*) indicates that coalescence has taken place between the polyisocyanate particles and the polyurethane dispersion particles, although it does, in this instance, reveal a certain microstructure, probably Benard cells due to evaporative phenomenon. The microstructure is not related to the particulate nature of the starting materials as the cell diameter is on the order of 30 to 50 μm whereas the polyisocyanate particles are around two microns and the polyurethane particles in the dispersion are less than 25 nm as determined by light scattering analysis. No particles are seen in the films.

MATERIALS

Water Dispersible Polyisocyanate

The water dispersible polyisocyanate crosslinker investigated in this study was based on an aliphatic, hydrophilically modified polyisocyanate.⁴ A low viscosity material is preferred to avoid the excess solvent addition that would be required to reduce the viscosity to a level at which it could be dispersed in water.

*Preparation of sample for electron microscopy. The particles in a five percent dispersion of the polyisocyanate were stabilized by crosslinking with diethylenetriamine centrifuged and the aqueous phase decanted. Without stabilization the particles would coalesce to a continuous phase. After vacuum drying to remove all traces of water, the resulting material was examined with a scanning electron microscope.

Hydroxy-Functional Polyurethane Dispersion

Two different approaches were taken to making the waterborne polyurethane "polyols." In a "one-step" process the diisocyanate was reacted with an excess of polyester diol and glycol and dimethylolpropionic acid (DMPA). The system obtained was a hydroxyl terminated polyurethane oligomer. Upon neutralization of the acid groups, this oligomer was dispersed in water to produce the hydroxy-functional polyurethane dispersion (Figure 3). Polyurethane oligomers with greater functionality could be produced by variation of the polyol in the oligomer backbone.

In a second approach, an isocyanate-terminated prepolymer was synthesized from a diisocyanate, polyols, and DMPA. Upon neutralization of the acid group, the prepolymer was dispersed in water and reacted with an OH functional chain terminator. This method for making the polyurethane dispersion is referred to as the "prepolymer" process (Figure 4). Polyurethane oligomers with higher and lower hydroxyl functionality were synthesized by varying the chain terminator.

There are some advantages to the prepolymer process. One is that by varying the chain terminator a dispersion with increased functionality can be made from a linear prepolymer. This results in a prepolymer with lower viscosity than would be obtained by making a polyurethane oligomer with similar functionality by the "one-step" process.

Another advantage of the polyurethane prepared by the prepolymer process made from the same chemical building blocks is that it appears to react more rapidly with the polyisocyanate crosslinker than either the "one-step" process polyurethane polyol or water. Figure 5 illustrates the fact that isocyanate is consumed more rapidly in a two-component formulation with the prepolymer method dispersion than in one based on the one-step dispersion or an emulsion of the polyisocyanate in water. Thus, the polyol made by the prepolymer method would be expected to react preferentially with the polyisocyanate crosslinker in a two-component aqueous system.

UNPIGMENTED FILMS

Unpigmented Film Formulation

Two-component formulations for clear films were made by mixing the water dispersible polyisocyanate directly into the hydroxy-functional dispersion, then reducing the viscosity with additional deionized water, if necessary. No additional catalyst was required.

Property Development

The time required for full film property development in films from the two-component waterborne formulation was studied. Solvent resistance (as measured by MEK double rubs), impact resistance, and hardness reached their maximum levels in only two days, but ultimate tensile strength developed fully after four to five days (Table 1).

Cure of the two-component films was also followed by dynamic mechanical analysis (DMA). What was observed closely parallels the property development profile. The storage modulus (E') curve changes little beyond the second day after the films were formed (Figure 6) although extension

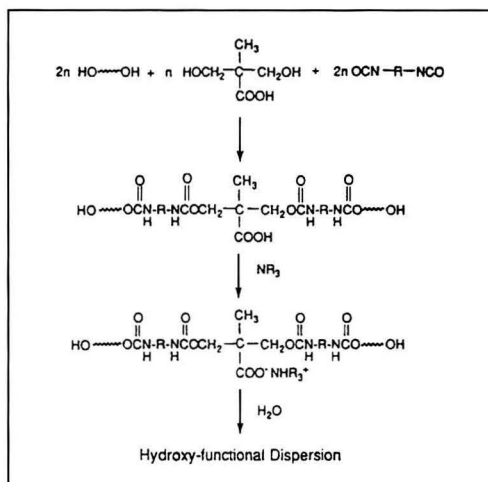


Figure 3—One-step process

and leveling off of the rubbery plateau region was observed. Glass transition temperature as determined from the tangent δ curves did not change after three days (Figure 7).

Comparison with Conventional Technology

Properties of films from the reactive two-component waterborne polyurethane formulations were compared to those of films from two-component solvent-borne formulations and fully reacted aqueous polyurethane dispersions. Under ambient temperature cure conditions, two-component solvent-borne polyurethane coatings from aliphatic polyisocyanates provide excellent flexibility, abrasion resistance,

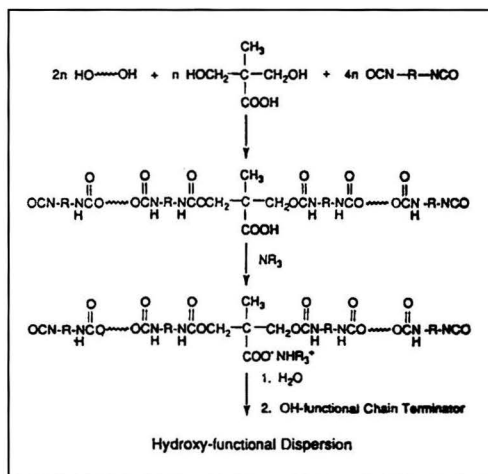


Figure 4—Prepolymer process

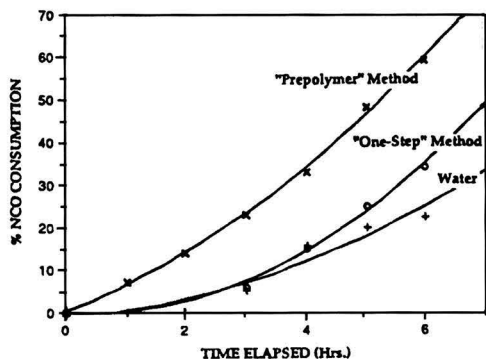


Figure 5—Isocyanate consumption vs time

chemical and solvent resistance, hardness, light stability, and gloss as well as enhance the appearance of the coated object. However, they often contain some (significant) amounts of solvent.

Films from fully reacted waterborne polyurethane dispersions provide polyurethane properties at low or zero solvent content. They are traditionally one-component dispersions consisting of fully reacted polyurethane particles dispersed in water. The advantages offered by coatings from polyurethane dispersions are good abrasion resistance, light stability, and flexibility. However, under ambient cure conditions chemical and solvent resistance can be inadequate. The reason for the poor solvent resistance is the generally low level of crosslinking found in the resins. Depending on the process, the extent of crosslinking is limited by the necessity of keeping cosolvent levels low. More highly branched prepolymers have high viscosity and thus require addition of more solvent so as not to overtax pumps and stirrers in the manufacturing process. Additionally, more highly crosslinked prepolymers require the addition of a coalescing solvent for good film formation. Thus, most polyurethane dispersions are made from either linear or only lightly crosslinked resins.⁵ Internal crosslinking can be introduced by the addition

of trifunctional amine chain extenders.⁶ Post-crosslinkers, including alkoxyated melamine/formaldehyde resins, aziridines, epoxides, carbodiimides, and blocked polyisocyanates have been used to increase crosslink density and improve properties of films from polyurethane dispersions.⁵

Clear films from the reactive two-component waterborne polyurethane system (Formulation D, Table 2) had improved solvent resistance and hardness with ambient temperature cure as compared to a typical coating with a conventional aqueous polyurethane dispersion with high hard segment content based on a cycloaliphatic diisocyanate and a polyester (Formulation C, Table 2). Because of the higher crosslinking, the two-component films had comparatively reduced elongation but still had excellent flexibility and adhesion as demonstrated by impact resistance. The higher hardness resulted from higher urethane/urea content. The greater solvent resistance was probably due to increased crosslink density resulting from the multi-functional nature of both the crosslinker and the hydroxy-functional polyurethane dispersion.

The properties of the films derived from the two-component waterborne system (Formulation D, Table 2) fell somewhere in between the properties of unpigmented films from two two-component solvent-borne formulations based on an HDI polyisocyanate and two different polyesters (Formulation A and Formulation B, Table 2). The solvent resistance and gloss were equivalent in the two solvent-borne films and the two-component waterborne films. The hardness of the film from the waterborne system was closer to that of the film from Formulation A, Table 2, which was based on a highly functionalized polyester. Films derived from the two-component waterborne system had greater flexibility than those from Formulation A as demonstrated by elongation, but less flexibility than the films from Formulation B based on the trifunctional polyester.

PIGMENTED FILMS

Formulation and Properties

Film properties with pigmented two-component waterborne coatings were also studied. A standard formula-

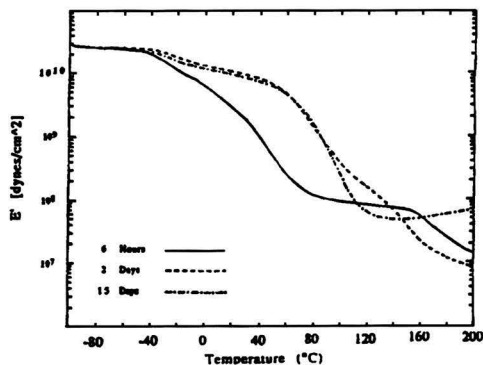


Figure 6—E' vs temperature (normalized)

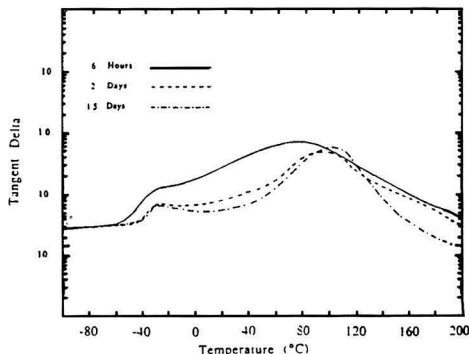


Figure 7—Tangent δ vs temperature (normalized)

Table 2—Property Comparison—Unpigmented Films

Formulation	A ^a	B	C	D
MEK 2X rubs	200+	200+	20	200+
Köenig pendulum hardness (sec)	170	23	70	134
Reverse impact (in. lb)	160	160	160	160
Tensile strength (psi)	4900	6200	5700	5755
Elongation (%)	<5	150	160	10
60° Gloss	>90	>90	>90	>90

(a) A = Solvent-borne HDI polyisocyanate and highly functionalized polyester.
 B = Solvent-borne HDI polyisocyanate and tri-functional polyester.
 C = Aqueous polyurethane dispersion with high hard segment content.
 D = Reactive two-component waterborne system (intermediate polyol functionality).

Table 3—Pigmented Waterborne Two-Component Polyurethane Coating Formulation

Raw Material	Weight	Volume (gal)	Weight Solids	Volume Solids
Component I				
PUD-OH ^a	463.92	51.72	185.57	18.59
Wetting agent	2.66	0.27	2.66	0.27
Defoamer	0.98	0.13	0.98	0.13
Titanium dioxide	251.99	7.80	251.99	7.8
Flow additive	22.18	2.65	1.10	0.12
Deionized water	56.93	6.84	0.00	0.00
Subtotal	798.66	69.41	442.3	26.91
Component II				
WD-ISO ^b	129.42	13.48	129.42	13.48
Solvent	31.49	4.33	0.00	0.00
Post-Add				
Deionized water	106.44	12.78	0.00	0.00
Total	1066.01	100.00	571.72	40.39
Weight solids, %			53.63	
Volume solids, %			40.39	
VOC, lb/gal			1.80	
Weight/gallon, lb/gal			10.66	
NCO:OH ratio			2:1	

(a) Hydroxy-functional polyurethane dispersion.
 (b) Water-dispersible polyisocyanate crosslinker.

Table 4—Properties of Pigmented Films

Property or Test	Results	ASTM
Pencil hardness	H-2H	D 3363
MEK double rubs	100+	D 4752
Impact - dir/rev (in. lb)	160/160	D 2794
Gloss (60°/20°)	85/65	D 523
Köenig pendulum hardness (sec)	120	D 4366
Taber abrasion (mg loss) CS-17 wheel, 1000 cycle	38	D 4060
VOC (lb/gal)	1.8	—
Dry time (hr to hard dry)	1.25	—
Working pot life (hr)	>5	—

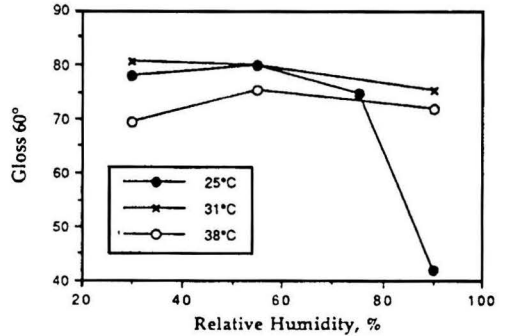


Figure 8—Gloss 60° vs relative humidity

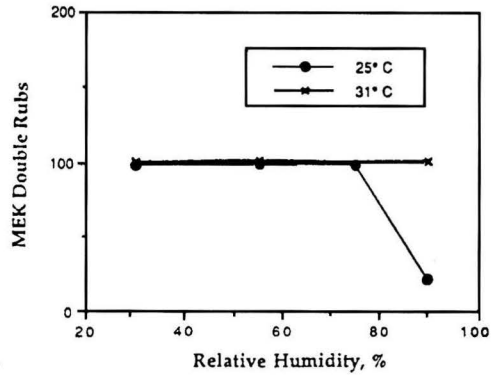


Figure 9—Solvent resistance vs relative humidity

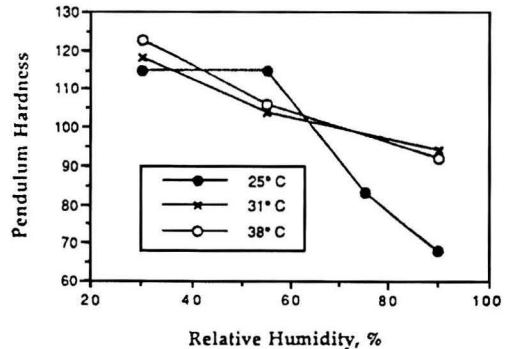


Figure 10—Pendulum hardness vs relative humidity

tion is shown in *Table 3*. Traditional catalysts used in aliphatic polyisocyanate based coatings, such as alkyl tin or zinc complexes, were not used in this study. In order to obtain good film appearance, surface active agents such as wetting agents, flow additives, and defoamers were incorporated in the formulation. To disperse the pigments, either a pebble mill or a sandmill could be used. As with other aqueous coatings, deionized water was found to be preferable to tap water as a viscosity reducer.

Typical film properties are shown in *Table 4*. When the films were cured in a controlled environment (55% RH and 77°F), film properties similar to solvent-borne polyurethane coatings were obtained. These were indicated by the excellent film flexibility, hardness, and abrasion and solvent resistance. Application properties were also good. For instance, the films dried within 1.5 hr, allowing early handleability. Also, the working potlife was relatively long with sprayability and film properties remaining constant over a period of about five hours. This long pot life could eliminate the need for more expensive two-component spray equipment. In addition, a great advantage in VOC can be seen with this type of coating. Depending on the pigmentation, VOC was equal to or lower than 1.8 pounds per gallon minus water.

Effect of Humidity and Temperature on Film Properties

It was found that conditions under which the cure was carried out did affect film properties. Hardness, solvent resistance, and 60° gloss were excellent when two-component waterborne pigmented films were cured at 25°C and up to 55% relative humidity. However, at 25°C and 90% relative humidity the properties were reduced. It is not surprising that the properties of the films were better at lower relative humidities. At higher humidity, the water does not evaporate from the films very rapidly, probably resulting in increased reaction with water as opposed to the polyol co-reactant. With more of the isocyanate reacting with water, the hydroxy-functional polyurethane oligomer might not have been as fully reacted, plasticizing the film and resulting in a softer and less solvent resistant film. Further study of the effects of humidity on the pigmented films showed that at somewhat higher cure temperature (31 to 38°C), the negative effect of high humidity was overcome (*Figures 8-10*).

CONCLUSIONS

Properties like those of two-component solvent-borne polyurethane films have been obtained from novel reactive waterborne two-component polyurethane formulations. These coatings were based on water dispersible polyisocyanates and hydroxy-functional aqueous polyurethane dispersions prepared by two different processes. Experimental work supports the theory that the polyisocyanate crosslinker reacts only slowly with water in these formulations over the pot life of the formulation (5+ hrs). When thin films are formed, the water evaporates rather rapidly and the isocyanate coalesces with the polyurethane oligomer particles, forming a continuous film in which crosslinking occurs.

In films based on a two-component waterborne coating system and cured at ambient temperature, maximum solvent resistance, impact resistance, and hardness were attained within two days. Full tensile strength developed in between four and five days. In DMA studies, the E' curve and $\tan \delta$ curves showed little change after two to three days. Pigmented films were readily formulated and exhibited excellent properties. At 25°C, high humidity affected film properties adversely, but this effect was moderated or negated at slightly higher cure temperatures.

ACKNOWLEDGMENTS

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References

- (1) Oertel, G., *Polyurethane Handbook*, Hanser Publishing, NY, 1985.
- (2) Seneker, S.D. and Potter, T.A., "Solvent and Catalyst Effects in the Reaction of Dicyclohexylmethane Diisocyanate with Alcohols and Water," *JOURNAL OF COATINGS TECHNOLOGY*, 63, No. 793, 19 (1991).
- (3) Dieterich, D., *Progr. Org. Coatings*, 9, 281 (1981).
- (4) Hombach, R., Reiff, H., and Dollhausen, M. (to Bayer A.G.), U.S. Patent 4,663,337 (May 5, 1987).
- (5) Tirpak, R.E. and Markusch, P.H., *Proc. 12th Water-Borne and Higher Solids Coatings Symposium*, February 1985, pp 159.
- (6) Witt, H. and Dieterich, D. (to Bayer A.G.), U.S. Patent 3,870,684 (March 11, 1975); and Hangauer, D.G. Jr. (to Textron, Inc.), U.S. Patent 4,203,883 (May 20, 1980).

Studies in the Thermal Diffusion of Copolymers Using Field-Flow Fractionation

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Earlier studies of copolymer thermal diffusion are extended here to include several new random and block copolymers of polystyrene and polyisoprene. Thermal diffusion coefficients for these polymers in tetrahydrofuran and cyclohexane were obtained by thermal field-flow fractionation (ThFFF). The results confirm the dependence of thermal diffusion (and therefore ThFFF retention) on the radial distribution of monomeric units in the solvated macromolecule. For random copolymers and block copolymers that assume a random configuration, the thermal diffusion coefficient D_T is a

linear function of copolymer composition. This relationship provides a basis for obtaining compositional information on such copolymers by ThFFF. For copolymers subject to radial segregation of their monomeric units, the significance of a given unit's role in thermal diffusion increases with the radial distance of the unit from the core of the solvated molecule. The dependence of retention on the radial distribution of monomeric units provides a basis for evaluating bonding arrangements in copolymers.

INTRODUCTION

Traditional methods used to characterize polymers are selective to either molecular weight or chemical composition, but not to both. For example, size exclusion chromatography (SEC) separates polymers according to size without regard to chemical composition, while infrared spectroscopy yields information on chemical composition but not the degree of polymerization. In contrast, thermal field-flow fractionation (ThFFF) separates polymers by chemical composition as well as size, and is therefore capable of yielding both size and compositional information on copolymers.

ThFFF is a chromatography-like technique, with separation occurring along the axis of flow. Unlike chromatogra-

phy, however, the separation is not achieved through interactions with a stationary phase (partition chromatography) or by diffusion into the pores of a packing material (SEC). In ThFFF, separation is achieved by applying a temperature gradient across the thin dimension of a ribbon-shaped channel, which contains a flowing carrier liquid (*Figure 1*). Polymers respond to the temperature gradient by concentrating at the cold wall, where the flow of carrier liquid is slower due to viscous effects. Polymer components are separated because they interact with the temperature gradient to different extents, and therefore migrate at different rates through the channel.

The movement of solute in response to a temperature gradient is called thermal diffusion; it is quantified by the thermal diffusion coefficient D_T , which relates mass flux to a temperature gradient.¹ The concentration of solute by thermal diffusion is opposed by ordinary (mass) diffusion, quantified by the mass diffusion coefficient D , which relates mass

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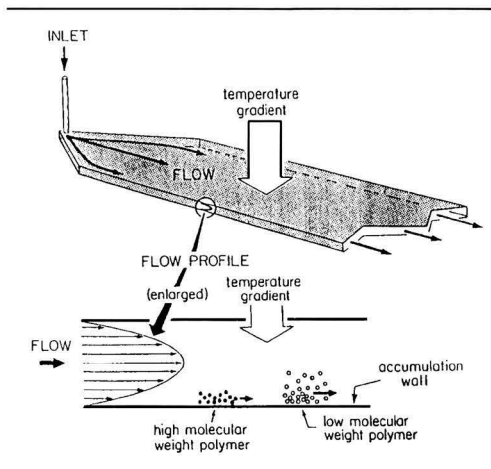


Figure 1—Illustration of principles of separation by ThFFF

flux to a *concentration* gradient. In a ThFFF channel, the opposing forces of thermal and ordinary diffusion yield a concentration profile which is highest at the cold wall and decreases exponentially toward the center of the channel. The distance ℓ from the cold wall to the center of gravity of the polymer zone can be mathematically defined in terms of the temperature gradient in the channel and the transport coefficients (D and D_T) of the polymer-solvent system. Parameter ℓ governs the rate at which a polymer component is flushed through the channel by carrier liquid. The rate is lower for systems with a large D_T value because greater compression of a component confines it to slower moving regions near the wall. A large value of D has the opposite effect; migration is faster because the more diffuse concentration profile extends into faster flowstreams toward the center of the channel. Thus, components with different transport coefficients separate into bands along the flow axis, much like chromatography.

Studies have shown that ThFFF retention is governed by the molecular weight of the polymer and the chemistry of both polymer and solvent.^{2,3} However, the molecular weight selectivity of ThFFF is not due to differences in the thermal diffusion coefficient, which is independent of molecular weight and branching configuration in homopolymers.⁴ This is fortunate because it makes calibration curves unnecessary to obtaining molecular weight information in homopolymers, once the D_T value of the polymer-solvent system has been established (by ThFFF), and provided that the relationship between D and molecular weight is known. Under these circumstances, the molecular weight distribution of a polymer sample can be obtained directly from its ThFFF elution profile.

Copolymer retention in ThFFF is more complex than that of homopolymers because thermal diffusion is dominated by

monomeric units (subsequently referred to as mers) located in the exterior region of the solvated polymer coil. If the mers assume a random profile in the solvated coil, copolymer D_T values can be predicted from D_T values for the corresponding homopolymers.⁵ However, in block copolymers that are subject to radial segregation of the different types of mers, two copolymers with identical composition and size may not have the same thermal diffusion coefficient.⁵ This is unfortunate because it means that the compositional distribution of block copolymers cannot be directly obtained from ThFFF elution profiles. Of course, detectors that are selective to composition (such as an infrared spectrometer) can be used to obtain the average composition as a function of ThFFF retention time. Still, we would like to better understand the effect of secondary structure on the thermal diffusion of block copolymers in order to determine whether or not we can predict and compensate for the effect, and perhaps use ThFFF to characterize secondary structure in copolymers.

While thermal diffusion in polymer solutions has been studied for decades, a valid predictive model has not emerged.³ In ThFFF we have a new and better technique to study this complex phenomenon. Convection currents which have plagued other methods are absent in ThFFF, and D_T values can be determined accurately with sub-milligram quantities of polymer. The studies outlined in this paper are designed to increase the understanding of thermal diffusion in a way that defines and expands the applicability of ThFFF to copolymer analysis.

THEORY

One of the significant advantages of FFF separations stems from the uniform open channel geometry and the well-defined flow profile. Consequently, retention can be related directly to physicochemical parameters of the analyte material and carrier liquid. In ThFFF, the distance ℓ from the cold wall to the center of gravity of the polymer zone is related, through the fundamental retention parameter λ , to the temperature gradient dT/dx in the channel and the transport coefficients,

$$\lambda = \frac{\ell}{w} = \frac{D}{w D_T (dT/dx)} \quad (1)$$

where w is the channel thickness (the distance between the hot and cold walls). Retention parameter λ can also be related, by considering the flow profile, to the volume V_f of carrier liquid required to elute the polymer zone. For parabolic flow⁶

$$V^0/V_f = 6\lambda[\coth(1/2\lambda) - 2\lambda] \quad (2)$$

where V^0 is the geometric (void) volume of the channel. In ThFFF, equation (2) must be corrected somewhat to account for the departure from parabolic flow induced by the temperature dependence of carrier-liquid viscosity.⁶ By using equation (1) and the corrected form of equation (2), accurate values of D/D_T can be calculated from the measured reten-

tion volume V_r . Conversely, if D_T is known for a polymer-solvent system, as well as the relationship between D and molecular weight, elution profiles can be used to determine the molecular weight distribution without calibration.

As V_r increases, the bracketed term on the right side of equation (2) approaches unity. When $V_r > 3 V^0$, V^0/V_r can be approximated by $V^0/V_r = 6\lambda$. In this case, combining equations (1) and (2) and approximating dT/dx as $\Delta T/w$, where ΔT is the temperature difference between the hot and cold walls, yields

$$V_r = \left(\frac{V^0 \Delta T}{6} \right) \left(\frac{D_T}{D} \right) \quad (3)$$

Equation (3) shows that for $V_r > 3 V^0$ and constant field strength (ΔT), retention is a linear function of ratio D_T/D .

The diffusion coefficient for dilute solutions is governed by the Stokes-Einstein equation, which can be related to the intrinsic viscosity $[\eta]$ by⁷

$$D = \left(\frac{kT}{6\pi\eta_0} \right) \left(\frac{10\pi N}{3M[\eta]} \right)^{1/3} \quad (4)$$

Here η_0 is the solvent viscosity, M is the polymer molecular weight, and N is Avagadro's number. In contrast to D , the physicochemical parameters governing thermal diffusion in liquids are unknown.

BACKGROUND

The value of an improved understanding of thermal diffusion has grown with advances in ThFFF theory and instrumentation. As a result, a systematic study was begun of thermal diffusion in polymer solutions.³⁻⁵ In 1987, Schimpf and Giddings⁴ demonstrated that D_T values in homopolymers are independent of both molecular weight and branching configuration, supporting deGenne's view⁸ that thermal diffusion in polymers is not subject to long-range frictional forces which govern the mass diffusion of polymers. In a subsequent study, D_T values were correlated with several polymer and solvent parameters,³ including the thermal conductivities of the polymer and solvent, the polymer density, and the viscous activation energy of the carrier liquid. More recently, the thermal diffusion of several copolymers in toluene was characterized.⁵ The intent of the copolymer studies was to examine the compositional dependence of thermal diffusion in copolymers, as well as the effect of mer location within the solvated sphere. For example, it was unclear whether thermal diffusion is affected equally by all the mers, or if the effect is dominated by mers located in specific regions, such as the outer free-draining region of the solvation sphere. Block copolymers are useful probes in addressing this issue because their mers are subject to radial segregation. For example, segregation can be built into the primary structure of copolymers during synthesis, especially in star-shaped copolymers prepared by joining the ends of linear diblock arms. In this case, the mers located proximal to the junction of the arms are physically anchored to the inner region of the

solvated molecule. Segregation can also be induced in the secondary structure of block copolymers dissolved in a liquid that is a better solvent for one of the mer types.⁹ In such a liquid, subsequently referred to as a selective solvent, the more soluble polymer segments migrate to the outer regions of the solvated molecule, surrounding a more condensed core containing less soluble segments. The presence of solvent-induced segregation has been supported by fluorescence-emission probe techniques and low-angle light scattering methods.¹⁰

In studying the effect of mer location on thermal diffusion,⁵ it was found that in random copolymers, D_T values apparently assume the weighted average of the corresponding homopolymer values, where the weighting factors are the mole-fractions of each mer type in the copolymer. However, in block copolymers subject to radial segregation of their mers, thermal diffusion appears to be dominated by mers located in the free-draining region of the solvated polymer molecule. In the work reported here, values of D_T were obtained for styrene-isoprene (PSI) copolymers of varying composition and structure in cyclohexane and THF. Cyclohexane is selective for PI, since it is a good solvent for PI and a theta-solvent for PS. Thus, PI segments are expected to segregate to the exterior of the solvated molecule in cyclohexane. In THF, which is an equally good (nonselective) solvent for PS and PI, solvent-induced segregation is not expected. However, the star-shaped copolymers have segregation built into their secondary structure. By studying the thermal diffusion of star-shaped copolymers in THF, we examine the effect of structural segregation on thermal diffusion independent of previous complications due to solvent-induced segregation.

METHODOLOGY

Polymer Samples

Detailed information on the polymers utilized in these studies is contained in *Table 1*. All samples were prepared by

Table 1—Summary of Polymers Examined

Polymer No.	MW (daltons)	Composition ^a (mol-%)	Shape	Bonding Arrangement ^b
1	— ^c	100 PS	linear	—
2	— ^c	100 PI	linear	—
3	28,000	77 PS, 23 PI	linear	diblock
4	39,000	43 PS, 57 PI	linear	diblock
5	40,000	16 PS, 84 PI	linear	diblock
6	38,000	51 PS, 49 PI	linear	random
7	315,000	22 PS, 78 PI	Star-4 ^d	PI inside
8	559,999	22 PS, 78 PI	Star-8	PI inside
9	833,000	22 PS, 78 PI	Star-12	PI inside
10	1,100,000	68 PS, 32 PI	Star-18	PS inside

(a) PS = polystyrene, PI = polyisoprene.
 (b) All arms of star-shaped polymers are linear diblocks.
 (c) Includes a variety of polymer standards of different molecular weights.
 (d) Number of arms.

Table 2—D and D_T Values for Copolymers and Component Homopolymers^a

Polymer No.	Solvent	D × 10 ⁷ (cm ² /s)	D _T × 10 ⁷ (cm ² /s-K)
1. PS	cyclohexane	— ^b	0.44 ^d
	THF	— ^b	0.96 (0.04)
2. PI	cyclohexane	3.4	0.08 ^d
	THF	— ^b	0.51 ^{c,d}
3. PSI	cyclohexane	1.89	0.12 ^d
	THF	11.8	0.87 ^d
4. PSI	cyclohexane	1.53	0.15 ^d
	THF	9.69	0.69 ^d
5. PSI	cyclohexane	0.52	0.05 ^d
	THF	9.52	0.58 ^d
6. PSI	cyclohexane	2.84	0.29 ^d
	THF	9.79	0.75 ^d
7. PSI	THF	3.45	1.01 (0.02)
8. PSI	THF	2.59	1.01 (0.03)
9. PSI	THF	2.52	1.03 (0.03)
10. PSI	THF	1.69	0.76 (0.02)

(a) Numbers in parentheses represent 1 standard error.

(b) Includes a variety of polymer standards of different molecular weight.

(c) Data obtained from reference (2).

(d) Uncertainty was not determined.

anionic polymerization to obtain a narrow molecular weight distribution (polydispersity less than 1.1), and were typically dissolved in the carrier liquid at a concentration of 1 mg/mL. Besides variations in composition, the copolymers can be divided into groups that differ in arm numbers and block arrangement. By examining the influence (or lack of influence) of these distinctive features on D_T values, we are able to more fully characterize the phenomenon of thermal diffusion in copolymers.

Instrumentation

Two ThFFF systems were used in this work. Both are similar to the model T100 polymer fractionator from

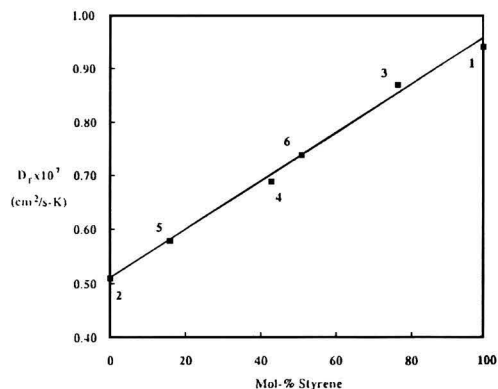


Figure 2—Plot of D_T vs mol-% styrene for linear-random and linear-diblock copolymers of styrene and isoprene (1-6 in Table 1) in the nonselective solvent THF

FFFractionation Inc. (Salt Lake City, UT), with a channel length of 46 cm (tip-to-tip), a width of 2.0 cm, and a thickness of 127 μm. However, control of the hot wall temperature in one system was achieved using a proportional controller built in-house. This controller is based on an operational amplifier functioning as an astable multivibrator, which governs the on and off times of the hot-wall heaters. To enhance stability, a thermistor is used to drive a feedback loop that alters the reference point of the multivibrator and hence the on and off times. Stability of the controller is better than ±0.1 Kelvin.

The SEC column used to measure polymer diffusion coefficients is a commercial Ultrastaygel column from Waters Chromatography Div., Millipore Corp. (Milford, MA). Detection was accomplished with a refractive index monitor for the toluene work; otherwise, a fixed-wavelength (254 nm) UV detector was used.

Determination of Diffusion Coefficients

In order to determine D_T values from ThFFF retention data, accurate values for the polymer diffusion coefficient D must be available. Values of D in THF were obtained by calibrating an SEC column as ln D versus retention volume using a series of polystyrene standards whose D values were obtained from light scattering data.³ A separate calibration curve was prepared for each solvent because the pore size of the column-packing material changes with solvent. Values of D in cyclohexane were obtained directly by dynamic light scattering.

RESULTS AND DISCUSSION

The D_T values obtained in these studies are summarized in Table 2. Figure 2 illustrates the linear dependence of D_T on styrene content in PSI copolymers dissolved in THF. Represented in Figure 2 are three diblock copolymers (numbers 3-5), one random copolymer (no. 6), and the homopolymer D_T values as endpoints. Although solvent-induced polymer segregation is possible in block copolymers, none is expected in the polymers represented in Figure 2 because THF is an equally good solvent for both polystyrene and polyisoprene. In this case, the data indicate that copolymer D_T values can be described as a weighted average of the D_T values of the homopolymer constituents, where the weighting factors are the mole fractions X_a and X_b of the constituentmers. This relationship can be expressed as

$$D_T(ab) = X_a D_T(a) + X_b D_T(b) \quad (5)$$

where D_T(ab), D_T(a), and D_T(b) are the thermal diffusion coefficients of ab copolymer, a homopolymer, and b homopolymer, respectively. This linear relationship between D_T and composition is common to that found earlier⁵ for styrene-methylmethacrylate random copolymers in toluene.

The thermal diffusion of branched PSI copolymers in THF is illustrated in Figure 3. The line marked "ideal de-

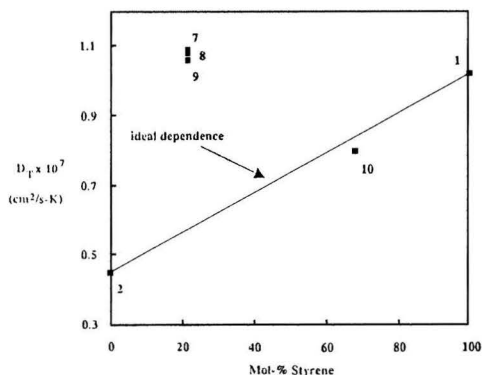


Figure 3—Plot of D_T vs mol-% for star-shaped diblock copolymers of styrene and isoprene (1, 2 and 7-10 in Table 1) in the nonselective solvent THF

pendence" indicates the linear relationship between D_T and composition based on the two homopolymer endpoints. Clearly a linear relationship does not exist in this case. In copolymers 7-9, linear diblocks of PSI are joined at the isoprene end to form a star-shaped copolymer. In this configuration, isoprene components are physically anchored to the interior, so that the free-draining region is enriched with mers of styrene. D_T values for these polymers are similar to that of polystyrene homopolymer, indicating that thermal diffusion is dominated by the styrene mers. In copolymer 10, the diblock arms are joined at the styrene end, so the free-draining region is enriched with mers of isoprene. The lower D_T value of copolymer 10 indicates that the isoprene mers influence thermal diffusion in this configuration. However, isoprene does not appear to dominate thermal diffusion as styrene does when it is located in the exterior regions. Although this behavior requires further study, it suggests that faster moving styrene mers located in the free-draining region carry the slower isoprene mers along in the thermal gradient, and that as expected, the frictional drag of the isoprene mers is greater when they are located in the free-draining region.

To explore the effect of solvent-induced segregation, we examined linear PSI copolymers 3 through 6 in cyclohexane, which is a good solvent for PI and a poor solvent for PS. As illustrated in Figure 4, the D_T values for block copolymers 3-5 are closer to that of PI than predicted by the ideal linear dependence of D_T on composition. This was anticipated, since PI segments are expected to segregate to the exterior of the solvated coil due to solvent effects. In random copolymer 6, where mer segregation is precluded by the absence of long segments that contain only one mer type, D_T falls in line with the homopolymer values, indicating that thermal diffusion is equally influenced by both mer types. These results further support the view that a given mer's role in thermal diffusion becomes more significant as the radial distance of the mer from the core of the solvated polymer increases.

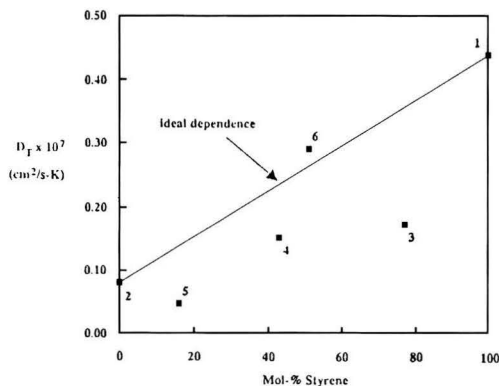


Figure 4—Plot of D_T vs mol-% styrene for linear-random and linear-diblock copolymers of styrene and isoprene (1-6 in Table 1) in the selective solvent cyclohexane

CONCLUSIONS

The thermal diffusion of copolymers, quantified by D_T , is a complex phenomenon which depends on copolymer structure as well as composition. For random copolymers and block copolymers that assume a random configuration in solution, D_T is a weighted average of the D_T values of the corresponding homopolymers, where the weighting factors are the mole-fractions of each component in the copolymer. This simple relationship can be used to analyze composition in randomly distributed copolymers.

In block copolymers subject to radial segregation of its mers, thermal diffusion is influenced by secondary structure. Consistent with previous findings, the work reported here demonstrates that mers located in the free-draining region influence thermal diffusion more strongly than mers in the nondraining region. When the free-draining region is enriched in the faster moving component, thermal diffusion mimics that of homopolymers composed of those mers. When the free-draining region is enriched in the slower moving component, the influence of those mers on thermal diffusion is enhanced, but D_T values cannot be predicted quantitatively.

There are two requirements for a random distribution of mers to exist in block copolymers. First, the solvent must be equally good for both components. Second, the ability of the mers to distribute randomly about the solvation sphere cannot be significantly restricted by bonding constraints. Complete randomization is impossible in any block configuration. However, such restrictions are apparently not significant for diblocks in a nonselective solvent, so that thermal diffusion follows the same linear dependence on composition as it does in random copolymers. Thus, ThFFF can be used to determine the composition of linear diblock copolymers using a nonselective solvent as the carrier liquid. More work is needed to determine the applicability of ThFFF to the compositional analysis of more complex blocking arrangements.

However, we suggest that segregation of homogeneous segments in block copolymers dissolved in a selective solvent provides a basis for using ThFFF to study bonding arrangements in block copolymers.

In contrast with linear-block copolymers, branched-block copolymers contain severe bonding constraints to randomization. In this case, ThFFF shows potential for characterizing such properties as the degree of grafting in graft copolymers.

ACKNOWLEDGMENTS

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References

- (1) Tyrell, H.J.C., *Diffusion and Heat Flow in Liquids*, Butterworths, London, 1961.
- (2) Gunderson, J.J. and Giddings, J.C., *Macromolecules*, *19*, 2618 (1986).
- (3) Schimpf, M.E. and Giddings, J.C., *J. Polymer Sci., Polymer Physics Ed.*, *27*, 1317 (1989).
- (4) Schimpf, M.E. and Giddings, J.C., *Macromolecules*, *20*, 1561 (1987).
- (5) Schimpf, M.E. and Giddings, J.C., *J. Polymer Sci., Polymer Physics Ed.*, *28*, 2673 (1990).
- (6) Gunderson, J.J. and Giddings, J.C., *Sep. Sci. Technol.*, *19*, 667 (1984).
- (7) Rudin, A. and Johnston, H.K., *J. Polymer Sci., Part B*, *9*, 55 (1971).
- (8) Brochard, F. and de Gennes, P-G., *Hebd. Seances Acad. Sci.*, *293*, 1025 (1981).
- (9) Sadron, C., *Angew. Chem. Intern. Ed.*, *2*, 248 (1983).
- (10) Watanabe, A. and Matsuda, M., *Macromolecules*, *18*, 273 (1985).

A Silane Primer: Chemistry and Applications of Alkoxy Silanes

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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 resulted in the development of alkoxy functional silanes for use as adhesion promoters, crosslinkers, and hydrophobes. The intent of this paper is to briefly review the unique chemistry of this class of materials and to discuss three areas of product development that have benefitted from the utilization of silanes: surface treatment, additive, and reactive intermediate. This discussion will include recommendations for specific organic/silane combinations.

INTRODUCTION

The ability of silane added to a coating formulation to migrate to the substrate interface and improve bonding is well known. In addition, silanes have been added to latices and hydrolyzed to form an interpenetrating polymer network (IPN) polymer with improved properties.¹ Two types of alkoxy silanes have widespread application in the coatings industries: alkyl/aryl and organofunctional.

Possessing both organic and inorganic properties, these hybrid chemicals react with the polymer and mineral components, forming durable covalent bonds across the interface. It has been proposed that these bonds are hydrolyzable, but can reform, and therefore provide a means of stress relaxation at the organic/inorganic interface. The results are improved adhesion and durability.²

CHEMISTRY OF ORGANOFUNCTIONAL ALKOXYSILANES

The general formula of an alkoxy silane shows two classes of moieties attached to the silicon atom:



R is a nonhydrolyzable organic moiety that can be either an alkyl, aromatic, organofunctional, or a combination of any of these groups. These groups provide the organic compatibility which allows the silane to form IPNs, or in the case of reactive organofunctional silanes, to co-react with the coating polymer. Alkyl and aryl silanes are utilized to improve gloss, hiding power, mixing time, and other properties related to improved pigment dispersion. Alkyl and aryl silanes are also utilized to provide hydrophobic surfaces in applications such as water repellents.

The X represents alkoxy moieties, most typically methoxy or ethoxy, which react with the various forms of hydroxyl groups and liberate methanol or ethanol. These groups can provide the linkage with inorganic substrates, pigment, or filler to improve coating integrity and adhesion. The methoxy groups are also capable of reacting with hydroxy functional polymers.

Reaction of these silanes involves four steps (see *Figure 1*). Initially, hydrolysis of the alkoxy (X) groups occurs. It is after the first and second alkoxy groups are hydrolyzed that condensation to oligomers follows. Compared to the hydrogen of a carbinol moiety, the silanol hydrogen is more electrophilic and much more reactive. This is due to the larger, more electropositive, atomic structure of silicon which results in a high dipole moment for the silanol group and greater hydrogen bonding. The tendency toward self condensation can be controlled by using fresh solutions, alcoholic solvents, dilution, and by careful selection of pH ranges.

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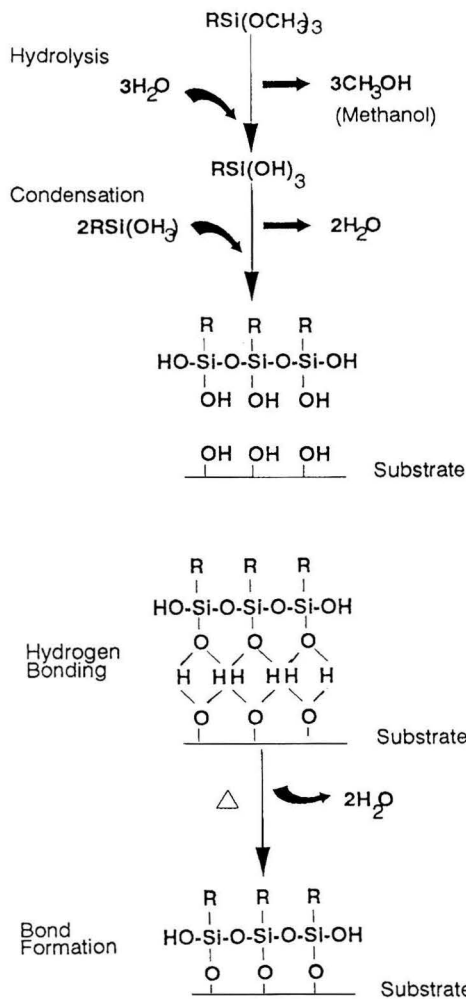


Figure 1—Reaction process of alkoxy silanes

Silanetriols are most stable at pH 3-6, but condense rapidly at pH 7-9.³

The third methoxy group upon hydrolysis is oriented towards, and hydrogen bonds with, hydroxy sites on the substrate. Finally, during drying or curing, a covalent bond is formed with the substrate and water is liberated. At the interface, there is usually only one bond from each silicon of the organosilane to the substrate surface. A moderate cure cycle (110°C/15 min) will leave silanol groups remaining in free form and, along with any silane organofunctionality, may bond with the subsequent topcoat, forming an IPN and providing improved adhesion.⁴

UTILIZATION OF ORGANOFUNCTIONAL ALKOXY SILANES

There are three basic methods of utilizing silanes in a coatings application: (1) surface treatment, which includes particle (i.e., pigments and fillers) treatment formulated into primers, and water repellents; (2) additive into paints, inks, and adhesives; and (3) reactive intermediate for silicone resin synthesis and organic resin modification. Each of these methods requires special consideration.

SURFACE TREATMENT

Often the silane is subjected to hydrolysis prior to the surface treatment. Following hydrolysis, a reactive silanol group is formed, which can condense with other silanol groups, for example, those on the surface of siliceous fillers, to form siloxane linkages. Stable condensation products are also formed with other oxides such as those of aluminum, zirconium, tin, titanium, and nickel. Less stable bonds are formed with oxides of boron, iron, and carbon. Alkali metal oxides and carbonate do not form stable bonds with Si-O. Sufficient water for hydrolysis may be available from atmospheric moisture, or on the substrate surface. In some cases, it may be necessary to add water to increase the degree of hydrolysis.

The most straightforward method of silylating a surface with a silane is from an alcohol solution. A two percent silane solution can be prepared in the alcohol of choice (methanol, ethanol, and isopropanol are typical choices). The solution can be wiped, dipped, or sprayed onto the surface. When dipping a large object, e.g., glass plates, allow one to two minutes of submersion to allow silane migration to the surface. After the surface dries, excess material can be gently wiped, or briefly (alcohol) rinsed off. Particles, e.g., pigments and fillers, can be silylated by stirring them in a solution for two to three minutes and then decanting the solution. The particles can then be rinsed with alcohol. Cure of the silane layer is for 5-10 min at 110°C or for 24 hr at ambient conditions.

Flow and adhesion are improved by applying silanes from aqueous alcohol solutions.³ A 95% ethanol-5% water solution is adjusted to pH 4.5-5.5 with acetic acid. Silane is added with stirring to yield a 2-10% final concentration.

Table 1—Recommendations for Water Soluble and Hydrophilic Polymers

Water Soluble & Hydrophilic Polymers	Silane			
	A	B	C	D
Acrylic latex	—	—	—	✓
Cellulosic	—	—	—	✓
Heparin	—	—	—	✓
Polyhydroxyethylmethacrylate	—	—	—	✓
Polysaccharide	—	—	—	✓
Polyvinyl alcohol	✓	—	✓	—
Polyvinyl acetate	—	—	✓	—
EVA	—	✓	—	—

(a) N-(2-aminoethyl)-3-aminopropyltrimethoxysilane.
 (b) 3-Methacryloxypropyltrimethoxysilane.
 (c) N-[2(vinyl)benzylamino]-ethyl]-3-aminopropyltrimethoxysilane.
 (d) 3-Glycidoxypropyltrimethoxysilane.

Table 2—Recommendations for Thermoset Systems

Thermoset Systems	Silane			
	A	B	C	D
Diallylphthalate	✓	✓	✓	—
Epoxy	✓	—	✓	✓
Furan	✓	—	—	✓
Imide	✓	—	✓	—
Melamine	✓	—	—	✓
Paralene	—	—	✓	—
Phenolic	✓	—	✓	✓
Polyester	—	✓	✓	—
Urethane	✓	—	—	✓

- (a) N-(2-aminoethyl)-3-aminopropyltrimethoxysilane.
- (b) 3-Methacryloxypropyltrimethoxysilane.
- (c) N-[2(vinylbenzylamino)-ethyl]-3-aminopropyltrimethoxysilane.
- (d) 3-Glycidyloxypropyltrimethoxysilane.

Typically, six hours are given to allow for hydrolysis and silanol formation.

Low VOC aqueous solutions can be prepared by dissolving 0.5-2.0% of the silane in pH adjusted (4.5-5.5 pH with acetic acid) water. For less soluble silanes, 0.1% of a non-ionic surfactant could be added and an emulsion rather than a solution is prepared. Stability of aqueous silane solutions varies from hours for the alkyl silanes to weeks for the aminosilanes. Poor solubility parameters limit the use of long chain alkyl and aromatic silanes by this method.

Filler and pigment treatment is usually accomplished by a spray-on method. It assumes that the sufficient hydroxyl moieties are present on the filler to allow reaction with the silane. The silane is prepared as a 25% solution in alcohol. The powder is placed in a high intensity solid mixer, the solution is pumped into the agitated powder as a fine spray, then the powder is dried.

ADDITIVE

The additive method is another means of utilizing alkoxy silanes. Here the silane becomes a component of the coating from which it diffuses or migrates to the inorganic substrate and reacts. Silanes, as additives, are generally effective in concentrations ranging from 0.05 to 1.00% of the coating.⁵ Effective coupling action with silanes as additives depends on meeting several criteria:

(1) Good mechanical dispersion of the silane into the coating will assure uniform coupling and best efficiency.

(2) The solubility parameters and reactivities of the polymer and silane must be compatible. No reaction should occur in storage. Matched solubility is necessary for silane interpenetration into the polymer.⁶ Proper pH ranges must be maintained to avoid silane condensation.

(3) Silanes, as additives in filled systems, in storage will migrate to the inorganic surfaces of pigments and fillers. Some excess silane should be added for that which is adsorbed onto the mineral surface of the fillers and for the silane which fails to migrate through the polymer to the coating/substrate interface.

(4) Hydrolysis to silanetriol by water must occur to render the silane active for coupling. Proper moisture condition-

Table 3—Recommendations for Thermoplastic Systems

Thermoplastic Systems	Silane			
	A	B	C	D
Acrylic	✓	✓	—	✓
ABS	—	—	✓	—
Alkyd	—	✓	✓	✓
Cellulosics	✓	—	—	—
Nylon	✓	—	—	—
Nitrile rubber	✓	—	—	—
PEEK	—	—	✓	—
Polyamide	✓	—	✓	—
Polycarbonate	✓	—	—	✓
Polyethylene	—	—	✓	—
Polyphenylene oxide	—	—	✓	—
Polyphenylene sulfide	✓	—	✓	—
Polypropylene	—	—	✓	—
Polystyrene	—	✓	✓	✓
Polysulfone	✓	—	—	—
Polyvinylbutyral	✓	—	—	—
Polyvinyl chloride	✓	—	—	✓

- (a) N-(2-aminoethyl)-3-aminopropyltrimethoxysilane.
- (b) 3-Methacryloxypropyltrimethoxysilane.
- (c) N-[2(vinylbenzylamino)-ethyl]-3-aminopropyltrimethoxysilane.
- (d) 3-Glycidyloxypropyltrimethoxysilane.

ing of filler or addition of extra water will help assure that the silane hydrolyzes and couples.

REACTIVE INTERMEDIATE

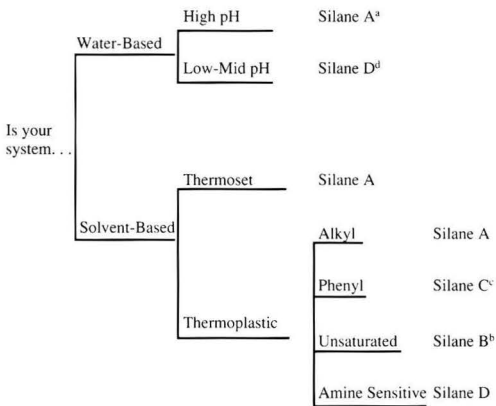
Alkoxy silanes, when cold blended with acrylic emulsions, undergo emulsion polymerization and siliconize the acrylic emulsion particles. These silicone acrylic emulsions have been shown to have improved weathering characteristics.¹ Silicone modification of acrylic latex coatings is applicable to both air-dry and baking systems.

Silicone modification is accomplished by adding the silanes dropwise to the acrylic latex (pH 8.0-9.0), and the mixture is stirred for three to five minutes to solubilize the silane. The latex is then allowed to stand for 8-16 hr to allow the silane to polymerize. The emulsion polymerization reaction is a two-step process. The first step is the hydrolysis of the alkoxy groups; the second step is the silanol condensation to form siloxane bonds. The silanol groups also react with hydroxy groups on the latex particle to form a silicone-organic copolymer.

By utilizing a unique blend of methoxy silanes, a silicone-modified latex was formulated into a high gloss, heat-cured coating designed for maintenance applications using conventional latex methods. This coating was exposed in Florida (45° South) for 48 months. As little as 10% silicone modification improved the gloss retention and color retention with no effect on checking, chalking, and dirt retention.

High Gloss Light Blue Water-Based Maintenance Paint Cured at 60 sec/550°F

% Silane	60° Gloss				Delta E Color Change				
	0	1	2	3	4	1	2	3	4
0	64	60	38	25	8	1.4	1.9	4.2	4.1
10	69	61	48	41	28	2.6	3.2	3.1	4.0
20	85	78	65	56	52	1.8	2.1	1.8	3.7
30	84	74	64	60	53	2.0	2.1	1.6	2.4

Table 4—General Silane Selection

(a) N-(2-aminoethyl)-3-aminopropyltrimethoxysilane.

(b) 3-Methacryloxypropyltrimethoxysilane.

(c) N-[2(vinylbenzylamino)-ethyl]-3-aminopropyltrimethoxysilane.

(d) 3-Glycidoxypopyltrimethoxysilane.

Another approach to utilizing alkoxy silanes that deserves study is the synthesis of novel silicone resinous polymers by hydrolysis of silane blends in slightly acidic solution. Low VOC materials can be produced by balancing the composition linearity, the degree of hydrolysis, and the removal of the methanol produced during hydrolysis. The resulting polymers are often compatible with organic polymers and can be cold blended to form interpenetrating networks. Materials of this type may be utilized in paints, primers, inks, and adhesives where excellent adhesion, weathering resistance, and high temperature stability are required.

RECOMMENDATIONS

Selection of the appropriate silane is accomplished by empirical evaluation of silanes within the recommended groups. Exact prediction of the optimum silane for a specific system is extremely difficult. Silane performance is affected by several factors—surface energy, wet out, absorption, adsorption, acid-base interaction, interpenetrating network for-

mation, and covalent reaction. Key consideration must be given to the polymer/silane reactivity, compatibility, and the polymer/silane solubility parameters.

Tables 1-3 list recommendations for water-based or hydrophilic, thermoset, and thermoplastic polymers. While these lists are not all-inclusive, several generalizations can be drawn from the data.

Despite the wide selection of silane chemistries available, and the fact that a specific coating system can benefit from more than one of these chemistries, silanes A, B, and C are chosen more often than any others (see Table 4). As an example: for coating systems which are water-based, hydrophilic, or amine sensitive, silane D is a viable selection for screening.

Solvent-based, high solids, solventless, or powder systems, whether they are thermoset or thermoplastic, will benefit from the utilization of an aminosilane. While silane A does have excellent water solubility, allowing for low VOC application, the need for greater hydrophobicity or higher temperature stability would suggest the use of silane C.

CONCLUSION

Owing to the highly reactive methoxy sites, organic compatibility, and unique silicone chemistry, alkoxy silanes provide the coating formulator with a myriad of straightforward synthesis solutions to high performance application requirements.

References

- (1) Finzel, W.A. and Parr, L.M., "Water-Borne Silicone Alkyds and Acrylics," *Journal of Water-Borne Coatings*, 2, No. 2 (1979).
- (2) Plueddemann, E.P. and Pape, P.G., "Surface Treatment of Industrial Minerals for Polymer Composites," Colloque Les Mineraux Industriels Materiaux Des Annees 90, Quebec, Proceedings, 269, 1989.
- (3) Plueddemann, E.P., "Silanols and Siloxanes as Coupling Agents and Primers," 39th Annual Conference, Reinforced Plastics/Composite, The Society of Plastics Industry, 1984.
- (4) Plueddemann, E.P. and Pape, P.G., "Techniques For Improved Bonding at Composite Interfaces Using Silane Coupling Agents," presented at 1990 RETEC Conference, Society of Plastics Engineers, Inc., Oct. 16-18, 1990.
- (5) Plueddemann, E.P., "Silane Adhesion Promoters in Coatings," *Prog. Org. Coat.*, 11:3, 297 (1983).
- (6) Chaudry, M.K., Gentle, T.M., and Plueddemann, E.P., "Study of Adhesion Through Interdiffusion and IPN Formation in the Interphase Region of Composites," 42nd RP/C Conference, SPI, Paper 21-E, 1987.

New Lower-Voltage EB Systems For Curing Polymers and Coatings

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The diverse uses of electron beam (EB) systems to cure polymers and coatings are reviewed, with consideration given to how appropriate the equipment is for the applications. Recent developments of EB-cured products and their attendant market expansions are described. A new series of EB systems, designed to operate at a lower voltage than former systems, is presented, and its optimized features for electron curing are highlighted. Anticipation for future growth in the use of EB-curing technology will be discussed.

Introduction

Electron beams (EB) have been used to cure coatings and inks for over 20 years. For a great many products, EB has added value by improving surface appearance and physical properties. For other products, EB has allowed a reduction in operating costs and made the products more profitable. For still other products, EB has provided a process to do things that previously were not possible.¹ EB has created a revolution, of sorts, and that revolution continues unabated with new value being added, new cost reductions being made, and new products being developed. The further development of improved EB equipment has been part of

the revolution, and recent changes will be described after a brief discussion of EB-cured coated products and coating developments.

EB-Cured Coated Products

When certain types of solventless chemicals are bombarded by high energy electrons, the resultant ionization leads directly to polymerization. If a chemical formula-

tion comprising acrylated oligomers, and mono- and multi-functional ethylenically unsaturated monomers are exposed to an electron beam, the electrons produce free radicals. Conversion of the product into a cured solid material proceeds very rapidly as a normal, bulk free radical polymerization.² The abrasion resistance and high-gloss appearance that can be achieved are well known and can be seen in giftwrap, food packaging, and wood furniture.

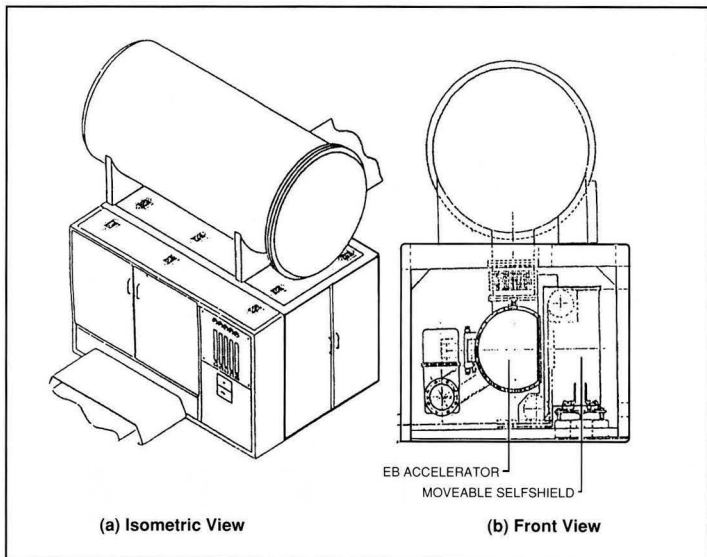


Figure 1—Schematics of the Electrocare series

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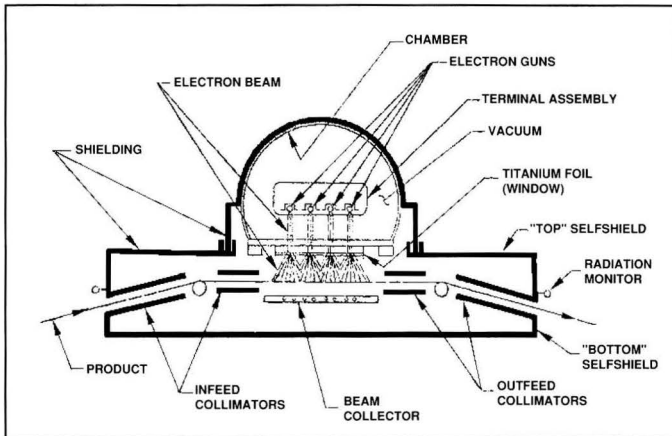


Figure 2—EPZ-4 Electrocurtain processor with Selfshield web handling assembly

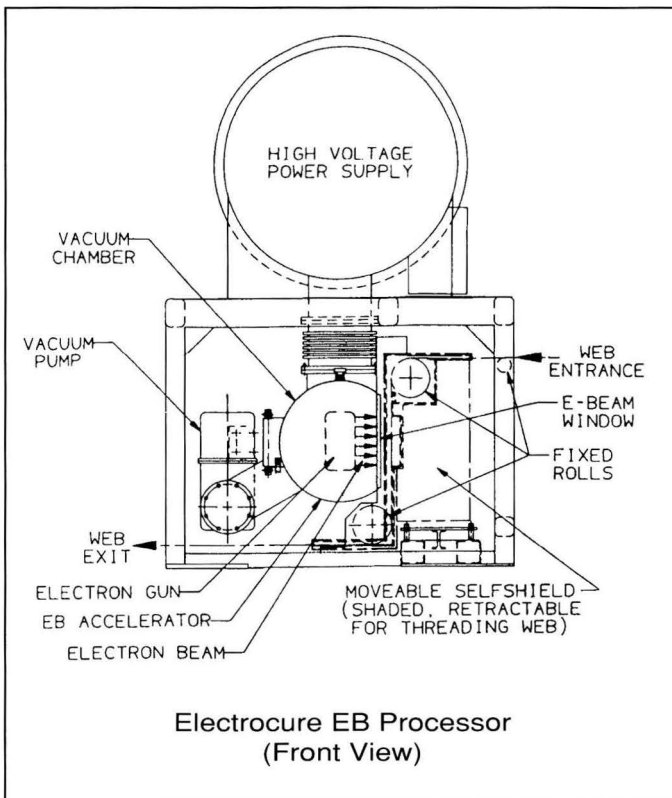


Figure 3—Elevation view of threaded Electrocurure

Bags for cosmetics and perfumes are an excellent example of a value-added product made with EB. An EB-cured clear coating is applied to the printed bags to improve aesthetic appeal and make their apparent value commensurate with the value of the expensive products within. Wrapping papers are another example where high-gloss, heavily pigmented coatings are cured on paper to add value beyond what conventional processes would provide.

For products such as metallized labels, EB has provided a way to make a good quality, commodity label at lower production cost. With metallized labels, the amount of aluminum used is a determining factor in the final cost of the label. EB allows less aluminum to be used to make the labels than other cure processes. This is because an EB basecoat cured on the label paper has a very hard, smooth surface, since no solvents have been driven off which would have disturbed the surface. A mottled surface, such as that produced using a solvent-based basecoat, requires a great deal of vacuum-deposited aluminum to create high gloss. In contrast, the smooth EB-cured coating only needs 300 to 400 Å of aluminum to create the high gloss, metallic appearance.

There are other products that cannot be made in any way other than with EB. Electrostatic-dissipative polyethylene bags, known as Staticure® bags, are excellent containers for sensitive integrated circuit chips. The better the bag's transparency, the easier it is to know the contents without opening the bag and exposing the sensitive contents to hostile environments. The bags are manufactured by using EB to cure a special coating on one side of a polyethylene web, and thus make both sides of the web highly static-dissipative. This results in a bag that has the dissipative characteristics of other more opaque materials but which is very transparent. Moreover, onto some of the Staticure bags, a thin layer of aluminum is vacuum metallized, creating an RF-shielded, static-dissipative (semi-transparent) bag.

EB Coatings Developments

Recently, there have been several developments in the field of electron beam technology that have exciting implications for the future. One such development is a cationic chemistry that is EB-curable. Unlike acrylates, these cationic systems can cure in air (i.e., oxygen will not inhibit the curing reactions) which eliminates the need for an inert curing zone. This will reduce greatly the equipment operating cost, since a continuous flow of pure nitrogen is not required.

Both the cationic chemistry and some new acrylate compounds will cure at much lower doses than were required in the past,

Staticure®—a registered trademark of Metallized Products Inc.

for example, from 0.5 to 2.0 megarads (5.0 to 20.0 kGy). The new acrylates are already being used on some commercial printing and coating lines. The advantage of the new systems relative to previously existing technology is being able to use less electron beam output (or electron "current") at the same line speed—or, to run the same line much faster with the same total EB output. Since there is a maximum output for each EB system, these lower dose-to-cure products could allow existing EB lines to run faster than they were able with a higher dose-to-cure coating.

Another new use of EB protective topcoats is a coating developed for use on X-ray medical imaging screens. The rare-earth elements used on the screens must be protected by an overcoat, and the overcoat must withstand frequent contact and pressure. The EB coating has been shown to have the abrasion resistance that is needed. Also, the electron beam does not degrade the screen's ability to intensify an X-ray signal, whereas other curing methods significantly degraded the screen. Clearly, this application of EB is a niche market, but it reconfirms that EB-curing is finding new ways to solve difficult problems.

Areas of rapid growth for electron curing include pigmented coatings on wood, silicone coatings on paper and film, and litho inks and overcoats on folding cartons and flexible packaging.

In the area of curing wood coatings, there has been growing interest throughout the world in EB. European companies installed four EB/UV wood lines in recent years, having a total production capacity of about one billion square feet of board per year. There is a great demand for very hard, abrasion resistant, surface coatings with variable gloss levels as those that can be obtained with EB/UV on wood furniture. Also, with the tremendous production efficiencies which are realized with an in-line continuous process, many wood companies are expected to begin using EB/UV curing of wood coatings. This market has been forecast to grow at an annual rate of 20%.

In the area of silicone coatings, the EB advantages of precise cure, low-heat, and high speed have led more companies to begin using EB curing. As with other markets, the growth in the EB application is worldwide, being seen in the Far East and Europe, as well as in North America. EB siliconizing lines as wide as 130 inches have recently been installed.

In the area of printing inks and overcoats, the market is likely to sustain the strong growth it has seen. EB is now used on nearly 50 web offset presses. In the past five years, seven new users of EB for this application have been added, most making multiple orders of EB lines. There are multifarious forces affecting the folding carton

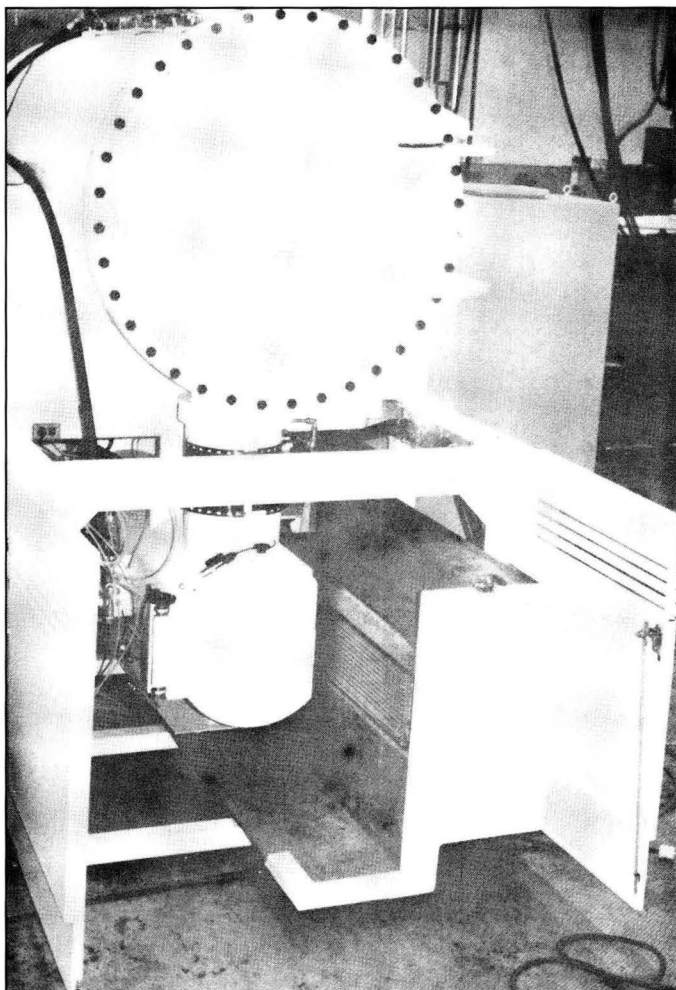


Figure 4—Electrocurtain EB system (EC 150/105/1050) showing Selfshield retracted through front doors for access to the window area through the side doors

converter, the flexible package printer, and the aseptic packager which have been described elsewhere.³ It is expected that many of these forces will continue to drive an increasing number of companies to use EB for drying their offset inks and overcoats.

Series of EB Dryers

A new series of EB equipment* is being manufactured for use in the applications described previously. In fact, these new electron beam systems are optimized for curing thin inks and coatings.

*Electrocurtain™—a registered trademark of Ford Motor Company.

Typical outline drawings of the system are shown in Figure 1. It becomes immediately obvious how different this system is from its predecessor,* shown in Figure 2. The new design has only two separate sub-units, as shown in Figure 3, rather than eight for the former design. The main sub-unit is the one shown schematically in Figure 3 and pictorially in Figure 4, which comprises the EB accelerator and product-treatment zone in the lower half, and the high voltage power supply in the upper half. The other sub-unit is an electronics enclosure. There is also a small operator's control

*Electrocurtain™—a registered trademark of Energy Sciences, Inc.

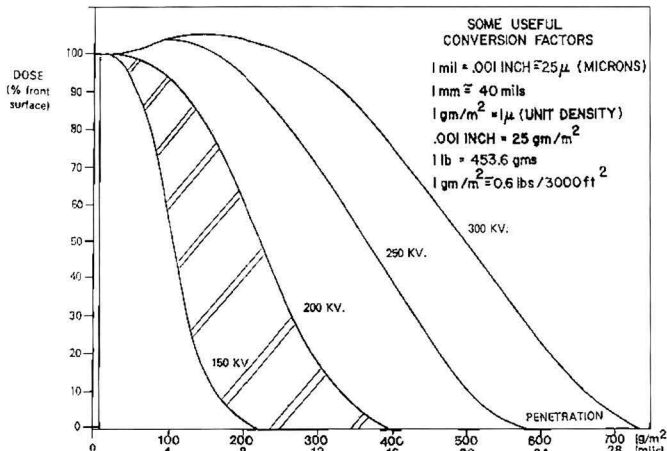


Figure 5—Deposited energy from an electron beam vs depth into a product

terminal which is installed in the customer's control console. Relative to the former design, the total floor space has been reduced by 40%. The space savings and the inherent simplicity of all sub-unit interconnections (of water, air, electrical, and nitrogen services) are apparent.

The Selfshield® arrangement is designed for simplicity of web threading and of serviceability. As seen in Figure 1(b) and 4, there is a moveable rectangular section of the Selfshield to the right of the accelerator. For easy access to the accelerator window and to thread the web, this section slides out on precision rails toward the operator's aisle. This is quite similar to removing a cartridge from a print station, without breaking the web. With the web in its final position over two stationary rollers [which are indicated in Figure 1(b)], the line can be run to test tension, tracking, etc., even before the Selfshield is reinserted and closed.

SPECIFICATIONS OPTIMIZED FOR COATING LINES: Of greatest importance in this system is its total optimization for thin coatings. The operating voltage has been lowered

Selfshield®—a registered trademark of Energy Sciences, Inc.

from a maximum of 175 kV or 200 kV, typical for earlier EB systems used with inks and coatings, to 150 kV. This has broad implications for size, uptime, and energy efficiency. The overall size of any accelerator is largely governed by its maximum operating voltage, since that determines the gaps or spacings between components at different voltage levels. Such gaps impact directly upon the size of the power supply and the accelerator chamber, and, as well, the maximum voltage determines the required thickness of the lead shielding. By designing these systems to operate at 150 kV, it was possible to make substantial reductions in all three areas.

The energy efficiency of this series is most clearly demonstrated in Figure 5. In this graph of deposited dose versus depth into the product, the deposition curves for four voltages (150, 200, 250, and 300 kV) are shown. For an EB system operating at 200 kV and curing a 10 μm (0.4 mil) ink/coating, approximately 95% of the energy in the electron beam is deposited, and thus wasted beyond the 10 μm target. By going to 150 kV, the energy deposited beyond the 10 μm target is less than one half what it was in the 200 kV case, as indicated by the

shaded area in the figure. Markedly less energy is wasted and, to the extent that electrons can cause a small amount of heating and either bond-scission or crosslinking in substrates, this is greatly reduced.

In terms of the dose-speed capacity, the model shown in Figure 4 has been designed for the delivery of 2.5 MR at 420 m/min. Higher capacity models are available which raise the specification to a speed of 525 m/min at 3.0 MR and 525 m/min at 6.0 MR.

Summary

A new series of EB curing systems which is optimized for thin coating applications has been described. Growth areas for EB coatings are discussed, and almost all require curing or grafting of a coating that is from 0.5 to 50 μm thick. In the past, EB systems have utilized far more energy than is necessary for the majority of coating curing applications. This latest advancement for EB equipment provides an energy-efficient and application-appropriate curing system.

References

- (1) Weisman, J. and Tripp, E.P., "An Analysis of EB Applications in the United States," *Radcure Europe '85 Conference Proceedings*, May 6-8, 1985, Basel, Switzerland; Association of Finishing Processes/Society of Manufacturing Engineers, Dearborn, MI.
- (2) "Radiation Curing Primer I: Inks, Coatings, and Adhesives," p 44-51, RadTech International North America, Northbrook, IL, 1990.
- (3) Quintal, B.S. and Nablo, S.V., "Integration of EB Equipment in Converting Operations," *Radcure '86 Conference Proceedings*, September 8-11, 1986, Baltimore, MD; Association of Finishing Processes/Society of Manufacturing Engineers, Dearborn, MI.
- (4) Fletcher, P. Michael, "Electron-Beam and Ultraviolet Dryers for Web-Offset Folding Carton Lines," presented at the TAPPI/PPC Folding Carton Division's Workshop on Printing Presses and Auxiliary Equipment, Cincinnati, OH, September 8-10, 1990.
- (5) Fletcher, P. Michael, "A New Series of EB Dryers for Offset Printing," presented at the RadTech Asia Conference, April 15-18, 1991, in Osaka, Japan.

Society Meetings

BIRMINGHAM APR.

"Chromate VI Replacement"

Peter M. Williams and Robert A.J. Allan were presented with 25-Year Pins in recognition of a quarter-of-a-century membership in the Club.

The meeting's technical presentation was delivered by John Roberts, of Henkel Metals Chemicals Ltd. His topic was "RECENT ADVANCES ON THE ISSUE OF CHROME VI REPLACEMENT IN METAL PRETREATMENT PROCESSES."

An overview of Chrome VI and various other heavy metal chromates that are used in the industry was presented. Also, Mr. Roberts reviewed the health and safety classifications of the metals.

According to the speaker, the customer's requirements for a Chrome VI replacement pretreatment can be summarized as follows: consistency of quality, total process cost reduction, ease of operation, environmental concerns, and improved worker safety.

Mr. Roberts briefly reflected on the history of chromium for use in metal pretreatment. In addition, he examined the pretreatment market in the U.S. and Europe.

Q. With coil coatings, is flexibility still a problem?

A. In general no. With only 0.1µm present, there has always been difficulty in proving that the coating is there. Lines use X-ray fluorescent for quick results to prove the coating is there.

Q. Does the newer range of polymeric species have an operating life?

A. Yes, polymerization will continue, especially on storage in its concentrated form, in which case it will last only a matter of months. Stability is getting better as development increases. Working solutions are okay, but watch for hot spots in the bath.

TERRY WOOTTON, *Publicity Chairman*

CDIC MAY

"Acid Catalysis"

Members elected to serve as Society Officers for the 1993-94 year are as follows: President—Paul R. Guevin, Jr., of P.R. Guevin Associates; Vice President—Alan L. Machek, of Dow Corning Corporation; Secretary—John C. Avery, of Cintech Industrial Coatings, Inc.; and Treasurer—William Jelf III, of Akzo Coatings, Inc.

Bill M. Hollifield, of Perry & Derrick Company, Inc., will continue to serve as the Society Representative to the Federation's Board of Directors.

David R. Sellers, of PPG Industries, Inc., has been appointed Chairman of the reactivated Manufacturing Committee.

Perry & Derrick's Hugh M. Lowrey, Society Representative to the Ohio Paint Council, reported that the Issues Committee is very active, and that Issue 5, which was defeated in the November 1992 election, may appear for vote again.

Richard Shain, of King Industries, Inc., presented a talk on "ACID CATALYSIS IN HIGHER SOLIDS SOLVENT-BORNE AND WATER-BORNE INDUSTRIAL FORMULATIONS." Mr. Shain is a member of the New York Society.

The use of acid catalysts for catalyzing urea-formaldehyde coatings for promoting a faster reaction was discussed. Mr. Shain said that amino-formaldehyde crosslinking resins, such as urea-formaldehyde, melamine-formaldehyde, and different types of triazines, which can be polymeric or monomeric, are used as catalysts.

The different types of amino crosslinkers and acid types were reviewed.

In conclusion, Mr. Shain stated that fully alkylated melamine catalysts offer improved properties such as higher solids, lower VOC, and improved flexibility.

Q. How do epoxy blocked catalysts differ from amine blocked catalysts?

A. When amine blocked catalysts are baked and the water solvent is driven off, the amine starts to come off causing the coatings to pop. When an epoxy blocked catalyst is used the epoxy unblocks and crosslinks into the film rather than evaporate. As a result, better chemical resistance could result.

The meeting's educational speaker was Judge Rupert A. Doan, Chief Justice for the Ohio Court of Appeals and Presiding Judge on the Hamilton County Court of Appeals. Judge Doan presented a talk entitled, "A VIEW FROM THE BENCH."

The presentation was a light hearted series of stories about Judge Doan's experiences while serving as an officer of the court.

PAUL R. GUEVIN, JR., *Acting Secretary*

CLEVELAND APR.

"Carbon Black"

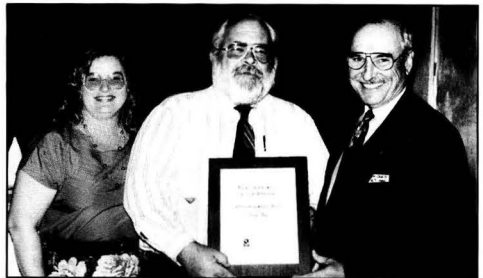
The slate of officers for the 1993-94 year was announced as follows: President—Freidun Anwari, of Coatings Research Group, Inc.; Vice President—Constance F. Williams, of The Glidden Company; Secretary—Michael A. Wolfe, of Seegott Inc.; Treasurer—Richard A. Mikol, of Tremco, Inc.; Assistant Treasurer—Barbara J. Varone, of The Sherwin-Williams Company; and Member-at-Large—Robert L. Toth, of The Glidden Company.

By-Laws Committee Chairman Charles K. Beck, retired, read the resolution regarding the newly created Society scholarship. The resolution was scheduled for a vote at the May meeting.

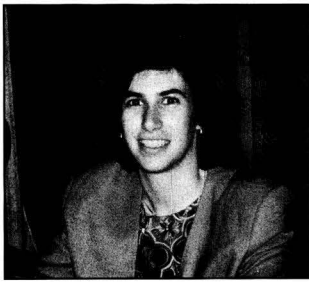
Educational Committee Chairman John J. Falsone, of B.F. Goodrich Company, announced that the Society had awarded nine prizes totalling \$400 to the Northeast Ohio Science Fair winners.

Mr. Falsone also recognized Marianne DeCapite, of The Sherwin-Williams Company, for her involvement with the science fair, and for being able to recruit educational advisors for high school students.

The technical program was presented by Rodney Taylor, of Columbian Chemicals



TALENT, EFFORT, AND DEVOTION—Parker Pace (c) receives the Los Angeles Society Outstanding Service Award from Society President Sandra Dickinson and Awards Chairman James Calkin. The presentation took place during the May meeting



FORMULATING POLYURETHANE COATINGS—Sherri Basner gives the technical presentation during the May Los Angeles Society meeting

Company, who presented a talk entitled, "CARBON BLACK MICRODISPERSION—EFFECT ON JETNESS AND UNDERTONE COATINGS."

Dr. Taylor discussed the important properties of carbon black pigment and the effects of microdispersion on jetness and tone.

The three types of carbon blacks used in the coatings industry were reviewed: lampblack, impingement black or old channel process blacks, and furnace black.

A history of the channel black process was presented, followed by a description of the current oil furnace carbon black process.

The four fundamental properties of carbon blacks include: fineness—particle size distribution; structure—aggregate size/shape distribution; porosity—pore size distribution; and surface chemistry—surface activity distribution.

Dr. Taylor stated that microdispersion on carbon blacks affects both the color performance and rheology.

In conclusion, the speaker listed the factors that influence color performance of carbon blacks in coatings. Dr. Taylor said the major factor is microdispersion, which is dependent on the following: nature of the system; grind methodology, hard agglomerates, surface chemistry/compatibility, impurities, phase effects, and particle and aggregate size (smaller are harder to disperse, but are jetter black).

Q. How easy is it to obtain a microdispersion with the equipment available today? Do you have to use a ball mill for 24-48 hours?

A. No, a ball mill is not necessary, but if a ball mill is used, the milling time will be dependent upon the carbon black used and how well the resin system used wets out the carbon black.

Q. You talked about three types of carbon blacks. Which is the best for use in water-based paints and which is the best for solvent-based paints?

A. For many years, carbon blacks have been optimized for use in solvent-based paints, but now with water-based paints carbon blacks will have to be changed to make them work in water systems. You would not want to use an oxidized, a high sulfur, or a black with impurities in a water-based paint.

CONSTANCE F. WILLIAMS, *Secretary*

KANSAS CITY MAY

"Ergonomics"

A moment of silence was observed in memory of former Society member Anthony J. Gomes, of Zeneca Resins. Mr. Gomes was a member of the Dallas and Houston Societies at the time of his death.

The following members were nominated to serve as Society officers for 1993-94: President—Lawrence J. Murphy, of Tnemec Company, Inc.; Vice President—Yvonne D'Arcy, of Cook Composites & Polymers; and Secretary—William T. Porter, of Hillyard Industries, Inc. A candidate for Society Secretary will be announced at a later date.

Educational Committee Chairman Peter J. Cerra, of Tnemec, reported that the Society judged projects at the Science Pioneer Fair and had selected three coatings-related projects as winners. The students received a \$100 U.S. Savings Bond each, and a \$100 prize for their respective schools.

The Science Fair winners, their parents, and teacher sponsors were invited to the Society's Educational Meeting where they were awarded their prizes.

The meeting's speaker Regina Neese, of ESSI Corporation, gave a talk on "ERGONOMICS."

Ms. Neese defined ergonomics as the study or knowledge of the laws governing work. She said the four major factors which contribute to cumulative human disorders are: posture, force, repetition, and work environment.

The speaker stated that ergonomics can improve quality, productivity, efficiency, reduce worker injuries, and lower Workman's Compensation costs.

In conclusion, Mr. Neese explained that ergonomics helps employees work smart and experience fewer accidents.

LAWRENCE J. MURPHY, *Secretary*

LOS ANGELES MAY

"Polyurethane Coatings"

Nominations for Society Secretary and Society Representative were announced as

follows: Secretary—Mary R. Rice, of Behr Process Corporation; and Society Representative—James Hall, of Sinclair Paint Company, and John A. Gordon, Society Honorary Member (from the floor).

Parker Pace, of Behr, was presented the Society's Outstanding Service Award for his contributions of talent, effort, and devotion to the Society.

Twenty-five Year Pins were awarded to the following: Juan G. Arroyo, of Ameritone Paint Corporation; Ed Barrie, of Sinclair Paint; Jose C. Borneo, of Delta Technical Coatings, Inc.; William Dow, of Dunn Edwards Paint Corporation; James Fluery, of Hoechst Celanese Corporation; Dan Gilbert, of Hill Brothers Chemical Company; Richard Nording, retired; Parker Pace, of Behr; Isao Shimoyama, retired; Frank Scanland, of Norton & Son, Inc.; Antonio A. Velasquez, of Cardinal Industrial Coatings; Robert W. Waltman, of Cal Western Paint Corporation; and Julian Witt, of Morton International.

Environmental Affairs Committee Chairman Dave Muggee, of E.T. Horn Company, reported that California has lowered the exposure limits for formaldehyde. He said that since many raw materials contain formaldehyde, many manufacturers will now have to monitor levels and inform workers.

The meeting's technical program was highlighted by a presentation by Philadelphia Society member Sherri L. Bassner, of Air Products & Chemicals, Inc. Her talk was entitled, "EXPERIMENTAL DESIGN IN FORMULATING HIGH SOLIDS POLYURETHANE COATINGS."

Dr. Bassner emphasized the need to reformulate for VOC regulations, worker exposure limits, and requirements that prevent the use of certain materials, and the need to differentiate products in a very competitive marketplace.

It was pointed out that experimental design permits quick and efficient formulating techniques to minimize the preparation of unnecessary samples through the use of a software program. The key advantage of this method is the ability to predict outcomes of blends of urethane prepolymers, or other components, to achieve a certain set of needs.

The speaker used a triangular chart to demonstrate the possible blends of three prepolymers. Results of the series of recommended blends and their test results versus the predicted outcome were shown.

Q. Have you done studies on how the pigments affect the properties predicted by the computer?

A. No, but that is a good point. We have concentrated only on clears at this point, but

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016	036	056	076	096	116	136	156	176	196	216	236	256	276	296
017	037	057	077	097	117	137	157	177	197	217	237	257	277	297
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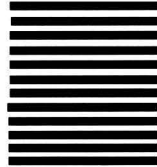


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will be working on pigmented systems in the future.

JOHN C. KULNANE, *Secretary*

LOS ANGELES..... JUNE

"Low VOC Coatings"

The candidates for Society Secretary and Society Representative were announced to the membership. Candidates for Secretary included: Roxanne R. Echevarria, of Davis Colors; Mary R. Rice, of Behr Process Corporation; and Robert J. Skarvan, of McWhorter, Inc. (from the floor).

James Hall, of Sinclair Paint Company, and John A. Gordon, Society Honorary Member, were running for the Society Representative position.

Following a vote, it was announced Mr. Skarvan was elected as Secretary and Mr. Gordon was elected to serve as Society Representative to the Federation's Board of Directors.

A 50-Year Pin was presented to John Warner, retired, for his one-half century membership in the Federation.

Donald I. Jordan, Society Honorary Member, the Chairman of the 1993 Western Coatings Societies Symposium and Show, presented President Sandra Dickinson, of Synergistic Performance Corporation, with a check for \$100,000 for the Society's scholarship fund.

Environmental Affairs Committee Chairman Dave Muggee, of E.T. Horn Company, reported the requirements for filing out the SARA Title III form R by July 1. He noted proposals by EPA to change some reporting requirements.

A presentation on "LOW VOC ALKYD COATINGS AND TWO PHASE EPOXY COATINGS" was delivered by Detroit Society member Stoil Dirlikov, of Eastern Michigan University.

Discussed were the attributes and contributions of vernonia oil as a reactive diluent to low VOC coatings. Dr. Dirlikov explained that vernonia oil will be commercially available in five years and will cost approximately \$1.50 per pound.

According to the speaker, vernonia oil is characterized by low toxicity, clear, nonyellowing appearance, and a low melting point of -2°C.

Dr. Dirlikov stated that coatings formulated with vernonia oil dried faster and showed excellent package stability, and possessed excellent adhesion, lower yellowing, slightly better weathering, and a slightly softer finish than an unmodified alkyd resin.

Q. What kind of odor does vernonia oil have?

A. It smells similar to a cooking oil, that is, very low odor.

Q. If no solvents are used, will there still be good pigment dispersion and an absence of float?

A. There may be a problem at zero VOC. At 150 g/L VOC, good pigment dispersion has been attainable.

JOHN C. KULNANE, *Secretary*

NORTHWESTERN..... APR.

Education Night

As the first of four speakers for the Education night program, Society member J. Edward Glass, of North Dakota State University (NDSU), gave a talk on, "CAREER DIVERSITY FOR COATINGS GRADUATES."

Dr. Glass reviewed the opportunities available to coatings program graduates. He said that the coatings industry, companies that support the coatings industry, opportunities in crossover areas, and continuing education in a graduate program are options for the coatings graduates.

The coatings program at NDSU was discussed. Dr. Glass indicated that job placement for coatings program graduates is virtually 100%. However, due to this year's poor job market, many students are opting for graduate school.

Rick Bourgon, of The Valspar Corporation, gave a presentation on "JOB TRANSITION IN THE INDUSTRY."

Mr. Bourgon stated that the most difficult part of change is not the technical work, but the cultural aspect. He reviewed the ways that transition can occur, including: advancement or transfer within a company; changing companies; and corporate mergers and consolidations.

"THE REAL THING—A FRESH GRADUATES PERSPECTIVE" was presented by Mike Annis, of Valspar.

Insights on the differences between school and the business world were provided. According to the speaker, the three major differences are: formulation, raw materials, and equipment.

Mr. Annis offered three considerations of the coatings industry: coworkers as a source of valuable information; documentation for all work; and opportunities for advanced education.

The final speaker was Society member Dave Nevison, of Valspar. His topic was, "BENEATH THE SURFACE: DETECTIVE WORK IN COATINGS SCIENCE."

Mr. Nevison explained that not all chemists in the industry are formulators. He said for an analytical chemist, the instrumentation is the same from lab to lab, but the work is different.

The responsibilities of the analytical chemist in the coating industry were reviewed, including: developing methods to analyze products; solving problems; analytical support; employee chemical exposure testing; and compiling a data base.

Educational Committee Chairman Herman M. Bacchus, of Valspar, presented Dr. Glass with a \$1,500 check for the NDSU coatings program scholarship fund.

MICHAEL GRIVNA, *Secretary*

NORTHWESTERN..... MAY

"Fluorochemical Surfactants"

The candidates for Society officer positions for the year 1993-94 were reported as follows: President—Sarah Oebser, of H.B. Fuller Company; Vice President—Michael Grivna, of Hirshfield's Paint Mfg., Inc.; Secretary—Harold H. Christhill, of The Valspar Corporation; and Treasurer—Joseph J. Mills, of Minnesota Solvents & Chemicals Corporation.

The first speaker was Society member Jeffrey W. Linert, of 3M Company, who presented a talk on "APPLICATIONS OF FLUORO-CHEMICAL SURFACTANTS IN WATERBORNE AND HIGH-SOLIDS COATINGS."

Discussed were the advantages using fluorochemical surfactants in waterborne and high-solids coatings, including: minimizing surface tension gradients, better wetting and spreadability, improved recoatability, increased oil and water repellancy, and better durability.

Carol Watson, of Missing Children Minnesota, discussed the primary objectives of this organization, assisting and supporting families of missing children, as well as searching for the children.

MICHAEL GRIVNA, *Secretary*



MEMBERSHIP AWARD—Theodore Young (l), recently retired from Jesse S. Young Company, was elected a Society Honorary Member by the New York Society. Mr. Young receives his award from Society President Michael Frantz at the group's May meeting

Elections

BALTIMORE

Active

Allen, Debar W.—McCormick Paint Co., Rockville, MD.
Moore, Ellis C.—Resinall Corp., Allentown, PA.

Associate

Eaton, William S.—SCM Chemicals, Baltimore, MD.
Fay, Bob W.—Callahan Chemical Co., Palmyra, NJ.
Hathaway, Julie A.—Reichhold Chemicals, Cinnaminson, NJ.
Kowalski, Edward B.—SCM Chemicals, Hedgesville, WV.

CDIC

Associate

Aziz, Sherif A.—Ceso Corp., Dayton, OH.
Corrigan, Brian P.—McWhorter, Inc., Carpentersville, IL.
Gerhold, John M.—Indiana Naval Stores, Indianapolis, IN.

CLEVELAND

Active

Brown, R. Alan—Mameco International, Cleveland, OH.
Czako, David R.—The Glidden Co., Strongsville, OH.
Stanislawczyk, Vic—The B.F. Goodrich Co., Avon Lake, OH.
Varone, Barbara J.—The Sherwin-Williams Co., Cleveland.

DETROIT

Associate

Steward, Gary R.—Auto Alliance, Flat Rock, MI.

NEW YORK

Active

Libero, Vincent R.—Benjamin Moore & Co., Newark, NJ.
Rieth, Theodore J.—Masonite Corp., Towanda, PA.
Weadock, Daniel K.—Monson Companies, Cliffside Park, NJ.

Associate

Haff, Douglas H.—Sun Chemical Corp., Annandale, NJ.
Moerck, Rudi—Troy Corp., East Hanover, NJ.
Penn, Gregory F.—The Sherwin-Williams Co., Wallington, NJ.
Salim, Sharif M.—Hardman, Belleville, NJ.
Schmitz, George M.—S.P. Morell & Co., Mineola, NY.
Zimmer, Peter J.—P.J.Z. Sales Inc., Englewood, NJ.

Retired

Jubanowsky, Louis J.—Hilton Head, SC.

NORTHWESTERN

Associate

McLean, Brent C.—Whittaker, Clark & Daniels Co., Madison, WI.

Educator/Student

Asmundson, Karen L.—North Dakota State University, Fargo, ND.

PIEDMONT

Active

Creamer, Gerald C.—Akzo Coatings Inc., Roanoke, VA.
Cuff, James J.—Stork X-cel, Inc., Charlotte, NC.
Griffin, Thomas F.—Deeks & Co., Inc., High Point, NC.
Modjewski, Roy J.—Akzo Coatings Inc., Highpoint.
Tabbi, Charles C.—Reichhold Chemicals Inc., Durham, NC.

Associate

Jones, Robert T. Jr.—SCM Chemicals Inc., Winston-Salem, NC.
Nelson, Eric T.—Cytec Industries, Morristown, NJ.
Warner, Ted E.—Kemira Inc., Charlotte, NC.

SOUTHERN

Active

Harper, William C.—Somay Products Inc., Miami, FL.
Ward, Michael E.—Stebbins & Roberts, Little Rock, AR.

Associate

Ashmead, Vicki S.—Sloss Industries Corp., Birmingham, AL.
Bemick, Barry K.—Rohm and Haas Co., Charlotte, NC.
Ritchie, Ed—Chemarco, Birmingham, AL.
Tucker, C. Kirby—Sloss Industries Corp., Birmingham.

TORONTO

Active

Kronberger, F.—Tiger Drylac Canada Inc., Guelph, Ont.
Mushani, Karim—Inter-Provincial Inks, Concord, Ont.
Shapiro, Jacob—Dr. J. Shapiro & Associates, North York, Ont.

Associate

Allan, James M.—3M Canada Inc., North York, Ont.
Barker, Ian R.—Sun Chemical, Mississauga, Ont.
Betty, Thomas A.—Rheox Inc., North York, Ont.
Boyd, Brian P.—Du Pont Canada Inc., Mississauga.
Briand, Gerald F.—Van Waters & Rogers, Downsview, Ont.
Carter, Gwen M.—Du Pont Canada Inc., Mississauga, Ont.
Crowfoot, Linda—Canada Colors & Chemicals Ltd., Don Mills, Ont.
DesRoches, James E.—Purity Zinc Metals, Stoney Creek, Ont.
Drye, James E.—Charles Tennant Co., Canada, Weston, Ont.
Naus, Carl J.—Delphax Systems, Mississauga.
Taylor, Drew B.—Goldschmidt Chemical Canada, Mississauga.
Young, Ralph O.—Purity Zinc Metals, Stoney Creek.

Event: 1993 Annual Meeting and Paint Industries' Show

Date: October 27-28-29, 1993

Place: Georgia World Congress Center,
Atlanta, GA

Sponsor: Federation of Societies for Coatings Technology

Theme: "Today's Competitive Coatings:
Lean, Mean and Green"

For more details, contact FSCCT, 492 Norristown Rd., Blue Bell, PA 19422
215/940-0777 • FAX: 215/940-0292

Or see pages 19-26 of this issue.

People

The Board of Directors at ARCO Chemical Co., Newtown Square, PA, has elected two Vice Presidents. **Ronald Remick**, a longtime employee with various ARCO companies and ARCO Chemical, is the new Vice President, Planning and Control. Previously, he had been Vice President and Treasurer for ARCO Chemical. Mr. Remick succeeds **Allan Comstock** who has become ARCO Vice President and Controller.

John A. Shaw was elected to fill the vacant Vice President and Treasurer position of ARCO Chemical. Mr. Shaw was most recently Vice President, Planning and Control for ARCO Chemical European Operations and had held a variety of positions with Atlantic Richfield Co. He will be relocating to the United States.

The position of Director of Marketing for Sannor Industries, Inc., Leominster, MA, has been accepted by **Rick G. Mazzariello**. He will be responsible for further expanding Sannor Industries' activities in the market place with solvent based and waterborne urethane polymers as well as other associated areas. Mr. Mazzariello has over 25 years of sales and marketing experience in the coatings industry.



R.G. Mazzariello

Troy Corp., East Hanover, NJ, has appointed **Eeva-Liisa Kuusisto** as Manager, Formulations Development for their Applied Research & Technical Service Team. She will develop formulations for the testing of new biocides and additives from Troy's manufacturing facility in Newark, NJ. Ms. Kuusisto brings 25 years of experience in the paint industry to her new position.

John Grubestic has assumed the title and responsibilities of Sales Manager of Rigid Packaging for The Dexter Corporation's Packaging Products Division, Waukegan, IL. Mr. Grubestic will oversee the rigid can coating sales in North America from the Waukegan headquarters. Prior to accepting his new position, Mr. Grubestic's professional experience in the can and metal coatings industry included 15 years with Valspar and O'Brien Corporation.

Sarah Zohn has been appointed to President of AFCON Control and Automation, Inc., Schaumburg, IL. Ms. Zohn, who previously held a Project Manager position at AFCON Ltd. in Israel, rejoins AFCON after an eight-year absence.



S. Zohn

Former President **Paul H. Olinick** has assumed the position of Director of Business Development. In this capacity, he will focus on identifying new business opportunities. Mr. Olinick will also remain a member of the Board of Directors at AFCON.

Hahn Northwest, Inc., Tukwila, WA, has named **Jeffrey Davis** as a Sales Representative. Mr. Davis has eight years of distribution experience in the Pacific Northwest territory.

The BOC Group, Murray Hill, NJ, has named **Seifi Ghasemi** as President, Process Systems, Gases Americas. In this position, he will be responsible for BOC's tonnage business in the U.S., Canada, and Latin America. Working out of the Murray Hill headquarters, Mr. Ghasemi also will assume the position of Executive Vice President, Operations, Gases Americas. In this capacity, he continues to have line responsibility for production, engineering, distribution, energy, materials, information management, safety, environment, and technology development activities for BOC's gases businesses in North and South America. Mr. Ghasemi's most recent position was Senior Vice President, Operations and Technology, Gases Americas.

The Powder Coatings Institute (PCI), Alexandria, VA, has announced the results of their recent elections for the 1993-94 fiscal year. They are: President—**Dick Simmons**, of Evtech; Vice President—**John Brvenik**, of O'Brien Powder Products, Inc.; and Secretary/Treasurer—**Sam Dawson**, of Nordson Corp.

Also, members of the PCI Board of Directors include: **Ed Bozzi**, of Ciba; **Ron Farrell**, of Ferro Corp.; **Marc Fooksman**, of Gema-Volstatic; and **Dieter Junglaus**, of Morton International. Continuing to serve on the board are **Anthony Forgione**, of Ruco Polymer Corp.; and **Greg Wagner**, of PPG Industries.

Wacker Silicones Corp., Adrian, MI, has announced new appointments in the Construction and Coatings Industries Group. **Kenneth Abate** has been named Technical Manager. He is responsible for all technical service functions as well as research and development for the group's paint raw materials and masonry water repellents. Mr. Abate's experience in chemical research and development spans 30 years including a recent position as Associate Director, Specialty Chemicals, at PPG Industries.

Lee S. Hertz has been named Technical Service Specialist. Mr. Hertz is responsible for technical service in the areas of high temperature coatings, modified organic resins, microemulsion primers, and silicone emulsion topcoats. Mr. Hertz is a member of the Detroit Society for Coatings Technology.

Also named as Technical Service Specialist, **Bruce A. Berglund** will be responsible for technical service in the areas of silicone masonry water repellents and masonry treatment products. Prior to joining Wacker, Berglund was a chemist at National Purity, Inc.

The Preservative Paint Co., Seattle, WA, has appointed **Lance Baze** to the newly created position of Area Sales Manager. Mr. Baze brings over 26 years of experience in the paint and coatings industry to this new position.

Federation Anniversaries

25-Year Members

Kansas City Society

GENE WAYENBERG—Tnemec Co.

New York Society

JOSEPH A. VONA—Retired.

50-Year Members

Houston Society

John W. Garrett—Retired.

Los Angeles Society

JOHN R. WARNER—Retired.

New York Society

WILLIAM L. LAWRENCE—Retired.
CARLTON H. ROSE—Retired.

Stan Haduch was named Vice President and General Sales Manager for Ranbar Technology, Inc., Glenshaw, PA. In his new position, Mr. Haduch will have complete responsibility for all sales activities. He joined the company in 1985 and was formerly employed by Koppers Co., Inc.

ICI, Wilmington, DE, recently honored **Lori R. Brown** for her outstanding sales performance in 1992. Mrs. Brown is a Sales Representative for ZENECA Biocides, where she serves a territory that includes the Northeast. She provides preservatives for use in industrial, household, cosmetic, and pharmaceutical products to her customers. Mrs. Brown maintains membership in the New York Society for Coatings Technology.

Brian A. Hagaman, a Technical Sales Representative with ZENECA Resins, Chicago, IL, was also recognized by ICI for his achievements. He handles sales and marketing of acrylic resins, waterborne polyurethane and other specialty resins to coatings, inks, and adhesives manufacturers for ICI Resins US.

The Truesdale Co., Brighton, MA, has named **Mark Skigis** as Technical Sales Representative. Based in New England, Mr. Skigis will be responsible for technical sales and support for the company's performance resins and specialties.

Datacolor International, Lawrenceville, NJ, has named **Jay Sylvester** as District Sales Manager for the Southeastern United States. Previously, he served as the company's West Coast Area Manager. He will be based in Datacolor International's North America Sales Headquarters in Charlotte, NC. Mr. Sylvester will be responsible for managing area sales managers and technical sales representatives serving the textile, paint and coatings, plastics, and ink and printing industries in the Southwest.

Also, **Ken Boyle** was promoted from Sales Manager to District Sales Manager for the Mid-Atlantic and New England states. In his new position, Mr. Boyle will be responsible for managing area sales managers and technical sales representatives serving the textile, paint and coatings, plastics, and ink and printing industries in the Mid-Atlantic and New England regions. In addition, he is responsible for the administration of the regional sales headquarters in Lawrenceville, NJ. Mr. Boyle has served Datacolor International for more than seven years.

The position of President of Cookson Pigments, Providence, RI, was accepted by **David H. Dinsmore**. He has been employed by Cookson America since 1977. Prior to his new position, Mr. Dinsmore was President of Spectrum Colors.

Liquid Carbonic, Oak Brook, IL, has promoted three employees in their Bulk Gases business unit.

Mike Hammar has been named National Sales Manager—Bulk Gases. Mr. Hammar, who joined the company in 1974, was previously National Sales Manager—Medical Gases.

Dan Murphy has assumed the title of National Marketing Manager—Food. His most recent position was as National Sales Manager. Mr. Murphy has been with the company for 20 years.

Ted Tiberi is the new National Marketing Manager—Emerging Technologies. Mr. Tiberi joined the company in 1986 and most recently served as Technical Marketing Manager.

Barbara Murray has joined ISK Biotech Corp., Mentor, OH, as Retail Products Business Manager, Industrial Biocides Division, in Memphis, TN. Her new responsibilities include managing sales and marketing for the Retail Product Line. Ms. Murray reports to **Dennis L. Carlson**, Sales and Marketing Manager, Coatings.

Engelhard Corp., Iselin, NJ, has announced the appointment of **Charles Spears** as General Manager of their Louisville, KY, manufacturing facility. He will preside over the production of color pigments used in the applications of plastics, paints and coatings, inks, and rubber. Mr. Spears replaces **James Doyle** who will become General Manager of Engelhard's petroleum catalyst manufacturing facility in the Netherlands. Mr. Spears, who has been with Engelhard since 1983, most recently served as a Plant Manager at the Middle Georgia Operations.



P. Makar



J.M. Kehmna

Hüls America, Inc., Piscataway, NJ, has appointed **Paul Makar** as Sales Representative, Eastern Region, for its Colorants and Additives Division. Mr. Makar's new sales territory includes New Jersey, Pennsylvania, Delaware, and New York City. Previously, he served as Technical Service Manager for Hüls' coatings additives product group. Mr. Makar is a member of the New York Society for Coatings Technology.

Also, **John M. Kehmna** was named Sales Representative, Eastern Region, for the Colorants and Additives Division. He is responsible for the sales of pigment dispersions, biocides, fungicides, metal soap/driers and HEC thickeners. His sales territory encompasses Northern New Jersey through Maine. Mr. Kehmna is a member of the New York Society for Coatings Technology.

In other news, **William Konecny** was recognized by Hüls for outstanding sales and performance achievements attained over the past year. In being named to "The Performers Club," Mr. Konecny was honored for achieving qualitative and quantitative criteria factors. He joined Hüls America in 1987 and served as a Senior Technical Service Chemist, before moving to the Sales Department three years later.

Obituary

Emerson Fowler, 77, founder of Anchor Paint Company, died on April 27, 1993, in Tulsa, OK. Mr. Fowler is noted for pioneering the development of special coatings. He developed a formula for latex paint in the 1950s which was adopted by other paint companies and later became the standard for the industry.

Mr. Fowler was a member of the Dallas and Houston Societies for Coatings Technology.

John Harbison Hirt, founder of Hirt Combustion Engineers and a pioneer in the air-pollution combustion engineering field, died on May 2. He was 78.

Mr. Hirt received a B.S. Degree in Mechanical Engineering, with a minor in Chemistry, from the University of California at Berkeley in 1937. He spent the next 17 years gathering experience in all phases of

the combustion industry, including fire-safety evaluation for fire-insurance rating; industrial furnace service; system and instrument design for U.S. and Arabian oil refineries; and engineering design for major contracting firms such as Bechtel, Parsons, and Solar Combustion.

As head of Hirt Combustion Engineers, Mr. Hirt earned a reputation as one of the industry's most respected combustion scientists. He received the Outstanding Service Award from the Air & Waste Management Association, and is a Diplomate in the Specialty Hazardous Waste Management of the American Academy of Environmental Engineers. In addition, Mr. Hirt was a member of various professional organizations including the Los Angeles Society for Coatings Technology and the Southern California Paint & Coatings Association.

New York Society Hosted Symposium, May 4-5, On Recent Advances in Additives and Modifiers

The Technical Committee of the New York Society for Coatings Technology sponsored a symposium on "Recent Advances in Additives & Modifiers for Coatings," on May 4-5, 1993, at the Holiday Inn North, Newark Airport, Newark, NJ.

The Keynote Speaker for the evening was Federation President Colin D. Penny, of Kapsulkote, Inc., Hampton, VA.

A total of 73 attendees were present to hear 14 technical papers during the two-day conference. The topics and speakers featured included:

"Acetoacetate Functionalized Reactive Diluents for Solvent-Borne and Waterborne Coatings"—Delano R. Eslinger, Senior Development Chemist, Cook Composites and Polymers;

"The Dominant Role of Organic Peroxide Initiators in Acrylic HSC Resin Syn-



John W. Du, Symposium Co-Chairman addresses the audience at the symposium

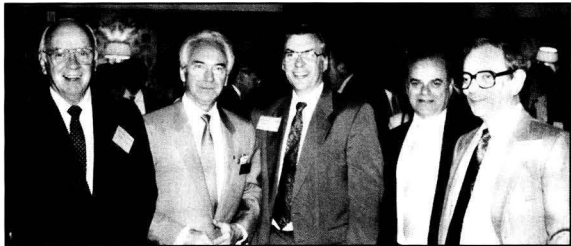
thesis and Properties"—Peter Callais, Manager/Applications, Elf Atochem North America, Inc.;

"Electrostatic Charge and Pigment Stabilization Properties of Fine Particle Sized Barium Sulfates"—Jochen Winkler, Executive Manager, Sachleben Chemie;

"Functional Polyethylene Additives: Reactive Polymers for a Changing Coatings Industry"—Arthur P. DeMonte, Manager/Commercial Development, Allied Signal Inc.;

"How to Avoid a Catastrophe: The Selection of Additives: Their Use and Misuse"—Marc S. Hirsch, Coatings Laboratory Manager, Rhone-Poulenc Inc.

"The Importance of Low Dynamic Surface Tension in Waterborne Coatings"—Joel Schwartz, Chemical/Technical Service, Air Products and Chemicals, Inc.;



From left to right: John J. Oates, Symposium Program Committee Co-Chairman; Colin D. Penny, FSCT President; Michael C. Frantz, New York Society President; Saul Spindel, former New York Society Representative; and William Singer, Symposium Attendee

"The Improvement of Substrate Wetting of Waterborne Paint Systems"—Gene Franklin, Senior Technical Representative, BYK-Chemie USA;

"Organic Corrosion Inhibitors in Direct-to-Metal Coatings"—I-Chyang Lin, Senior Scientist, CIBA-GEIGY Corporation;

"Organo-Nitrite Corrosion Inhibitors for Coating Systems"—James Walther, Manager/Commercial Development, General Chemical Corporation;

"The Protection of Photosensitive Substrates by a New Class of UV Absorbers"—Mark Holt, Group Leader/Additives for Coatings, CIBA-GEIGY Corporation;

"Silicone Microemulsions"—S. Lee Hertz, Technical Service Specialist, Wacker Silicone Corporation;

"The Synergistic Effect of Metal Sulfonates on Anticorrosive Pigments in Coatings"—Robert Coughlin, Technical Service Manager, King Industries, Inc.; and

"The Use of Fine Particle Titanium Dioxide for UV Protection in Coatings"—John Clayton, Chemist/Technical Service Department, Tioxide Specialties Ltd.

"New Oxazolidine-Based Moisture Scavenger for Polyurethane Coating Systems"—Marina Hoffman, Senior Chemist/Applications Research, ANGUS Chemical Company;

Nice, France to Host EUROCOAT 93, Sept. 14-17

EUROCOAT 93, the XXth Congress of the French Association of Technicians of Paints, Varnishes, Printing Inks and Adhesives (AFTPV) is slated for September 14-17, in Nice, France. This Congress-Exhibition, which is designed for professionals in the paint, pigment, printing ink, glue, and adhesive market, is expected to draw more than 300 international exhibitors.

The agenda for this four-day event includes lectures on paints and adhesives and sessions on specialized topics such as: ecol-

ogy, recycling of wastes, surface treatments according to paint types, and aqueous paints for the ennoblement of materials. Also scheduled is a "six minutes to attract and convince" session that enables participants to become rapidly familiar with new products, raw materials, and innovations.

For more information on EUROCOAT 93, contact Annik Chauvel, Secretariat UATCM, c/o AFTPV-5 rue Etex-F, 75018 Paris.

Detroit Society Promotes Coatings Industry As Members Participate in Local Science Fair



Detroit area students show interest in the sample parts at the Detroit Society table. Answering their questions are (standing) Detroit Society President William Passeno, of Red Spot Paint Co.; (seated) President Scot Westerbeeck, of Matteson-Ridolfi; and Secretary Jane Allen, of Reichhold Chemicals

On Tuesday, April 20, 1993, representatives of the Detroit Society for Coatings Technology attended the Metropolitan Detroit Science Fair and Career Day at Cobo Hall in downtown Detroit. All of the Detroit public schools, including middle and high schools, participated. In addition to the Society, several other professional organizations, including the Society of Plastic Engineers and The Engineering Society of Detroit, participated.

The primary focus of the Society's participation was to inform students and teachers of the many educational programs within the paint industry. Literature on all college programs being offered nationwide was distributed. Some teachers showed interest in attending the annual summer workshop that Eastern Michigan University presents with assistance from local industry.

Society members presented samples of plastic interior automotive parts coated with a variety of different technologies along with injection molded model cars coated with basecoat/clearcoat pearlescent coating.

Atlas Sponsors Weather-Ometer® Accelerated Weathering Workshops

Atlas Electric Devices Co., Chicago, IL, has announced the dates for its 1993 Weather-Ometer® Workshop. The two-day workshop is scheduled to be held August 18-20 and November 17-19 in Chicago at the Holiday Inn O'Hare.

This workshop, which is designed for operators of the Atlas Weather-Ometer instrument, provides a hands-on program that features two operating Weather-Ometers and training on set-up, calibration, and operation of current Xenon Weather-Ometers and Fade-Ometers. The cost of the course is \$725 which includes course materials, lunch and refreshments both days, and a welcoming reception.

Also, Atlas hosted their annual Atlas School of Natural and Accelerated Weathering on May 3-7 in Miami, Florida. The school is designed to teach the fundamentals of natural and accelerated weathering of materials to product managers, material engineers, quality control supervisors and other personnel involved in determining the durability of their products.

To obtain more information on these events, contact Margaret MacBeth, Atlas Electric Devices Co., 4114 N. Ravenswood Ave., Chicago, IL 60613.

Call for Papers

17th Annual Meeting of the Adhesion Society

February 21-23, 1994

Clarion Plaza Hotel, Orlando, FL

The 17th annual meeting of the Adhesion Society will be held at the Clarion Plaza Hotel in Orlando, FL, on February 21-23, 1994. Papers on all aspects of adhesion science are invited for presentation. Topics to be emphasized in the technical sessions include, but are not limited to, the following:

- Fiber/Matrix Adhesion and Composite Properties
- Fundamentals of Particle Adhesion
- Mechanics of Interfacial Fracture
- Nondestructive Evaluation of Adhesively Bonded Joints

Deadline for one-page abstracts is August 1, 1993. Send abstracts to Program Chairman Prof. Ken Liechti, University of Texas at Austin, ASE/EM WRW 217, Austin, TX 78712.

In addition, the symposium "Fundamentals of Particle Adhesion," will be held in conjunction with the Adhesion Society's annual meeting. The tentative program of papers is as follows:

"Particle-Substrate Collisions, Particle Entrainment and Hydrodynamic Removal"; "Mechanics of Particle Adhesion"; "Effect of Particle Charge on Adhesion"; "Electrostatic Detachment of Particles from Substrates"; "Effect of Humidity of Particle Adhesion"; "Surface Roughness and Particle Adhesion"; and "Molecular Dynamic Modeling of Particle Adhesion."

Send a one-page abstract by August 1, 1993 to Symposium Chairman, Donald S. Rimai, Eastman Kodak Company, 901 Elmgrave Rd., Rochester, NY 14653.

**International Symposium
on
Volatile Organic Compounds
Sponsored by ASTM
Committee E-47**

ASTM Committee E-47 on Biological Effects and Environmental Fate is sponsoring an International Symposium on Volatile Organic Compounds (VOCs) in the Environment. The symposium will be held April 17-19, 1994, in Montreal, Quebec, Canada, in conjunction with the April 17-21 standards development meetings of Committee E-47.

The objectives of the symposium are to provide a forum for reporting the latest advancements, reviewing the state of the science, and exchanging experiences in VOCs in a broad range of topics, including sources, fate, transport, effect, risk assessment, and treatment. The symposium will begin Monday morning with a keynote presentation, and paper presentations will continue through Wednesday. Also, a panel discussion on critical issues will be held. A special poster session on Monday afternoon will emphasize creative presentations on various aspects of VOCs. This session is planned to stimulate discussion among participants. Displays, videos, and demonstrations are encouraged for this session. The following is a list of topics expected to be discussed:

- Quantification of VOCs
- Point and nonpoint sources
- VOCs in refuse, sludge, leachate, effluent, soil, and sediment
- VOCs in air and air toxics modeling
- Fate and reaction of VOCs
- Toxicity of VOCs to animals, plants, and microorganisms
- Regulation of VOCs in air, water, and effluent
- Clean Air Act, Clean Water Act, and RCRA
- Risk assessment
- Enhanced bioremediation
- Nonbiological treatment

More information is available from Symposium Chairman Dr. Wuncheng Wang, U.S. Geological Survey, WRD, P.O. Box 1230, Iowa City, IA 52244; or Co-Chairmen, Dr. Jerald Schnoor, University of Iowa, Department of Civil and Environmental Engineering, Iowa City, IA 52242; and Dr. Jon Doi, Roy F. Weston, Inc., One Weston Way, West Chester, PA 19380.

Papers Solicited for International Symposia

Abstracts are being sought for two international symposia being sponsored by Skill Dynamics, an IBM Company, Thornwood, NY. The programs will be held November 3-5 and 8-10, 1993 in Las Vegas, NV.

The first symposium on "Polymer Surface Modification: Relevance to Adhesion," is slated for November 3-5. Papers dealing with surface modification of all types of polymers by any technique will be considered. Some of these techniques include: plasma, UV, laser, ion processing, flame, mechanical roughening, monolayer deposition, grafting, and wet chemical. Also, the modification of polymers to improve their adhesion to any material, e.g., metal layers (metallized plastics), organic coatings, inks, matrix (reinforced composites), microorganisms, etc., is all within the purview of this symposium.

This program is designed to provide a forum for discussion of the latest developments in polymer surface modification, and both fundamental and applied aspects will be covered.

The second symposium, "Plasma Polymerization/Deposition: Fundamental and Applied Aspects," will be conducted on November 8-10.

Topics to be considered include: plasma sources and reactor systems; factors affecting plasma polymerization/deposition, and plasma enhanced deposition; properties of plasma deposited coatings; characterization of plasma deposited coatings; monitoring plasma deposition processes; and application of plasma deposited coatings.

The purpose of this symposium is to provide a forum for discussion of the latest developments in plasma polymerization/deposition. Both fundamental and applied aspects will be covered. Plasma polymerization/deposition of all kinds of materials (organic, inorganic) will be within the purview of this symposium.

Abstracts (for both symposia) of 200 words should be sent by August 1, 1993 to, K.L. Mittal, Organizer, Skill Dynamics, an IBM Company, 500 Columbus Ave., Thornwood, NY 10594.

The Association de Recherches Scientifiques Paul Neumann in conjunction with the Association Française des Techniciens des Peintures, Colles, Vernis et Adhésifs (AFTPV) will be conducting the symposium entitled:

"Developments in the Field of Water Paints for the Surface Improvement of Materials"

September 15, 1993 • Nice, France

The program will include a Poster Session.

For more information, contact:

Mme Petuisot, Tour Roussel Hoechst, 92080, Paris/la Defense

**First World Congress on Emulsion, Oct. 19-22
Will Be Presented in Paris, France**

Over 350 papers from more than 50 countries have been selected to be presented at the first World Congress on Emulsion to be held on October 19-22, 1993, in Paris, France.

The subject matter of the papers will cover different types of emulsions, addressing their scientific, technical, and industrial aspects.

The program is broken down into four themes. They are:

- Theme 1—Stability and Manufacturing of Emulsions
- Theme 2—Wetting and Adhesion
- Theme 3—Rheology and Flow Properties
- Theme 4—Applications and Case Histories: Bitumen Emulsions—Emulsion Industries

For more details, contact CME, 50, Place Marcel Pagnol, 92100 Boulogne, France.

**Two-Day Polymer Coatings
Mini-Course Slated for Oct. 25-26**

Drs. Shelby F. Thames, of The University of Southern Mississippi (USM), and James O. Stoffer, of the University of Missouri-Rolla, will be conducting a two-day polymer coatings mini-course on October 25-26, 1993, Atlanta Marriott Marquis, in Atlanta, GA. Topics to be covered include: waterborne, high-solids, powder, and solvent-base coatings, and the function of formulation to meet new VOC regulations, etc.

For more information, contact Shelby F. Thames, USM, Box 10076, Hattiesburg, MS 39406-0076.

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<i>J. Koleske, 1991</i> |
| <input type="checkbox"/> 8. Automotive Coatings
<i>B.N. McBane, 1987</i> | <input type="checkbox"/> 18. Rheology
<i>C. Schoff, 1991</i> |
| <input type="checkbox"/> 9. Coating Film Defects
<i>P.E. Pierce and C. K. Schoff</i> | <input type="checkbox"/> 19. Powder Coatings
<i>J. Jilek, 1992</i> |
| <input type="checkbox"/> 10. Application of Paints and Coatings
<i>S.B. Levinson, 1988</i> | <input type="checkbox"/> 20. Introduction to Pigments
<i>J. Braun, 1993</i> |



**Federation of Societies for
Coatings Technology**

492 Norristown Road
Blue Bell, PA 19422-2350
Phone: 215-940-0777
FAX: 215-940-0292

Also available from:

IN THE U.K.: Birmingham Paint, Varnish and Lacquer Club, Robert McD. Barrett, B.I.P. Chemicals Ltd., P.O. Box 6, Popes Lane, Oldbury, Warley, West Midlands B69 4PD, United Kingdom. (British Pounds Sterling)

IN MEXICO: Ms. Margarita Aguilar, Mexico Society, Gabriel Mancera 309 Col. Del Valle, 03100 Mexico, D.F., Mexico.

Coating Adhesion Promoters

The introduction of a new family of metal organic adhesion promoters has been made through a product release. These products are designed to be used as a post addition to both waterborne and solvent borne coatings. For more information, contact Chartwell International, Inc., 32 Condor Rd., Sharon, MA 02067.

Circle No. 200 on Reader Service Card

Water Reducible Coatings

New literature describing a line of VOC-compliant water reducible coatings is available. The two-page, four color brochure is designed to be used as a quick-reference guide by product finishers when selecting coatings for metal, plastic, and some wood products. To receive the Kem Aqua[®] Sell Sheet, write The Sherwin-Williams Co., c/o HKM Direct, 5501 Cass Ave., Cleveland, OH 44102.

Circle No. 201 on Reader Service Card

Sample Holders

A new data sheet focuses on sample pads that do not interfere with sample analysis. The sample pads are designed for use as sample holders in moisture/solids analyses that require accuracy and precision. For additional information, write CEM Corp., 3100 Smith Farm Rd., P.O. Box 200, Matthews, NC 28106-0200.

Circle No. 202 on Reader Service Card

Capabilities Brochure

A 42-page color brochure outlines a company's technical, product, research, and service capabilities. This brochure includes information on the firm's technology centers, its R & D group, and its Materials Engineering Centers. To receive a copy of "We Don't Succeed Unless You Do," write to The Dow Chemical Co., P.O. Box 1206, Midland, MI 48641-1206.

Circle No. 203 on Reader Service Card

Dual-Cylinder Pumps

Series VPA dual-cylinder pumps are the topic of a data sheet. These pumps are designed to eliminate waste, error, and liquid spillage during liquid filling. For more information and a copy of a Catalog VPA, write Plast-O-Matic Valves, Inc., 430 Route 46, Totowa, NJ 07512.

Circle No. 204 on Reader Service Card

Instruments and Systems

A comprehensive guide to Nikon instruments and systems for industry is now available. The two-color brochure, with product photos and descriptions, outlines the features and capabilities of a company's microscopes and measuring instruments and systems. For a free copy of "Nikon Instruments and Systems for Industry," contact Nikon Inc., Instrument Group, Technological Dept., 1300 Walt Whitman Rd., Melville, NY 11747.

Circle No. 205 on Reader Service Card

Spectrometer

The introduction of a spectrometer, designed for experimental sampling flexibility, has been made through literature. The instrument reportedly covers a broad spectral range by using different sources as well as several beamsplitters and detectors that can optionally span the range from 50 to 15,000 cm⁻¹. For more information, contact the FT-IR Division, Bruker Instruments, Inc., Manning Park, Billerica, MA 01821.

Circle No. 206 on Reader Service Card

Products Brochure

The products available from a manufacturer are presented in an eight-page pamphlet. The pamphlet describes the products and gives characteristics of their dyes, pigments, and additives. For a copy of "Products for Water-Based Inks and Coatings," write Mike Cummins, Sandoz Chemicals Corp., 4000 Monroe Rd., Charlotte, NC 28205.

Circle No. 207 on Reader Service Card

Bar Coded Label

The introduction of a bar coded customer shipment label has been made through a brochure. This new label, which utilizes a Universal Product Code (UPC) labeling system, enables customers to maintain records of shipments received and inventory available by using scanning equipment. More information is obtainable by writing the Colors Group, Pigments Division, Sun Chemical Corp., 411 Sun Ave., Cincinnati, OH 45232-1993.

Circle No. 208 on Reader Service Card

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Solution to June's "CrossLinks"

Shipping Container

A new four-page, four-color brochure describes a hazardous liquid shipping container designed for low-cost handling of corrosive and flammable liquids and oxidizers. The illustrated booklet details the features and benefits of the container and provides specifications. Further information on the Econo 330 Poly Bin container is available from the Clawson Tank Co., P.O. Box 350, 4545 Clawson Tank Dr., Clarkston, MI 48346-0350.

Circle No. 209 on Reader Service Card

Light Microscopy Camera

A fully automatic, single-lens-reflex, instant camera for photographing any specimen through a light microscope is the subject of literature. The new camera reportedly combines low cost with an exposure and filtration control system to produce instant color and black and white prints with the touch of a button. For further details on the Microcam SLR, write Polaroid Corp., 575 Technology Sq., Cambridge, MA 02139.

Circle No. 210 on Reader Service Card

Resins

A complete line of products for the industrial paint and coatings industry are presented in a new brochure. This brochure describes the G-Cure[®] acrylic resin product line. A complimentary copy of "G-Cure[®] Acrylic Polyol Resins" may be obtained by writing the Henkel Corp., Coatings & Inks Division, 300 Brookside Ave., Ambler, PA 19002.

Circle No. 211 on Reader Service Card

Plastics Color System

A new color system designed to provide a means of selecting, specifying, and controlling color reproduction in plastics is the topic of a data sheet. This system reportedly contains over 2800 opaque and transparent colored polystyrene chips arranged chromatically and also includes a selection of grays, browns, pearlescents, fluorescents, and metallics. For more information on the Pantone Plastics Color System[®], write Pantone, Inc., 590 Commerce Blvd., Carlstadt, NJ 07072-3098.

Circle No. 212 on Reader Service Card

Twin Surfactants

Twin surfactants, developed to promote defect-free coverage in the most difficult waterborne coating applications, have been introduced through literature. Reportedly, the surfactants provide low dynamic surface tensions that allow quick migration to newly formed interfaces, preventing film retraction, craters, and other surface defects. For more information on Surfynol[®] 502 and 504, contact Air Products and Chemicals, Inc., Performance Chemicals Division, 7201 Hamilton Blvd., Allentown, PA 18195-1501.

Circle No. 213 on Reader Service Card

Cryogenic Grinding System

A cryogenic grinding precooling system is the topic of a data sheet. This product was developed to provide mixing and steady, controlled feeding, and to reduce a variety of materials including polyester, epoxy, acrylics, rubber, and spices. For more information, request Form #6964 from Liquid Carbonic, Corporate Communications Dept., 800 Jorie Blvd., Oak Brook, IL 60521-2216.

Circle No. 214 on Reader Service Card

When you need a pigment extender, you need GENSTAR.

CAMEL-WITE[®] & CAMEL-WITE SLURRY[®] The industry standard. Exceptionally white, fine particle size, wet-ground product produced from high-grade calcite limestone.

CAMEL-TEX[®] Fine ground general purpose grade of calcium carbonate produced from extremely white Calcite. Low vehicle demand, rapid dispersibility.

CAMEL-CARB[®] A quality extender that's economically priced. Produced from white Calcite. Provides uniform low vehicle demand, good color, high brightness.

CAMEL-CAL[®] & CAMEL-CAL SLURRY[®] New from Genstar. Ultra-fine ground calcite limestone with extender efficiency and hiding power of precipitated calcium carbonate.

GENSTAR

Genstar Stone Products
Hunt Valley, MD 21031
(410) 527-4225

Interior Can Linings

The introduction of a new resin for interior and exterior can coatings has been made through a product release. This product, which is a saturated, high molecular weight polyester resin, was designed as an alternative to polyvinyl chloride coatings. More information on Dynapol® L 490 resin can be obtained from Hüls America Inc., Coatings Raw Materials Div., 80 Centennial Ave., Piscataway, NJ 08855.

Circle No. 215 on Reader Service Card

Product Finishers Brochure

A new, four-page, color brochure describes the comprehensive technical support services available to product finishers. The brochure explains how design engineering consultants work with manufacturers and outlines the available services. To receive a copy of "Taking Technology to the Finish," identify inquiries as Design Engineering Brochure, and direct to The Sherwin-Williams Co., c/o HKM Direct, 5501 Cass Ave., Cleveland, OH 44102.

Circle No. 216 on Reader Service Card

Product Directory

Products, markets and industries served, and sales office telephone and fax numbers are available in an eight-page directory. The four-color pamphlet lists alphabetically all the markets served by Cytec Industries. For a copy of the "Directory of Advanced Technologies Serving Industry," contact Cytec Industries, Five Garret Mountain Plaza, West Paterson, NJ 07424.

Circle No. 217 on Reader Service Card

Syringe Filters

Literature has been released on a 4 mm syringe filter. Tests reportedly show that the filters have a less than 7.5 µL holdup volume. The filters have been specifically developed to use in chromatography, robotics, and cell culture applications. For more information, contact Sharman V. Pate, Whatman, Inc., 9 Bridewell Place, Clifton, NJ 07014.

Circle No. 218 on Reader Service Card

Organic Intermediate

Technical information highlights a 3-(n-pentadecyl) phenol, a reactive intermediate. A typical application is as a coupling agent for azo and other organic dyes and pigments. For more information on Cardolite® NC-510, contact Deirdre Igo, Marketing Manager, Cardolite Corp., 500 Doremus Ave., Newark, NJ 07105.

Circle No. 219 on Reader Service Card

Dry Grinding Attritor

Dry grinding attritors are the subject of a new six-page, full color brochure. The brochure contains information about the dry grinding process, schematic drawings, tables, tips, features, and options. For a free dry grinding attritor brochure, contact Union Process, 1925 Akron-Peninsula Rd., Akron, OH 44313.

Circle No. 220 on Reader Service Card

Diaphragm Valve

Literature is now available on a miniature air-operated valve for pressure applications to 100 PSI. The 1/2 in. model of this 1,000,000 cycle-life thermoplastic valve measures 2 1/2 in. x 3 in. and was designed for use with highly corrosive or ultra-pure liquids. Contact Plast-O-Matic Valves, Inc., 430 Route 46, Totowa, NJ 07512, to obtain more information.

Circle No. 221 on Reader Service Card

Paint Finish Selector Guide

A new six-page paint finish selector brochure has been introduced. This guide was developed to help specifiers, designers, and builders integrate ceiling colors, and features swatches of the 24 standard colors offered in Acoustone and Auratone ceiling panel lines and the 32 colors available in the Donn Suspension Systems ceiling grid. For a copy of the "Color Solutions™ Paint Finish Selector Brochure," write USG Interiors, P.O. Box 4470, Chicago, IL 60680-4470.

Circle No. 222 on Reader Service Card

Cyclic Corrosion Tester

A product release highlights a new, redesigned, corrosion tester. This product was designed to improve correlation with outdoor results, perform multifunctional automotive tests, or do traditional salt spray. For further information, contact Russell Raymond, The Q-Panel Co., 26200 First St., Cleveland, OH 44145.

Circle No. 223 on Reader Service Card

Additives

A new literature series developed for the industrial coatings industry is now available. The first, titled "Corrosion Inhibition," includes a technical presentation on organic corrosion inhibition, formulations, and two environmental narratives. To receive the first series and future mailings, write Laura Havranek, Additives Div., CIBA-GEIGY Corp., 7 Skyline Dr., Hawthorne, NY 10532.

Circle No. 224 on Reader Service Card



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Circle No. 106 on the Reader Service Card

Chromatography System

A 12-page color brochure highlights a new multitasking, multiuser chromatography system designed for analytical laboratories that need a centralized approach to chromatography data processing. For more information on the Access.Chrom™ system, write The Perkin-Elmer Corp., 761 Main Ave., Norwalk, CT 06859-0012.

Circle No. 225 on Reader Service Card

Quality Control Instruments

A 36-page catalog featuring coatings inspection instrumentation has been published. The catalog contains descriptions, ranges, models, and pricing of over 100 quality control instruments for monitoring ambient conditions, surface profile and cleanliness, and wet and dry film thickness, along with instruments for measuring adhesion, pinhole detection, and field microscopy. For a complimentary copy, contact KTA-Tator, Inc., 115 Technology Dr., Pittsburgh, PA 15275.

Circle No. 226 on Reader Service Card

Viscometry/Rheometry

Product information on viscosity measuring instruments, systems, and accessories for liquids, slurries, and pastes is available in a 32-page guide. To receive a free copy of the "1993 Guide to Viscometry/Rheometry," contact Brookfield Engineering Laboratories, Inc., Dept. NR-95, 240 Cushing St., Stoughton, MA 02072.

Circle No. 227 on Reader Service Card

Mixing Applications

Mixing applications are featured in a four-color brochure. The literature describes a range of mixers from portable mixers to draft tube circulators and profiles a laser-designed impeller. For a free copy of "Getting the Job Done Right," contact LIGHTNIN, 135 Mt. Read Blvd., Rochester, NY 14603.

Circle No. 228 on Reader Service Card

Sulfonate-Based Coating

The availability of a waterborne coating that utilizes sulfonate-based technology to provide a hard, thin film for industrial corrosion-preventive applications has been announced in a product release. The coating is recommended for pipes, small parts, and other industrial applications where resistance to both corrosion and abrasion is sought. Contact Witco Corp., 520 Madison Ave., New York, NY 10022 for more information on Saci® 4215 coating.

Circle No. 229 on Reader Service Card

Salt Fog Chambers

A product release has introduced a cyclic salt fog (CSF) chamber for industrial paints and protective coatings. The CSF is intended to provide more realistic simulation of corrosive environments by utilizing a programmable controller that automatically alternates wet and dry cycles which reflect the stresses found in real life conditions. To obtain more information, contact Margaret MacBeth, Atlas Electric Devices Co., 4114 North Ravenswood Ave., Chicago, IL 60613.

Circle No. 230 on Reader Service Card

Acrylic Polyol

An acrylic polyol developed to reduce dry time is the subject of a product release. The product, whose property balance reportedly provides long pot life, fast dry time, and gloss retention, can be used to make high performance urethane coatings in the 3.0 to 3.5 VOC range. To obtain more information on SCX™-910, contact SC Johnson & Son, Inc., 1525 Howe St., Racine, WI 53403-5011.

Circle No. 231 on Reader Service Card

Penetrometer

A brochure detailing a penetrometer has been published. This instrument reportedly monitors the texture and consistency of products continuously over time, or under changing temperature conditions. To obtain more information on the PNR 20 Load and Tensile Penetrometer, contact Petrolab Corp., 874 Albany-Shaker Rd., Latham, NY 12110.

Circle No. 232 on Reader Service Card

Mixer/Reactor/Dryer Units

A line of turbulent mixers/reactors/dryers and planetary mixers is the topic of a 16-page brochure. This brochure, which serves as a problem solving reference guide, includes photos and text that demonstrate the process functions, advantages, and applications of each model. For a complimentary copy, write Draiserwerke, Inc., 3 Pearl Court, Allendale, NJ 07401.

Circle No. 233 on Reader Service Card

Surface Thermometer

The introduction of a small, reusable, and self-adhesive thermometer strip has been made through literature. This product is designed to indicate whether or not the surface is within the appropriate temperature range to permit maximum paint performance. For further information on tempPAINTure™ contact John Harris, R. Mitchel Products, 875 South Colorado Blvd., Suite 723, Denver, CO 80222.

Circle No. 234 on Reader Service Card



Precious Life

Not too many years ago, this nurse was a patient at St. Jude Children's Research Hospital. She fought a tough battle with childhood cancer. And won.

Now married and with a child of her own, she has returned to St. Jude Hospital to care for cancer-stricken children.

Until every child can be saved, our scientists and doctors must continue their research in a race against time.

To find out more, write St. Jude Hospital, P.O. Box 3704, Memphis, TN 38103, or call 1-800-877-5833.



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Coming Events

FEDERATION MEETINGS

For information on FSCT meetings, contact Federation of Societies for Coatings Technology, 492 Norristown Rd., Blue Bell, PA 19422 (215) 940-0777, FAX: (215) 940-0292.

1993

(Oct. 27-29)—71st Annual Meeting and 58th Paint Industries' Show. World Congress Center, Atlanta, GA.

1994

(May 12-15)—Federation "Spring Week." Spring Seminar on the 12th and 13th; Incoming Society Officers Meeting on the 14th; Board of Directors Meeting on the 15th. Marriott City Center Hotel, Minneapolis, MN.

(Oct. 12-14)—72nd Annual Meeting and 59th Paint Industries' Show. New Orleans Convention Center, New Orleans, LA.

1995

(Oct. 9-11)—73rd Annual Meeting and 60th Paint Industries' Show. Cervantes Convention Center, St. Louis, MO.

SPECIAL SOCIETY MEETINGS

1994

(Feb. 9-11)—21st Annual Waterborne, Higher-Solids, and Powder Coatings Symposium. Sponsored by the Southern Society for Coatings Technology and The University of Southern Mississippi (USM), New Orleans, LA. (Robson F. Storey or Shelby Thames, Co-Organizers, WBHS&PC Symposium, Dept. of Polymer Science, USM, P.O. Box 10076, Hattiesburg, MS 39406-0076).

(Apr. 27-30)—Pacific Northwest Society, 47th Annual Spring Symposium. 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).

OTHER ORGANIZATIONS

1993

North America

(July 25-29)—Conference on "Lead in Paint, Soil, and Dust." Cosponsored by ASTM Committees D-22, E-6, D-1, and D-18. University of Colorado, Boulder, CO. (ASTM, 1916 Race St., Philadelphia, PA 19103).

(July 28-30)—"Basic Coatings for Sales and Marketing Personnel." Short course sponsored by University of Missouri-Rolla (UMR), St. Louis, MO. (Cynthia N. Campbell, UMR Coatings Institute, Dept. of Chemistry, 142 Schrenk Hall, Rolla, MO 65401).

(Aug. 2-6)—Gordon Research Conference on "Chemistry and Physics of Coatings and Films." Colby-Sawyer College, New London, NH. (A.K. St. Clair, Head, Advanced Aircraft Program Office, Materials Div., NASA, Langley Research Center, Hampton, VA 23681-0001).

(Aug. 2-6)—"Electrochemical Impedance Spectroscopy." Short course co-sponsored by the University of Virginia and EG&G Instruments Princeton Applied Research. University of Virginia, Charlottesville, VA. (Cynthia Nienart, EG&G Instruments Princeton Applied Research, P.O. Box 2565, Princeton, NJ 08543-2565).

(Aug. 3-5)—"Fundamentals of Corrosion and Its Control." Course sponsored by LaQue Center for Corrosion Technology, Blockade

Runner Hotel, Wrightsville Beach, NC. (LaQue Center for Corrosion Technology, Inc., P.O. Box 656, Wrightsville Beach, NC 28480).

(Aug. 9-12)—"Coatings Science of Powder Coatings." Short course sponsored by The University of Southern Mississippi (USM), Hattiesburg, MS. (Debbie Ballard or Shelby Thames, USM, Dept. of Polymer Science, Southern Station, P.O. Box 10076, Hattiesburg, MS 39406-0076).

(Sept. 12-14)—"Back to Basics." 81st Annual Convention of the Canadian Paint and Coatings Association (CPCA), Queen's Landing Inn, Niagara-on-the-Lake, Ontario, Canada. (CPCA, 9900 Cavendish Blvd., Ste. 103, St.-Laurent, Quebec H4M 2V2, Canada).

(Sept. 13-17)—"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).

(Sept. 20-24)—"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).

"Coatings Science Mini-Course"

Presented by

Dr. Shelby F. Thames & Dr. James O. Stoffer
of the University of the University
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Tuition of \$875 includes lecture notes, continental breakfast, luncheon, and breaks.

For more information, contact: Dr. Shelby F. Thames or Debbie Ballard, University of Southern Mississippi, Polymer Science Department, Box 10076, Hattiesburg, MS 39406-0076; (601) 266-5618; FAX (601) 266-5880.

Circle No. 141 on the Reader Service Card

(Sept. 23)—Detroit Colour Council Meeting. Michigan State Management Education Center, Troy, MI. (James Hall, General Motors Corp., 30009 Van Dyke, Warren, MI 48090).

(Sept. 29-30)—"Advanced Radiation (UV/EB) Curing Marketing/Technology." Seminar sponsored by Armbruster Associates, Inc. Marriott Hotel, Newark Airport, Newark, NJ. (David Armbruster, Ambruster Associates, Inc., 43 Stockton Rd., Summit, NJ 07901).

(Sept. 29-Oct. 1)—"Accelerated and Natural Weathering Techniques for Coatings and Polymers." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Oct. 3-5)—"Crosslinked Polymers: Chemistry, Properties and Applications"; "Fundamentals of Adhesion: Theory, Practice and Applications"; and "Polymer Blends and Alloys: Phase Behavior, Characterization, Morphology, Alloying Technology." Conferences sponsored by State University of New York (SUNY) at New Paltz, New Orleans, LA. (Angelos Patsis, Institute of Materials Science, SUNY, New Paltz, NY 12561).

(Oct. 5-8)—"Introduction to Coatings Technology." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Oct. 6-8)—"Organic Thin Films for Photonic Applications." Topical meeting sponsored by American Chemical Society and Optical Society of America. Royal York Hotel, Toronto, Ont., Canada. (Optical Society of America, Meetings Dept., 2010 Massachusetts Ave., NW, Washington, D.C. 20036-1023).

(Oct. 10-12)—"Advances in Polymer Colloids/Emulsion Polymers"; and "Principles of Polymer Degradation and Stabilization." Conferences sponsored by State University of New York (SUNY) at New Paltz, Orlando, FL. (Angelos Patsis, Institute of Materials Science, SUNY, New Paltz, NY 12561).

(Oct. 12-14)—"Industrial Painting: Application Methods." Short course sponsored by Kent State University, Kent, OH. (Carl J. Knauss,

Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Oct. 24-28)—National Board of Registration for Nuclear Safety-Related Coatings Engineers and Specialists meeting. Crown Sterling Suites Hotel, Deerfield Beach, FL. (National Board of Registration for Nuclear Safety-Related Coatings Engineers and Specialists, Office of the Executive Director, Box 56, Leola, PA 17540-0056).

(Oct. 25-26)—"Polymer Coatings." Mini-course cosponsored by The University of Southern Mississippi (USM) and University of Missouri-Rolla. Atlanta Marriott Marquis, Atlanta, GA. (Shelby Thames or Debbie Ballard, USM, Dept. of Polymer Science, P.O. Box 10076, Hattiesburg, MS 39406-0076).

(Oct. 25-27)—106th National Meeting of the National Paint and Coatings Association (NPCA). Hilton Hotel and Towers, Atlanta, GA. (NPCA, 1500 Rhode Island Ave., NW, Washington, D.C. 20005).

(Oct. 25-29)—"Image Analysis and Measurement in Scanning Electron Microscopy"; "Scanning Electron Microscopy and X-Ray Microanalysis for Materials Science. An Introductory Course"; and "Scanning Electron Microscopy for Polymeric Science. An Introductory Course." Conferences sponsored by State University of New York (SUNY) at New Paltz. Nevele Resort Hotel, Ellenville, NY. (Angelos Patsis, Institute of Materials Science, SUNY, New Paltz, NY 12561).

(Nov. 1-4)—12th Biennial Symposium on Managing Corrosion with Plastics. Sponsored by National Association of Corrosion Engineers (NACE). American Society for Testing Materials, Materials Technology Institute of the Chemical Process Industries, Inc., SPI Composites Institute, and Technical Association of the Pulp and Paper Industry, Baltimore, MD. (NACE, P.O. Box 218340, Houston, TX 77218-8340).

(Nov. 2-4)—"Fundamentals of Corrosion and Its Control." Training course sponsored by LaQue Center for Corrosion Technology. Holiday Inn, Wrightsville Beach, NC. (LaQue Center for Corrosion Technology, Inc., P.O. Box 656, Wrightsville Beach, NC 28480).

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Australian Paint Company Seeks U.S. Manufacturer

Galmet Paints & Chemicals Pty. Ltd., New South Wales, Australia, a producer of anticorrosive and surface coatings to steel fabricators, and the trade sales and D.I.Y. markets, is looking to expand their position in the paint and coatings industry.

An enterprising business venture with a similar U.S. company is being sought. The company must be willing to produce a highly commercial and unique coating under a licensing agreement.

For more details on the above proposed venture, please contact:

John Dillon
Galmet Paints & Chemicals Pty. Ltd.
53 Mitchell Road
P.O. Box 37
Brookvale, N.S.W.
2100 Australia
Telephone: (02) 905 0696; Fax: (02) 939 1509

Circle No. 143 on the Reader Service Card

(Nov. 3-5)—"Polymer Surface Modification: Relevance to Adhesion." Symposium sponsored by IBM. Las Vegas, NV. (K.L. Mittal, Organizer, Skill Dynamics, an IBM Co., 500 Columbus Ave., Thornwood, NY 10594).

(Nov. 8-10)—"Polymerization/Deposition: Fundamental and Applied Aspects." Symposium sponsored by IBM. Las Vegas, NV. (K.L. Mittal, Organizer, Skill Dynamics, an IBM Co., 500 Columbus Ave., Thornwood, NY 10594).

(Nov. 9-11)—9th Annual Advanced Composites Conference and Exposition and 3rd Annual Advanced Coatings Technology Conference and Exposition. Sponsored by The Engineering Society. Hyatt Regency, Dearborn, MI. (Clare B. Ellis, The Engineering Society, 2350 Green Rd., Ste. 190, Ann Arbor, MI 48105).

(Nov. 10-12)—Electroless Nickel '93. Conference sponsored by *Products Finishing*. Orlando Airport Marriott, Orlando, FL. (Cindy Goodridge, Gardner Management Services, 6600 Clough Pike, Cincinnati, OH 45244).

(Nov. 15-16)—"Fundamentals of HPLC." Short course sponsored by Kent State University (KSU), Kent, OH. (Carl J. Knauss, Director, Cooperative & Continuing Education—Chemistry, KSU, P.O. Box 5190, Kent, OH 44242-0001).

(Nov. 19-21)—46th Annual National Decorating Products Show. Sponsored by National Decorating Products Association (NDPA). Indiana Convention Center, Indianapolis, IN. (Ruth Wilms, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132).

South America

(Sept. 8-10)—3rd International Paint Congress and Exhibition on Paint Industry Suppliers. Sponsored by the Brazilian Association of Paint Manufacturers. Palácio de Convenções do Anhembi, São Paulo, Brazil. (Especifica S/C Ltda, Rua Augusta, 2516-2nd, Cj 22, 01412-100 São Paulo SP, Brazil).

Europe

(Dec. 6-8)—"Styrenics '93." Conference sponsored by Maack Business Services, Swissôtel Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804 AU/ZH, Switzerland).

(Sept. 5-10)—3rd International Congress on Polymer Photochemistry. Sponsored by Manchester Metropolitan University and University of Milan. Genova, Italy. (Emmezeta SRL, Via C. Farini, 70, I-20159, Milano, Italy).

(Sept. 8-11)—Conference on "Innovative Responses from an Industry under Siege." Sponsored by the Skandinaviska Lackteknikers Forbund (SLF) Congress. Copenhagen, Denmark. (Michael Symes, President, SLF, Strandboulevarden 38, DK-2100, Copenhagen, Denmark).

(Sept. 14-17)—Eurocoat '93 and XXth Congress of the French Association of Technicians of Paints, Varnishes, Printing Inks, and Adhesives (AFTPV). Acropolis Palace, Nice, France. (Secretariat UATCM, c/o AFTPV, 5 rue Etex, F. 75018 Paris, France).

(Sept. 15)—"Developments in the Field of Water Paints for the Surface Improvement of Materials." Symposium sponsored by the Association de Recherches Scientifiques Paul Neumann in conjunction with the Association of Technicians of Paints, Varnishes, Printing Inks, and Adhesives. Nice, France. (Mme Pertuisot, Tour Roussel Hoechst, 92080, Paris/La Defense, France).

(Oct. 4-6)—"Polyethylene '93." Conference sponsored by Maack Business Services, Swissôtel Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804, AU/ZH, Switzerland).

(Oct. 19-20)—"Aspects of Photoinitiation." Conference sponsored by Paint Research Association (PRA). Anugraha Conference Centre, Egham, England. (Richard Kennedy, Radcure Services Dept., PRA, 8 Waldegrave Rd., Teddington, Middlesex, TW11 8LD, England).

(Oct. 19-22)—World Congress on Emulsion. Paris, France. (CME, 50, place Marcel Pagnol, 92100 Boulogne-Billancourt, France).

(Oct. 25-27)—"Polypropylene '93." Conference sponsored by Maack Business Services, Swissôtel Zürich, Switzerland. (Maack Business Services, Moosacherstrasse 14, CH-8804, AU/ZH, Switzerland).

(Nov. 15-17)—"Powder Coatings." Paint Research Association's (PRA) 13th International Conference. Brussels. (Conference Secretary, PRA, 8 Waldegrave Rd., Teddington, Middlesex TW11 8LD, United Kingdom).

(Nov. 23-25)—Conchem '93. International Exhibition and Conference sponsored by Reed Exhibition Companies. KKA Congress and Exhibition Centre, Karlsruhe, Germany. (Diane R. Tiberio, Reed Exhibition Companies, 999 Summer St., P.O. Box 3833, Stamford, CT 06905-0833).



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North America

(Feb. 11-13)—37th Annual Southern Decorating Products Show. Sponsored by National Decorating Products Association (NDPA). Georgia International Convention & Trade Center, College Park (Atlanta), GA. (Ruth Wilms, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132).

(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. 23-25)—Electrocoat '94. Sponsored by *Products Finishing Magazine*. Hyatt Orlando, Orlando, FL. (Cindy Goodridge, Gardner Management Services, 6600 Clough Pike, Cincinnati, OH 45244).

(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. 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).

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'Humbug' from Hillman

I'm pleased to have had a note from Saul Spindel again. He included an article entitled "COMBAT SAVVY—38 Battle-Proven Facts of Life—Some of the Things a Grunt Learned While Under Fire," compiled by a Tony May. Saul thought that they would bring a nostalgic smile to ex-GIs. I've chosen a number of them that might be more ecumenical. Funny how so many of the items seem appropriate for today's industrial battleground.

- You are not superman.
- If it's stupid but works, it ain't stupid.
- Don't look conspicuous—it draws fire.
- Never draw fire—it irritates everyone around you.
- Never share a foxhole with someone braver than you are.
- Your weapon was made by the lowest bidder.
- Try to look unimportant. They may be low on ammo.
- The easy way is always mined.
- The important things are very simple.
- The simple things are very hard.
- All five-second grenade fuses are three seconds.
- Teamwork is essential. It gives them other people to shoot at.
- If you are short everything except enemy, you are in combat.
- Incoming fire has right of way.
- Friendly fire—isn't.
- Anything you do can get you shot, including doing nothing.
- The enemy diversion you are ignoring is the main attack.
- The only thing more accurate than incoming enemy fire is incoming friendly fire.

Recent mail also brought a communication from dear friend and almost neighbor, Sid Lauren, as follows:

"In the April 1993 issue of the NPCA publication, *The Primer-State Affairs* (Vol. 6, No. 4) I read that a bill, CA S. 734, pending in the California Senate, would require all state and local public agencies to purchase recycled products (including anti-freeze!) in a list of categories, including paints. "The purchase of the listed materials is required only when they are available and of a fitness and quality equal to their nonrecycled counterparts," reads the proposed legislation.

This reminded me of a clipping that a friend gave to me a long time ago, of a help wanted advertisement that appeared in a now defunct paint industry trade magazine soon after World War II. The ad solicited an "Experienced Chemist, to formulate surplus paints." If things continue to go as they are in California, I wouldn't be surprised to hear of an ad seeking an experienced chemist to formulate recycled paints. (*Aside to Sid—You might be surprised to learn it's a growing business*).

I can't avoid the thought that there are some legislators who have earned the privilege of being served recycled beer.

Those of our readers who are too young to recall earlier issues of *Humbug* or those who are too old to remember, might get a giggle from this version, sent to me by Werner Zimmt, of a story that made the rounds some years ago.

A painting contractor was asked by the congregation to which he belonged to paint the church building. Because of the finances of the congregation, he was also asked to do it at a minimum cost. To reduce the loss on the job, he thinned the paint, as it turned out later, too much. The paint came off very soon, and the board of the congregation was not happy, so they sent him the following message:

REPAINT, REPAINT, THIN NO MORE!

Marty Miller wowed me with this one:

Wife walks into husband's den and says, "I have good news and bad news."

Husband—"What's the good news?"

Wife—"The air bag works!"

The job of flight attendant has changed considerably since the first hostesses took to the air on May 15, 1930. On that day all Boeing Air Transport (now United Airlines) planes began to carry attendants. The first flight service manual included the following instructions:

—Before each flight, clean the cabin, sweep the floor, dust off the seats, window sills, etc.

—Make sure that all seats are securely fastened to the floor.

—Warn passengers against throwing cigars and cigarettes out of the window.

—Keep the clock and altimeter wound up.

—Carry a railroad timetable in case the plane is grounded.

—Keep an eye on passengers when they go to the lavatory to be sure they don't mistakenly go out the emergency exit.

—TWA Skyliner as quoted in
1978 *Farmers Almanac*

—Father to son: Of course this country has faith in your generation. Just look at the size of the national debt we expect you to pay.

—If someone tells you nothing is impossible, ask him to dribble a football.

—Don't knock procrastination. It saves a lot of useless work.

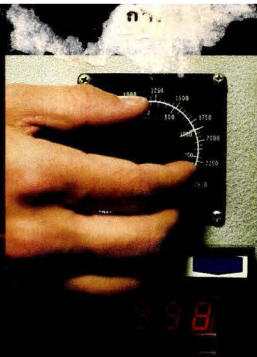
—The Lion

—Herb Hillman

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