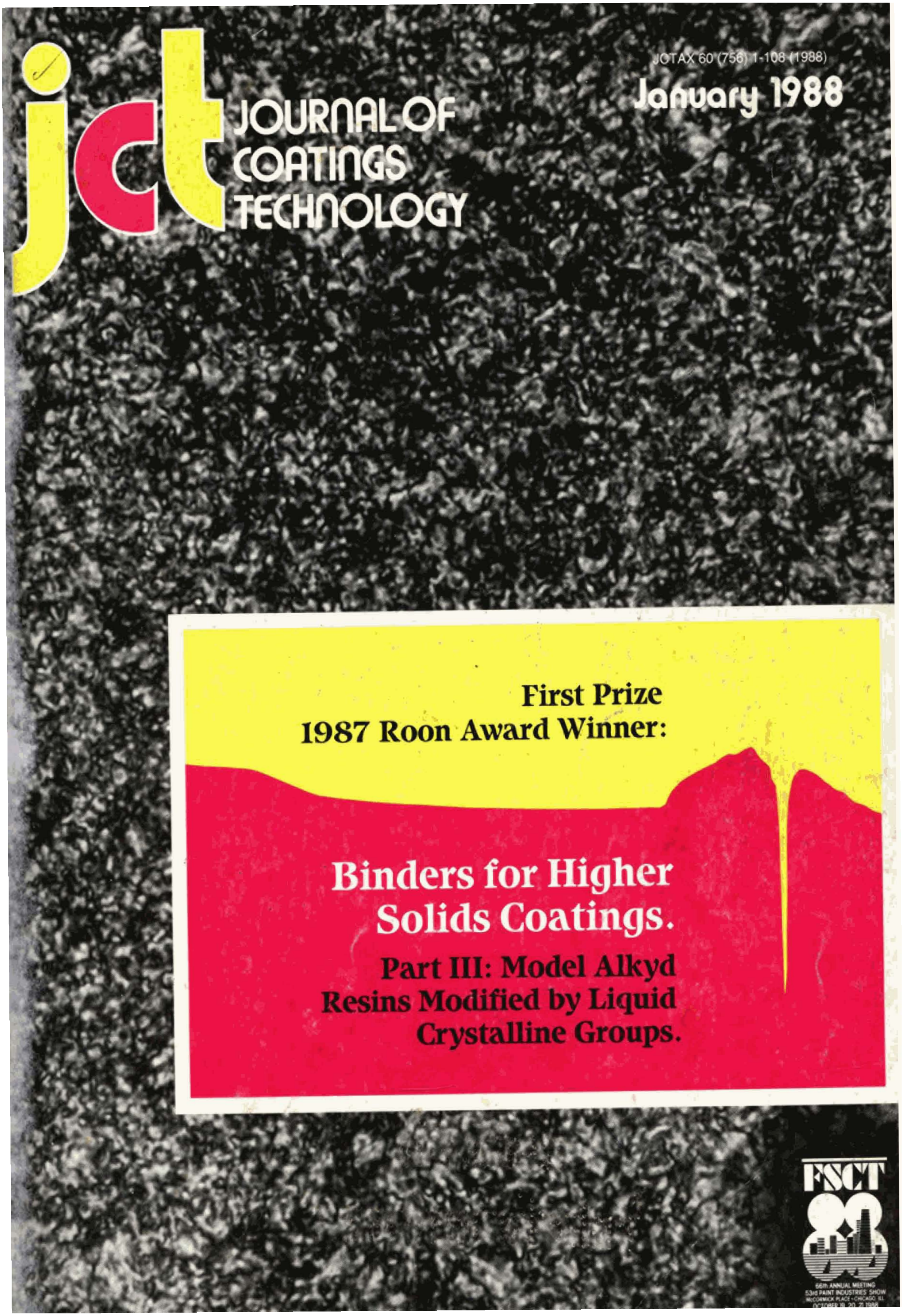

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JCTAX 60 (756) 1-108 (1988)

January 1988

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JANUARY 1988

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VOLUME 60 NUMBER 756

## Technical Articles

## Federation News

## Departments

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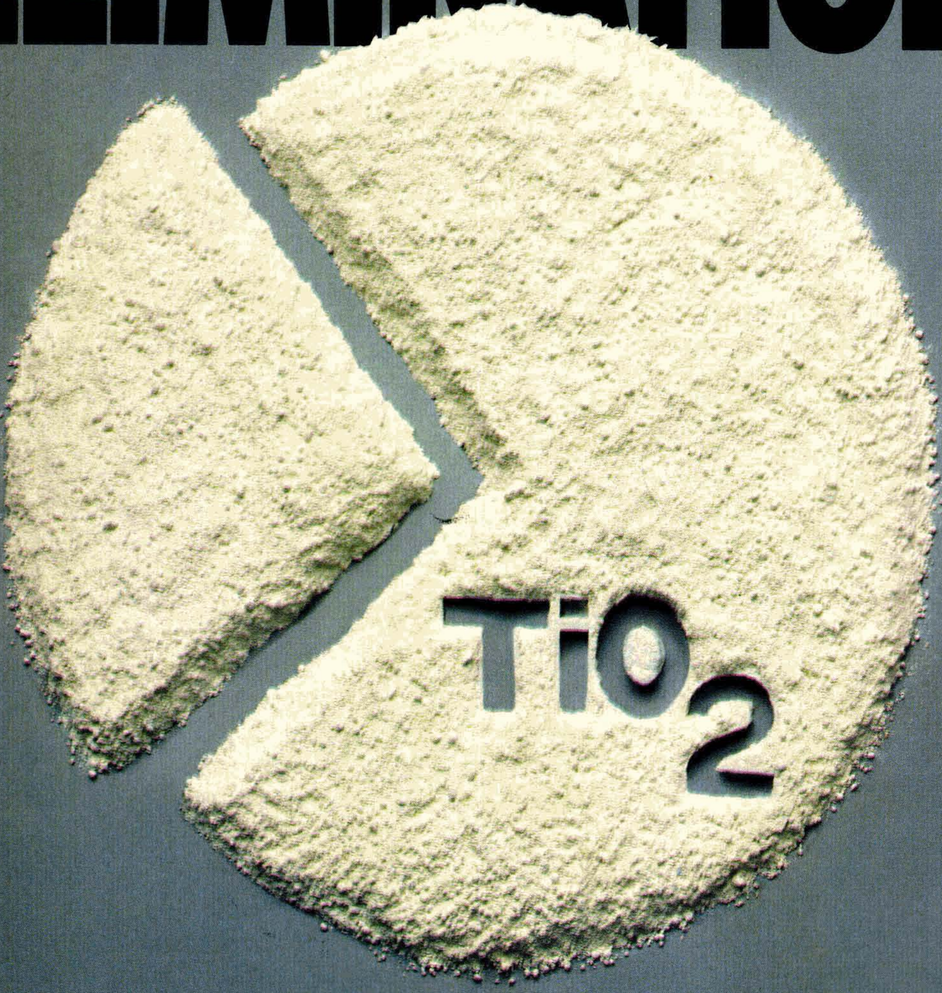

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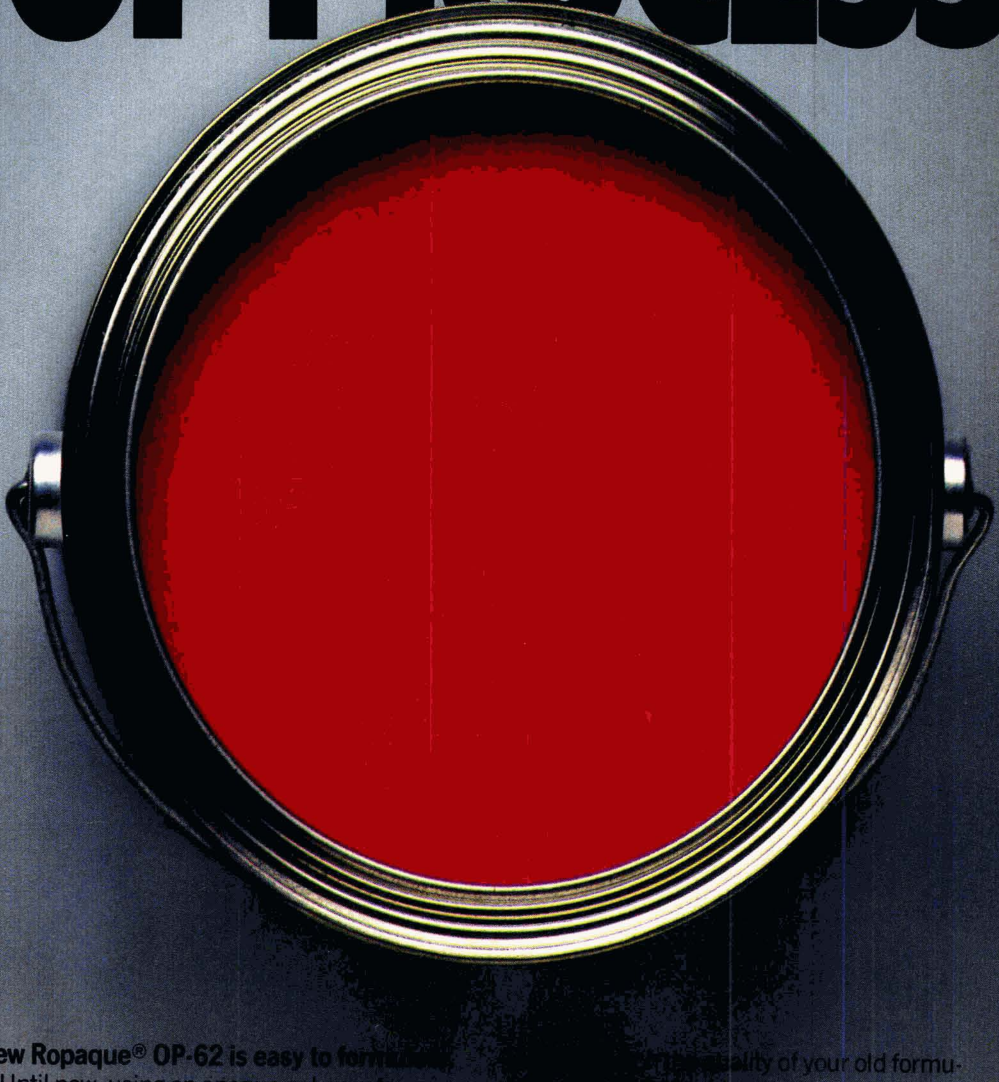

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# Comment

## Sagging and Silking and Seeding, Oh My!

With the increasing use of water-borne and high solids coatings, one of the major problems facing the coatings industry today is the formation of surface defects. One needn't possess a great brain to discern that the obvious solution can be found in the prevention of such defects in the first place. Obvious—yet not easily accomplished. Often, despite efforts to the contrary, surface appearance problems do appear and their formation must be analyzed before solutions can be approached.

Yet coatings chemists should not lose heart. The Federation is providing two paths which can be taken to arrive at a better understanding of this costly problem. ''Coatings Defects: Their Prevention and Cure'' is the theme of the FSCT Spring Seminar in Orlando. Offered in conjunction with the 1988 Spring Week, May 17-20, the programs will focus on surface appearance problems and the coatings systems in which they develop. Techniques for handling defects, encountered both in the laboratory and on-site, will be discussed by industry experts.

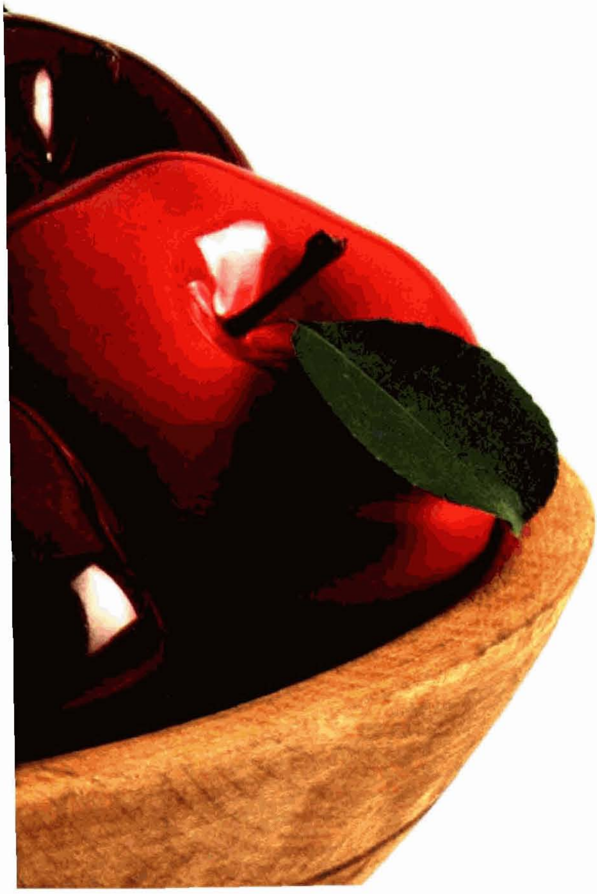
Also, the ninth monograph in the new Federation Series on Coatings Technology has been published. In their study, "Coating Film Defects," authors Percy Pierce and Clifford Schoff offer methods and approaches to effectively deal with this issue. They provide general guidelines for the prevention/solution of coating defects.

Even if you are a wizard in the coatings field, the road to surface defect elimination can be wrought with frustrating obstacles. Changes which may alleviate one type of defect can result in other problems. Yet, with the suggestions provided through discussions at the Spring Seminar and in the monograph, those in the industry need never fear shadows (or craters) again. A plan of action for eliminating common surface appearance problems can be obtained—and you don't have to go ''over the rainbow'' to find it.

Patricia D. Viola

Patricia D. Viola,
Editor

# CIBA-GEIGY PIGMENTS: BECAUSE NEW ORGANIC REDS DON'T GROW ON TREES.



# Abstracts of Papers In This Issue

## BINDERS FOR HIGHER-SOLIDS COATINGS PART III: MODEL ALKYD RESINS MODIFIED BY LIQUID CRYSTALLINE GROUPS—D-S. Chen and F.N. Jones

Journal of Coatings Technology, 60, No. 756, 39 (Jan. 1988)

A new approach toward reducing VOC and improving properties of nonbake alkyd coatings is described. It involves grafting liquid crystalline (LC) segments to the alkyd resin. In this study, the LC segments were formed by grafting p-hydroxybenzoic acid (PHBA) or terephthalic acid (TPA) and PHBA to the alkyd. LC character is imparted only when two or more aromatic units are connected to form rod-like segments. Randomly copolymerized PHBA does not form liquid crystals.

Presence of LC segments has at least three substantial benefits: (1) viscosities are reduced by formation of nonaqueous dispersions; (2) dry-to-touch times are reduced as much as 1000-fold; and (3) films are both hardened (H-2H) and toughened (impact resistance >80 in.-lb).

## QUANTIFYING PIGMENT DISPERSION—Montreal Society for Coatings Technology

Journal of Coatings Technology, 60, No. 756, 49 (Jan. 1988)

One of the most important steps in the manufacture of any surface coating is the combining of pigment and resin by the process of dispersion. Successful dispersion is imperative if optimum optical properties are to be obtained. An infrared scattering technique has been successfully used to measure the degree of dispersion in paint systems containing titanium dioxide pigments. The literature contains many examples of how this "flocculation gradient technique" can be used to determine the influence of pigment dispersion on optical properties and exterior durability.

This method has now been applied to simple alkyd paint systems containing other white pigments, calcium carbonate extenders, red iron oxide pigments, or colored organic pigments. The results obtained indicate that the technique is of value in studying the degree of dispersion of a wide range of pigments, although it is particularly applicable to those having a high refractive index.

## POLYALLYL GLYCIDYL ETHER RESINS FOR VERY FAST CURING HIGH PERFORMANCE COATINGS—J.W. Knapczyk

Journal of Coatings Technology, 60, No. 756, 63 (Jan. 1988)

Described herein are the characteristics of a model polyallyl glycidyl ether resin that significantly accelerates free radical curing of very high solids acrylate and methacrylate coating compositions. Suitably formulated compositions will cure at low temperature in air or under practical anaerobic conditions. The resulting coatings are saturated, solvent resistant, and have other properties that depend in large measure on the nature of the co-ingredients. This allows curing and performance versatility not previously possible with acrylate functionality.

An autooxidative mechanism is postulated to account for the ability of polyallyl glycidyl ether resins to overcome oxygen inhibition and to become incorporated in the films that are produced.

## ATMOSPHERIC OXIDATION OF CELLULOSE NITRATE LACQUERS—D.N-S. Hon and L-G. Tang

Journal of Coatings Technology, 60, No. 756, 73 (Jan. 1988)

Cellulose nitrate film and solution were readily autooxidized in air to produce hydroperoxide. Gradual denitration and decrease in molecular weight of pure cellulose nitrate film and solution were observed during autooxidation. Ferric and ferrous ions, phenol, and lignin had no adverse effect on the nitrogen content of cellulose nitrate film. However, with the exception of ferrous ions, the other reagents did promote denitration of cellulose nitrate in solution. The presence of ferric ions, phenol, and lignin also promoted the rate of oxidation. Due to a high acidity from degradation products during autooxidation, cellulose nitrate solution suffered more denitration and decrease in molecular weight than the cellulose nitrate films.

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# Abstracts of Papers in This Issue

## ELECTRIC DISCHARGES DURING ELECTRODEPOSITION OF ORGANIC COATINGS—R.E. Smith and D.W. Boyd

Journal of Coatings Technology, 60, No. 756, 77 (Jan. 1988)

Electric discharges (sparks) are shown to occur during the cathodic electrodeposition of organic coatings. The occurrence of electric discharges is demonstrated in three ways: by direct visual observation using a special transparent resin solution; by detection of spikes in the electric current over short (millisecond) intervals; and by measurement of acoustic emission. The acoustic technique is especially easy to use and may be useful on a production line to monitor the electrodeposition process. On galvanneal zinc-iron alloy coated steel, discharges occur at relatively low voltage (270 volts) and cause undesirable crater-like defects in the coating. On nongalvanized steel, discharges are observed visually at higher voltage (c. 330 volts), do not necessarily cause visible defects, and are accompanied by acoustic emission but without current spikes. Rather, a continuous, broad peak is observed in the current-time measurement, interpreted to mean that a large number of sparks occur simultaneously.

Discharges are fewer in number but more intense on galvanneal than on nongalvanized steel. The results suggest that the long-standing problem of "rupture," which occurs during deposition at high voltage and is usually ascribed merely to gas evolution from the electrolysis of water, is actually caused by electric discharge.

## Papers to Be Published In the February JCT

"Hydrophilic-Lipophilic Balance System and the Emulsification of Coatings Components"—Philadelphia Society for Coatings Technology.

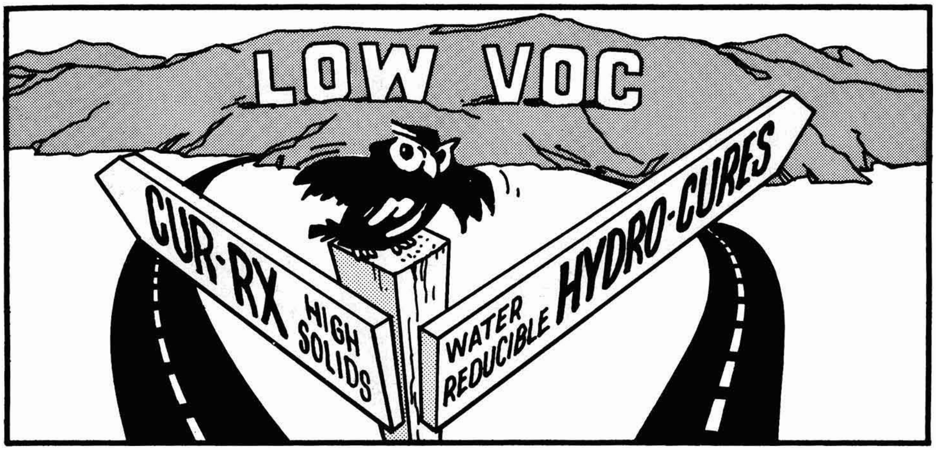
"Application of the Coulostatic Impulse Technique for the Evaluation of Metallic Substrates with Paint Coatings in Artificial Sea Water"—A.R. DeSarli, et al., of CIDEPINT.

"Developments in High Solids Magnetic Dispersions and Coatings"—J.W. Gooch, of Georgia Tech Research Institute.

"A Further Study of Water-Soluble Acrylic Baking Enamels"—Z.Z. Jin, et al., of Nanjing University.

"Cathodic Blistering of Two Alkyd Paints"—V.S. Rodriquez and H. Leidheiser, Jr., of Lehigh University.

# No Matter What Route You Take To Meet VOC Regulations...



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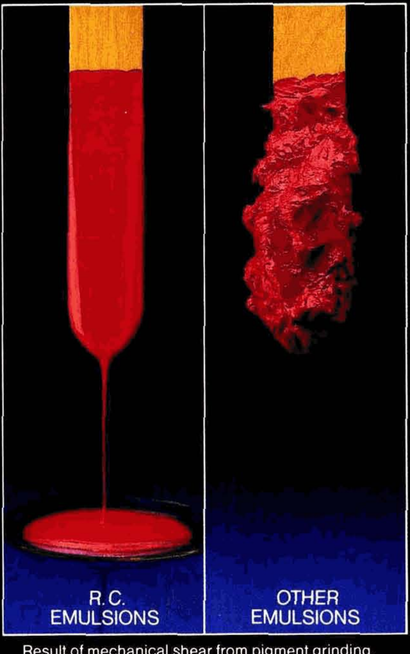
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# Statistical Process Control for the Coatings Industry To Be Focus of FSCT Regional Seminars During March

A series of introductory and intermediate-level seminars on Statistical Process Control for the Coatings Industry has been announced by the Federation.

The seminars, to be held at regional locations during March 1988 under the auspices of the Federation's Professional Development Committee, will present Statistical Process Control (SPC) methods for application to coatings manufacturing and related areas (e.g., chemical, pigments) which employ a batch process.

### Level I

An introductory (Level I) two-day seminar will be held in Philadelphia, March 14-15; Chicago, March 21-22; and Cleveland, March 28-29. This is a repeat of the FSCT-sponsored seminar presented at regional locations in March 1987, and it will again be conducted by Dr. Peter J. Hunt, President of Productivity Management Consultants, Madeira Beach, FL.

The seminar emphasizes the application of Dr. Edwards Deming's concepts which apply statistics to production samples to reduce variation and minimize waste, and covers the mathematics of variability, system and special causes, the normal distribution, histograms, control charts and how to determine and use statistical control limits, and quality control sampling to make machine and process adjustments.

Programming focuses on: identifying appropriate product and machine variables to measure; plotting and interpreting SPC control charts; evaluating process capability; and implementing an SPC system.

Attendees will participate in summarizing sample data, plotting charts, determining process capability, and interpreting results in terms of the process or machine changes warranted. Topics to be covered include the following:

Measuring the Cost of Quality
What Is Statistical Process Control?
Benefits to Be Obtained from SPC
Construction of Control Charts
Standard Deviation and Other Measures of Variability
Examination of Production Process Both In and Out of Control
Process Capability Analyses
Introduction to Attribute Charts
Automotive Industry's SPC Mandate to Its Suppliers
Establishing Your SPC Program
Comparison of Production Process with Customer Specifications

### Level II

An intermediate (Level II) three-day seminar will be held in Philadelphia, March 16-18; and Chicago, March 23-25. This seminar, also conducted by Dr. Peter Hunt, stresses the practical application of statistical procedures to respond to manufacturing, research, and management concerns in order to improve first run capability.

The seminar content focuses on statistical techniques to answer management questions such as the reliability of the test equipment, statistical differences between procedures, and the use of correlated variables to control and/or predict outcomes.

The seminar theme is understanding when to use a particular technique and how to interpret and use the results to improve product quality. Coatings personnel from Engineering, Quality Control, Research & Development, Production, and Management should all benefit from attending.

Registrants should have a basic understanding of SPC (e.g., attendance at the Level I seminar, or equivalent) and a working knowledge of basic algebra.

Topics to be considered include:
Formulating Management/Research Questions
Data Gathering and Organization
Statistical Inference Testing
Correlation Techniques
Design of Experiments Formats
Utilizing Statistical Software
Normal Distribution
Hypothesis Testing

For further information, contact Federation of Societies for Coatings Technology, 1315 Walnut St., Suite 832, Philadelphia, PA 19107 (215) 545-1506.

## Regional Presentations March 1988

| *Level I* | *Level II* |
|---|---|
| **Philadelphia**<br>**March 14-15** | **Philadelphia**<br>**March 16-18** |
| **Chicago**<br>**March 21-22** | **Chicago**<br>**March 23-25** |
| **Cleveland**<br>**March 28-29** | |

# Student-Authored Manuscript Entries Invited For 1988 A.L. Hendry Award Competition

Prospective student authors are invited to submit manuscript entries in the 1988 Southern Society Alfred L. Hendry Award competition. The Award is a $1,000 cash prize for the best paper on some aspect of coatings technology, authored by an undergraduate student currently enrolled in a college program.

Sponsored by the Southern Society for Coatings Technology, the Award commemorates the industry contributions of the late Alfred L. Hendry, President of A.L. Hendry & Co., Tampa, FL, and a Past-President of the Southern Society. It is administered by the Educational Committee of the Federation of Societies for Coatings Technology; the Committee also judges the entries.

Those wishing to enter the competition must send a letter of intent, along with the title of the proposed paper and a brief abstract, by March 15, to: Hendry Award Competition, c/o FSCT, 1315 Walnut St., Suite 832, Philadelphia, PA 19107. Deadline for receipt of manuscripts at the FSCT office is June 15.

Presentation of the Award will be at the 1988 FSCT Annual Meeting in Chicago, IL, October 19-21.

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*Note: Reservations must be made at least 30 days in advance of seminar to guarantee room availability and rate.*

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# Manuscript Entries Invited for 1988 Roon Awards Competition: Authors of Winning Papers Will Share $4,000 in Cash Prizes

Prospective authors are invited to submit manuscript entries in the 1988 Roon Awards competition, and are reminded that they must advise of intent to compete by March 1. The announcement was made by Gary Gardner of Tnemec Co., Inc., Chairman of the Roon Awards Committee of the Federation.

A total of $4000 in cash prizes will be awarded for the top papers submitted for presentation at the 1988 Federation Annual Meeting, to be held October 19-21, at McCormick Place, Chicago, IL.

The Awards, sponsored by the Coatings Industry Education Fund (formerly the Paint Research Institute), were established in 1957 by the late Leo Roon, founder of Nuodex Products Co., and are supported by funds provided through the Roon Foundation. They are presented to the winning authors at the Federation Annual Meeting each year.

Papers submitted in the competition must: (1) Describe original work not previously published or presented; (2) Be directly related to the protective coatings industry; (3) Be of such a caliber that they reflect a step forward in real scientific contribution to the coatings industry; and (4) Be accompanied by clearance for publication.

Papers to be considered for the competition are those by individuals associated with the organic coatings industry, including raw material suppliers and educators.

Those wishing to enter the competition must send a letter of intent, along with the title of the proposed paper and a brief abstract (by the March 1 deadline) to: Gary Gardner, Tnemec Co., Inc., P.O. Box 411749, Kansas City, MO 64141.

### 1987 Winners Of the Roon Competition

First Prize (tie):
"Multilobed Acrylic Latices"—Chuen-Shyong Chou, Alexander Kowalski, Joseph M. Rokowski, and Edward J. Schaller, Rohm and Haas Co., Spring House, PA.
"Binders for Higher Solids Coatings. III. Model Alkyd Resins Modified by Liquid Crystalline Groups"—Der-Shyang Chen and Frank N. Jones, North Dakota State University, Fargo, ND.

Second Prize:
"Polyallyl Glycidyl Ether Resins for Very Fast Curing High Performance Coatings"—Jerome W. Knapczyk, Monsanto Co., Springfield, MA.

Third Prize:
"New Heterocyclic Red Pigments"—Abul Iqbal, CIBA-GEIGY Ltd., Fribourg, Switzerland.

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# Principles Governing the Roon Awards

The Awards, sponsored by the Coatings Industry Education Fund (formerly the Paint Research Institute), were established in 1957 by the late Leo Roon, founder of Nuodex Products Co. Supported by funds provided through the Roon Foundation, they are for the best technical papers (other than those by a Constituent Society of the Federation) submitted for presentation at a Federation Annual Meeting.

Papers to be considered for the competition will be those by individuals associated with the organic coatings industry, including raw material suppliers and educational institutions.

The principles governing the awards are as follows:

(1) The papers will be of such caliber that they will reflect a step forward in real scientific contribution to the coatings industries. The papers shall describe original work which has not been previously published or presented.

(2) Papers must be directly related to the protective coatings industry.

(3) None of the work shall originate from, be guided by, or be any part of, a Coatings Technology Society. These awards shall in no way detract from the cooperative efforts of Societies' Technical Committees and their convention papers.

(4) An Awards Committee, appointed by the President of the Federation, will judge the entries.

(5) The Committee is not obligated to award prizes if in its opinion none of the submitted papers are of a caliber to be worthy of such recognition.

(6) The submitted papers may be presented at the Annual Meeting with the consent of the President of the Federation and the Chairman of the Program Committee. Although it is the intent of the Roon Awards that winning papers will be presented at the Annual Meeting, papers accepted for presentation and papers awarded prizes are separate and distinct. An invitation from the Program Committee to present his/her paper should not be construed by any author as an indication that the Roon Committee has awarded the paper a prize.

(7) Winning papers will be published in the Journal of Coatings Technology, which has prior rights to publication of all submitted papers.

(8) The papers shall be concise and informative discussions of up to approximately 6,000 words. Papers greatly exceeding this length should be divided into more than one paper. Multiple entries in the competition from a single author are acceptable. It is requested that manuscripts be prepared in accordance with Journal of Coatings Technology style, as outlined in the Guide for Authors. Copies are available from the Federation office in Philadelphia upon request.

(9) A 150 to 200 word abstract shall accompany the paper.

(10) Papers will be rated with emphasis on: (a) Originality (40%); (b) Scientific Importance (20%); (c) Practical Value (20%); and (d) Quality of Composition (20%).

(11) The Awards will be open to anyone involved in study or engaged in work related to the protective coatings industries, including paint, varnish and lacquer manufacturers, raw material suppliers, research laboratories, and universities. (The Committee, however, will not accept papers which involve raw material sales promotion or are self-serving in regard to exploiting a proprietary product.)

(12) The Committee may award any number of prizes, the total of which is not to exceed $4,000.

(13) All papers must be accompanied by company or educational institutional clearance for publication.

(14) Those planning to submit a paper in 1988 must advise the Chairman (Mr. Gary Gardner, Tnemec Co., Inc., P.O. Box 411749, Kansas City, MO 64141) by March 1. He must have 10 publication manuscripts by May 1.

(15) The 1988 Awards and accompanying engraved plaques will be presented during the Annual Meeting in Chicago, IL, October 19-21.

# Roon Award Winners

## 1986

FIRST PRIZE: "Control of Foaming in Water-Borne Coatings"—Pamela Kuschnir, Richard R. Eley, and F. Louis Floyd, SCM Pigments, Strongsville, OH.

SECOND PRIZE: "Binders for High-Solids Coatings, Part I and Part II"—Steven L. Kangas and Frank N. Jones, North Dakota State University, Fargo, ND.

## 1985

FIRST PRIZE: "The Effect of α-Methyl Groups on Room Temperature Crosslinking in Acrylic Polymers Containing MAGME Monomers"—Howard R. Lucas, American Cyanamid Co., Stamford, CT.

SECOND PRIZE (tie): "An Investigation of Microencapsulated Fungicides for Use in Exterior Trade Sales Paints"—Gerry K. Noren, Mary F. Clifton, and Alex H. Migdal, DeSoto, Inc., Des Plaines, IL.

"The Role of Azeotropy in Speeding Up Water/Solvent Evaporation in Humid Air"—Albert L. Rocklin, Shell Development Co., Houston, TX.

## 1984

FIRST PRIZE: "Dependent Scattering Theory: A New Approach to Predicting Scattering in Paints"—Susan Fitzwater and John W. Hook III, Rohm and Haas Co., Spring House, PA.

SECOND PRIZE (tie): "Dispersion of (Magnetic) Pigment Powders in Organic Liquids"—H.F. Huisman, PD Magnetics B.V., Oosterhout, The Netherlands.

"An Analysis and Prediction of Roller Spatter from Latex Paints"—Debora F. Massouda, University of Delaware, Newark, DE.

## 1983

FIRST PRIZE: "The Transformation of Liquid to Amorphous Solid: Effect of Reaction Mechanism on the Time to Vitrify for Linear and Network Polymerization"—Marc T. Anonhime and John K. Gillham, Princeton University, Princeton, NJ.

SECOND PRIZE: "Protection of Mildewcides and Fungicides from Ultraviolet Light Induced Photo-Oxidation"—Peter D. Gabriele and Robert A. Iannucci, CIBA-GEIGY Corp., Ardsley, NY.

THIRD PRIZE: "Pigment Volume Concentrations and Interpretation of the Oil Absorption of Pigments"—H.F. Huisman, PD Magnetics B.V., Oosterhout, The Netherlands.

## 1982

FIRST PRIZE: "Comparative Solvent Evaporation Mechanisms for Conventional and High-Solids Coatings"—William H. Ellis, Chevron Research Co., El Segundo, CA.

SECOND PRIZE: "Popping of Water Soluble Baking Enamels"—Zeno W. Wicks, Jr., North Dakota State University, Fargo, ND, and Ben C. Watson, Sherwin-Williams Co., Chicago, IL.

THIRD PRIZE: "Predictive Model for Cracking of Latex Paints Applied to Exterior Wood Surfaces"—F. Louis Floyd, Glidden Ctgs. & Resins Div., SCM Corp., Strongsville, OH.

FOURTH PRIZE (tie): "Presence and Effects of Anaerobic Bacteria in Water-Based Paints"—Robert A. Opperman, Cosan Chemical Corp., Carlstadt, NJ.

"Interrelationships between Pigment Surface Energies and Pigment Dispersions in Polymer Solutions"—G. Dale Cheever and J.C. Ulichy, General Motors Research Laboratories, Warren, MI.

## 1981

FIRST PRIZE: "Factors Affecting Metal Marking"—Dr. Leslie A. Simpson, BTP Tioxide Ltd., Cleveland, England.

## 1980

FIRST PRIZE: "Kinetic Parameter Considerations for Maximizing Stability and Minimizing Cure Temperature of Thermosetting Coatings. Sulfonium Salts as Latent Thermal Initiators for Cationic Polymerization"—S.P. Pappas, North Dakota State University, Fargo, ND, and Loren W. Hill, Monsanto Co., Indian Orchard, MA.

SECOND PRIZE: "A Computer Method for Predicting Evaporation of Multicomponent Aqueous Solvent Blends at Any Humidity"—Albert L. Rocklin, Shell Development Co., Houston, TX, and David C. Bonner, Shell Oil Co., Houston, TX.

THIRD PRIZE: "Primary Amine Zwitterion Copolymers"—Zeno W. Wicks, Jr. and Chiew-Wah Koay, North Dakota State University, Fargo, ND.

FOURTH PRIZE: "Synthesis of Blocked MDI Adducts, Their DSC Evaluation and Effect of Pigmentation"—Taki J. Anagnostou, Wyandotte Paint Products, Inc., Troy, MI, and E. Jaul, Union Carbide Corp., S. Charleston, WV.

## 1979

FIRST PRIZE: "Transfer and Leveling Process and Rheological Design in Water-Borne Reverse Roll Coatings Systems"—T. Matsuda and W.H. Brendley, Jr., Rohm and Haas Co., Spring House, PA.

SECOND PRIZE: "Plastic Pigment—A Novel Approach to Microvoid Hiding"—Alexander Ramig, Jr. and F. Louis Floyd, Glidden Ctgs. & Resins Div., SCM Corp., Strongsville, OH.

THIRD PRIZE: "Polyphosphazenes as New Coating Binders"—A.K. Chattopadhyay, R.L. Hinrichs, and S.H. Rose, DeSoto, Inc., Des Plaines, IL.

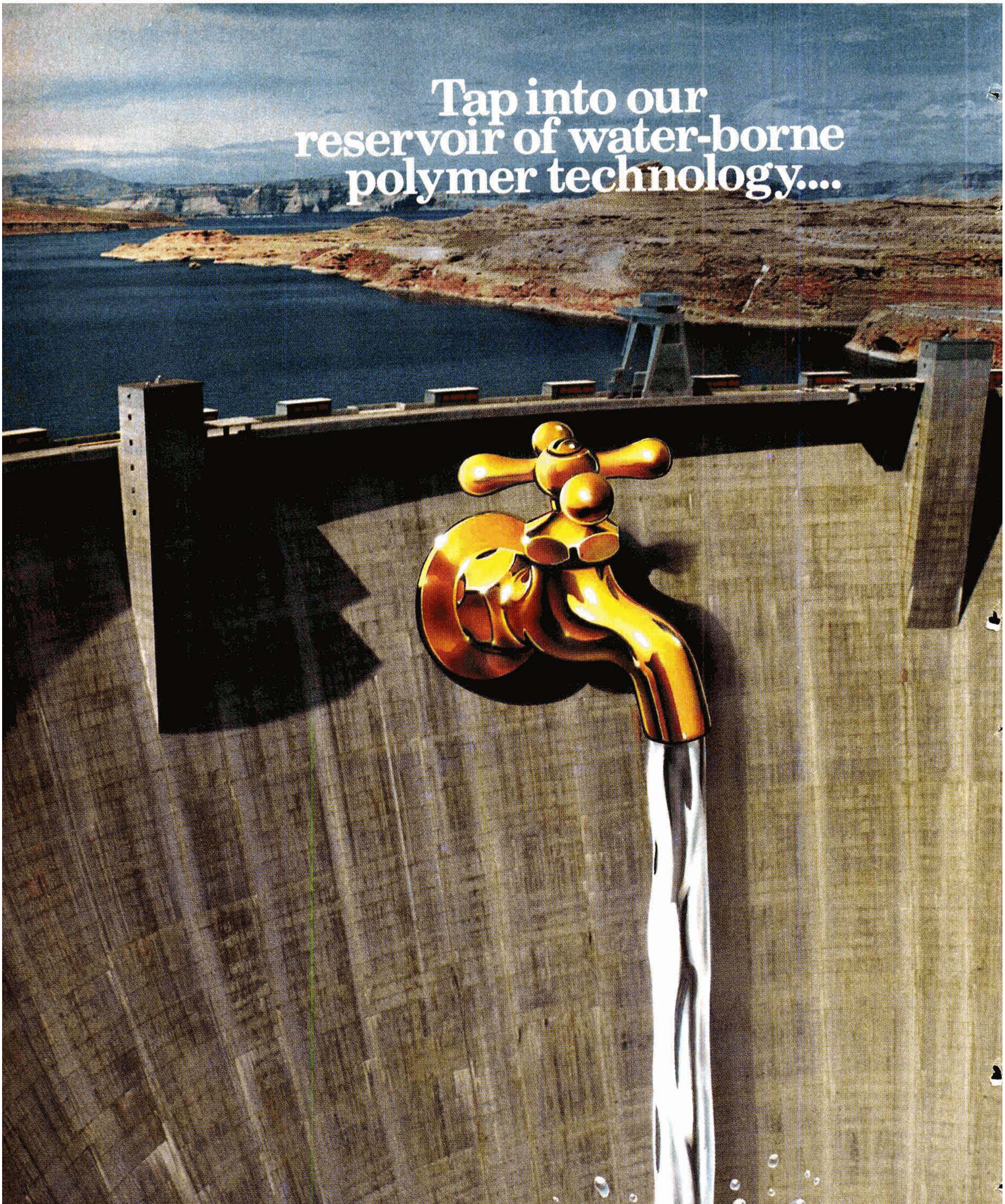
## 1978

FIRST PRIZE: "Cathode Reactions and Metal Dissolution in Cationic Electrodeposition"—D.G. Anderson, E.J. Murphy, and J. Tucci, III, DeSoto Inc., Des Plaines, IL.

SECOND PRIZE: "Effect of Humidity and Other Ambient Conditions on Evaporation of Ternary Aqueous Solvent Blends"—Albert L. Rocklin, Shell Development Co., Houston, TX.

THIRD PRIZE (tie): "Rheological Properties of Styrene/Acrylic Polymers"—H.P. Schreiber and G. Thibault, Ecole Polytechnique, Montreal PQ, Canada.

"Single Grade Rutile $TiO_2$ Concept for Interior Latex Trade Sales Systems"—Calvin C. Tatman, Glidden Chemical/Metallurgical Div., SCM Corp., Baltimore, MD.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### 1977

First Prize: "Application of Critical Relative Humidity and Evaporation Analog of Azeotropy to the Drying of Water-Borne Coatings"—Paul W. Dillon, Union Carbide Corp., Tarrytown, NY.

Second Prize: "Comparison of Tensile and Morphological Properties with Abrasion Resistance of Urethane Films"—Robert M. Evans and Joseph Fogel, Tremco, Inc., Cleveland, OH.

Third Prize: "Radical Anion Quenching by Emulsion Polymer Components"—Vincent D. McGinniss and Ann F. Kah, Glidden Ctgs. & Resins Div., SCM Corp., Cleveland, OH.

Fourth Prize: "Reactions of Diethyl Malonate Blocked Cyclohexyl Isocyanate"—Zeno Wicks, Jr. and Barry W. Kostyk, North Dakota State University, Fargo, ND.

### 1976

First Prize: "Photostabilization of Coatings. Studies on Resonance Energy Transfer"—E.L. Breskman and S.P. Pappas, North Dakota State University, Fargo, ND.

Second Prize: "Evaporation Phenomena: Precise Comparison of Solvent Evaporation Rates from Different Substrates"—A.L. Rocklin, Shell Development Co., Houston, TX.

Third Prize: "Surface Chemistry of Pigment-Vehicle Systems"—C.A. Kumins, Tremco, Inc., Cleveland, OH.

Fourth Prize: "Computer Simulation to Optimize Paint Packaging"—D.L. Gebauer and J.N. Wiborg, PPG Industries, Inc., Pittsburgh, PA.

### 1975

First Prize: "Photochemistry of Pigments—Studies on UV Curing and Energy Transfer"—S.P. Pappas and Walter Kuhhirt, North Dakota State University, Fargo, ND.

Second Prize: "Calculation and Absorption of UV Radiation by Photosensitizers in Pigmented Ultraviolet Curing Coatings"—Zeno Wicks, Jr. and Walter Kuhhirt, North Dakota State University, Fargo, ND.

Third Prize: "Water and Solvent Evaporation from Latex and Latex Paint Films"—D.A. Sullivan, Shell Development Co., Houston, TX.

Fourth Prize: "Interaction of Trizaine-Crosslinked Acrylic Films and Detergent Solutions"—D.G. Anderson and Edward J. Murphy, DeSoto, Inc., Des Plaines, IL.

### 1974

First Prize: "Photo-Chemistry of Pigments—Studies on the Mechanism of Chalking"—S.P. Pappas and R.M. Fischer, Jr., North Dakota State University, Fargo, ND.

Second Prize: "Role of Critical Coating Thickness in Electrostatic Power Deposition"—George F. Hardy, Celanese Research Co., Summit, NJ.

Third Prize: "Application of Acid/Base Concept Describing the Interaction between Pigments, Binders, and Solvents"—Palle Sorensen, Koge Chemical Works, Koge, Denmark.

Fourth Prize: "Hydrolysis of Water-Dispersible Resins"—E.T. Turpin, Glidden-Durkee Div., SCM Corp., Strongsville, OH.

### 1973

First Prize: "Kubelka-Munk Scattering and Absorption Coefficients for Use with Glossy Opaque Objects"—P.S. Mudgett and L.W. Richards, Cabot Corp., Billerica, MA.

Second Prize: "Effect of Particle Crowding on the Scattering Power of $TiO_2$ Pigments"—D.F. Tunstall and M.J. Hird, Tioxide International Ltd., Stockton-on-Tees, England.

Third Prize: "Comparative Kinetics of Ultraviolet Curable Coatings Systems"—V.D. McGinniss and D.M. Dusek, Glidden-Durkee Div., SCM Corp., Strongsville, OH.

Fourth Prize: "Reaching an Objective in Oil Absorption Measurements"—T.K. Hay, Sherwin-Williams Research Center, Chicago, IL.

### 1972

First Prize: "CPVC Calculations"—G.P. Bierwagen, Sherwin-Williams Co., Chicago, IL.

Second Prize: "Synthesis of Extracellular Cellulases in Aqueous Emulsion Coatings by Pseudomonads"—Harvey Winters, Fairleigh Dickinson University, Teaneck, NJ.

Third Prize: "Microscope Method for Examination of Pigment Dispersions"—Hubert J. Golden, PPG Industries, Inc., Barberton, OH.

### 1971

First Prize: "Theoretical Computation of Light Scattering Power: Comparison between $TiO_2$ and Air Bubbles"—William D. Ross, E.I. DuPont de Nemours & Co., Wilmington, DE.

Second Prize: "Determination of Mercury at the Parts-per-Billion Level"—James K. Duffer, DeSoto, Inc., Des Plaines, IL.

Third Prize: "Quantitative Measures of Leveling"—James S. Dodge, Sherwin-Williams Co., Chicago, IL.

Fourth Prize: "Precise Control of Solvent Blend Composition During Evaporation"—William H. Ellis and Phillip L. Goff, Chevron Research Co., Richmond, CA.

### 1970

First Prize: "Flocculation of Phthalocyanine Blue—Fact or Fiction"—Dr. William Carr, CIBA-GEIGY Ltd., Manchester, England.

Second Prize: "Ultrastructure of Coalesced Latex Film and Its Influence on the Optical Properties of Practical Coatings"—James W. Herr and Robin A. Withers, Dow Chemical Co., Walnut Creek, CA.

Third Prize: "Corrosion and the Electrodeposition Process"—Clayton A. May, Shell Development Co., Emeryville, CA.

Fourth Prize: "Mechanism of Paint Chipping"—Howard S. Bender, General Motors Research Labs., Warren, MI.

### 1969

First Prize: "Hiding Power from Transmission Measurements—Theory and Practice"—Richard J. Bruehlman and William D. Ross, E.I. DuPont de Nemours & Co., Inc., Wilmington, DE.

Second Prize: "Electrodeposition of Maleic Adduct of a Polymeric Polyol-Oleic Acid Ester: Mechanism and Some Basic Studies"—Drs. Alfred E. Rheineck and A.M. Usmani, North Dakota State University, Fargo, ND.

Third Prize: "Structures of Wet and Dry Latex Emulsion Paints"—Dr. H.A. Wildt, E.I. DuPont de Nemours & Co., Inc., Wilmington, DE.

Fourth Prize: "Paint Adhesion on a Scribed Surface—The PASS Test"—Jack Stone, Ford Motor Co., Detroit, MI.

### 1968

First Prize: "Optical Behavior of Iron Oxide Pigments"—Valentino Buttignol, PPG Industries, Inc., Springdale, PA.

Second Prize: "Dissolution of the Anode During the Electrodeposition of Surface Coatings"—C.A. May and George Smith, Shell Development Co., Emeryville, CA.

Third Prize: "An Introduction to High Resolution Nuclear Magnetic Resonance Spectroscopy and its Applications to Coatings Chemistry"—Leonard C. Afremow, DeSoto Inc., Des Plaines, IL.

Fourth Prize: "The Use of Kovats Retention Indices and Response Factors for the Qualitative and Quantitative Analysis of Coatings Solvents"—Dennis G. Anderson, DeSoto Inc., Des Plaines, IL.

Fifth Prize: "New Coatings Based on Drying Oil Aldehydes and Hydroxyl Bearing Resins"—Dr. Alfred E. Rheineck and P.R. Sampath, North Dakota State University, Fargo, ND.

Sixth Prize: "Gelation Prediction and Related Concepts"—Joseph Bernardo, Interchemical Corp., Clifton, NJ, and Dr. Paul Bruins, Polytechnic Institute, Brooklyn, NY.

### 1967

First Prize: "Measuring and Minimizing the Variability in Evaluation Outdoor Exposure Results"—P.B. Mitton and R.L. Church, National Lead Co., South Amboy, NJ.

Second Prize: "Scattering and Absorption of Light by Carbon Black"—H.C. Donoiam and A.I. Medalia, Cabot Corp., Billerica, MA.

Third Prize: "Computers, Chemists and Costs"—T.J. Sheerin and R.M. Briber, General Electric Co., Chelsea, MA.

Fourth Prize: "A New Look at Sulphide Staining"—E.M. Watson, Cosan Chemical Corp., Clifton, NJ.

Fifth Prize: "Graphic Analysis of Resin Solubilities"—J.P. Tess, The Flood Co., Hudson, OH.

Sixth Prize: "An Automatic Titrator for Alkyd Resin Acid Number Analysis"—F.H. Zimmerli, Rohm and Haas Co., Philadelphia, PA.

### 1966

First Prize: "The Evaporation of Non-Hydrogen Bonding Solvents from Resin Films"—Gordon M. Sletmoe, Shell Development Co., Emeryville, CA.

Second Prize: "A New Method for the Viscosity Measurement of Paint in the Settling, Sagging, Leveling, and Penetration Shear Rate Range of .001 to 1.0 Reciprocal Seconds Using a Cone/Plate Spring Relaxation Technique"—Temple C. Patton, Baker Castor Oil Co., Bayonne, NJ.

Third Prize: "Thermosetting Acrylic Emulsions: A Novel Method for Estimating Crosslink Density in Polymeric Films"—Sheldon N. Lewis, Rohm and Haas Co., Spring House, PA.

Fourth Prize: "Evaluating $TiO_2$–Colorant Interaction by Measurement of Scattering Coefficients"—Parker B. Mitton and Alexander J. Madi, National Lead Co., Sayerville, NJ.

Fifth Prize: "Formation and Growth of Zinc Phosphate Coatings"—G. Dale Cheever, General Motors Research Laboratories, Warren, MI.

Sixth Prize: "Color, Strength and Dispersibility of Pigments by the Sherwin-Williams Miniature Sand Mill"—B.R. Orwig, Sherwin-Williams Co., Chicago, IL.

### 1965

First Prize: "Long-Range Effects of Polymer Pigment Interaction in the Solid State"—Charles A. Kumins, Interchemical Corp., Clifton, NJ.

Second Prize: "The Effect of Water on the Adhesion of Surface Coatings"—Peter Walker, Atomic Weapons Research Establishment, Aldermaston, Berkshire, England.

Third Prize: "Encapsulated Corrosion Inhibitive Primer"—A. Stanley Dalton, Air Force Materials Laboratory, Wright-Patterson Air Force Base, OH.

Fourth Prize: "The Influence of Polarity Upon the Solubility Parameter Concept"—J.L. Gardon, Rohm and Haas Co., Spring House, PA.

Fifth Prize: "High Resolution Spectra of Inorganic Pigments and Extenders in the Mid-Infrared Region from 1500 cm$^{-1}$ to 200 cm$^{-1}$"—Leonard C. Afremow and John T. Vandeberg, DeSoto Chemical Coatings, Inc., Chicago, IL.

Sixth Prize: "Practical Applications of Rheology in the Paint Industry"—Harvey L. Beeferman and Dennis A. Bergren, DeSoto Chemical Coatings, Inc., Chicago, IL.

### 1964

First Prize: "Factors Controlling Latex Paint Rheology and Their Measurement"—Robert W. Kreider, General Tire & Rubber Co., Akron, OH.

Second Prize: "A Rheological Study of High Speed Pigment Dispersion"—Harold E. Weisberg, Mineral Pigments Corp., Muirkirk, MD.

Third Prize: "A Photographic Technique for the Macroscopic Objective Evaluation of the Degree of Film Leveling"—E. Lloyd Kelley, Rohm and Haas Co., Philadelphia, PA.

Fourth Prize: "Role of the Adsorbed Resin Layer in the Dispersion of Pigmented Alkyd Systems"—E.C. Rothstein, Keuffel & Esser Co., Hoboken, NJ.

Fifth Prize (tie): "Mechanism of Bubble Entrapment in Sprayed

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Coatings"—Guy C. Bell, Jr., E.I. DuPont de Nemours & Co., Inc., Philadelphia, PA.

"The Free Volume Interpretation of Plasticizing Effectiveness and Diffusion of Solvents and Plasticizers in High Polymers"—Charles M. Hansen, Danish Varnish and Paint Industry, Copenhagen, Denmark.

### 1963

*Class "A" Competition*

FIRST PRIZE: "Rapid Pigment Volume Concentration Determination"—Jack E. Bissey, Rinshed-Mason Co., Anaheim, CA.

SECOND PRIZE: "Correlation of a Ball Mill Abrasion Test with Mechanical Properties of Concrete and Polymers"—Robert M. Evans and Francis E. Reed, The Master Mechanics Co., Cleveland, OH.

THIRD PRIZE: "Analysis of Alkyds by Nuclear Magnetic Resonance"—Carl J. Opp, Interchemical Corp., Cincinnati, OH.

*Open Competition*

FIRST PRIZE: "A Method for Measuring Solvent Release Using Radiotracers"—R.E. Murdock and William J. Wirkus, Shell Chemical Co., Union, NJ.

SECOND PRIZE: "Continuous Ultra-Sonic Rheography in High Speed Dispersions"—Harold E. Weisberg, Mineral Pigments Corp., Muirkirk, MD.

THIRD PRIZE: "A Critical Review of the Factors that Control the Quantity and Quality of a Three-Roll Mill Paint Grind"—Temple C. Patton, Baker Castor Oil Co., Bayonne, NJ.

### 1962

*Open Competition*

FIRST PRIZE: "Dispersion Flocculation Phenomena and the Dielectric Constant"—Dr. Harold E. Weisberg, Mineral Pigments Corp., Muirkirk, MD.

SECOND PRIZE: "Caution Required in Absolute Color Measurement with Colorimeters"—Dr. Fred W. Billmeyer, Jr., E.I. DuPont de Nemours & Co., Wilmington, DE.

THIRD PRIZE: "Analysis for Pigment Volume Concentration"—H.E. Ashton, National Research Council, Div. of Building Research, Ottawa, Canada.

### 1961

*Class "A" Competition*

FIRST PRIZE: "The Glass Transition in Coating Formulations"—Harry Burrell, Interchemical Corp., Cincinnati, OH.

*Open Competition*

FIRST PRIZE: "Surface Analysis and Adhesion"—W.T.M. Johnson, DuPont Co., Philadelphia, PA.

SECOND PRIZE: "The Viscosity Reduction Power of the Xylenes"—Arthur M. Thompson, Jr., Esso Research & Engineering Co., Linden, NJ.

THIRD PRIZE: "Quantification of the Hydrogen Bonding Parameter"—E.P. Libermann, DuPont Co., Wilmington, DE.

### 1960

*Open Competition*

FIRST PRIZE: "Molybdate Pigments: New Corrosion Inhibitors"—Helmuth O. Schoen and Benson G. Brand, Battelle Memorial Institute, Columbus, OH.

SECOND PRIZE: "A Unique Alkyd Constant for Designing and Assessing Alkyd Formulations"—Temple C. Patton, Baker Castor Oil Co., Bayonne, NJ.

### 1959

*Class "A" Competition*

FIRST PRIZE: "Trail of the Fugitive Mahogany Varnish Stain"—Dr. Leroy D. Soff, Dutch Masters Paint & Varnish Co., Brooklyn, NY.

SECOND PRIZE: "Powdered Insulating Finishes"—I.N. Elbling, Westinghouse Electric Corp., Pittsburgh, PA.

*Open Competition*

FIRST PRIZE: "Efflorescence and Chalking on Painted Masonry Surfaces"—Gerould Allyn, Rohm and Haas Co., Philadelphia, PA.

SECOND PRIZE: "The Influence of Cold Rolled Steel Surfaces on Paint Performance and Paint Testing"—George W. Grossman, Jr., Q-Panel Co., Cleveland, OH.

THIRD PRIZE: "Organic Coatings and Impressed Currents"—Dr. D.F. Koenecke, Esso Research & Engineering Co., Enjay Labs., Linden, NJ.

### 1958

*Open Competition*

FIRST PRIZE: "The Solvent Properties of Olefins from Petroleum"—W.W. Reynolds and H. Low, Shell Oil Co., Wood River, IL.

SECOND PRIZE: "The Influence of Solvent Composition on the Flow Properties of Paint"—E.C. Larson and W.W. Reynolds, Shell Oil Co., Wood River, IL.

THIRD PRIZE: "Pigment Optical Behavior—Evaluation on a Physical Basis"—P.B. Mitton and L.S. White, National Lead Co., Sayreville, NJ.

### 1957

*Class "A" Competition*

FIRST PRIZE: "A Solvent Formulating Chart"—Harry Burrell, Interchemical Corp., Cincinnati, OH.

SECOND PRIZE: "Chemistry and Theory of Polyurethane Coatings"—Harry E. Pansing, Ander Chemical Co., Cincinnati, OH.

*Open Competition*

FIRST PRIZE (tie): "Effect of Solvent Properties on the Viscosity of Alkyd Resin Solutions"—W.W. Reynolds and H. Gebhart, Jr., Shell Oil Co., Wood River, IL.

"Use of Hexylene Glycol and other Solvents in Styrene-Butadiene Latex Paint"—Roy W. Tess and Robert D. Schmitz, Shell Development Co., Emeryville, CA.

THIRD PRIZE (tie): "Correction Factors Applied to the Carothers Equation for Condensation Polymerization"—R.F. Carmody, Socony Paint Products Co., Metuchen, NJ.

"A Mathematical Analysis of the Precision in Determining Hiding Power"—Parker B. Milton, National Lead Co., South Amboy, NJ.

# Program Theme Announced for 1988 FSCT Annual Meeting; Papers Invited for Event, to Be Held October 19-21 in Chicago

The 1988 Annual Meeting of the Federation of Societies for Coatings Technology will have as its theme, "Performance *and* Compliance: The Challenge Intensifies," it was announced by Program Chairman Richard M. Hille, General Paint & Chemical Co., Cary, IL.

The Annual Meeting will be held in conjunction with the Paint Industries' Show, at McCormick Place, Chicago, IL, October 19-21.

The theme underscores the impact of regulatory restrictions on the coatings industry, which must respond to the dual challenges of producing quality products while meeting increasingly restrictive compliance standards. Programming will focus on such areas as corrosion protection, aerosol coatings, "high tech" coatings research, and major regulatory issues affecting coatings formulation and manufacture.

Prospective speakers are invited to present original papers on the theme and its various aspects, and are requested to submit abstracts (150 to 200 words) for review to Richard M. Hille, General Paint & Chemical Co., 201 Jandus Road, Cary, IL 60013.

*Deadline for receipt of abstracts is March 1.*

Assisting Chairman Hille in the program development is a Steering Committee composed of: George R. Pilcher (Vice-Chairman), Hanna Chemical Coatings Corp., Columbus, OH; Adrian Adkins, Olympic Homecare Products Co., Pleasanton, CA; Jay Austin, Halox Pigments Corp., Hammond, IN; Gary Gardner, Tnemec Co., Inc., N. Kansas City, MO; Richard J. Himics, Daniel Products Co., Jersey City, NJ; Gus W. Leep, Seymour of Sycamore, Inc., Sycamore, IL; and Joseph P. Walton, Jamestown Paint & Varnish Co., Jamestown, PA.

# Preventing and Curing Coatings Defects to Be Topic Of FSCT Seminar Scheduled for May 17-18 in Orlando

The 1988 Federation Spring Seminar, to be held May 17-18 at the Orlando Marriott, Orlando, FL, will have as its topic, "Coatings Defects: Their Prevention and Cure."

Programming will focus on defects that develop in various types of coatings systems, and industry speakers will discuss the many aspects of dealing with the problem, both in the laboratory and on-site.

Several open forum sessions will be featured, at which attendees can question speakers on specific problems.

The seminar is part of the annual Federation Spring Week, which includes Society Officers' meeting (May 19) and the FSCT Board of Directors meeting (May 20).

Complete details on the seminar program, along with registration and housing information will be published in a subsequent issue of the JOURNAL OF COATINGS TECHNOLOGY.

# Coating Film Defects Analyzed In Ninth FSCT Series Monograph

The ninth monograph in the continuing Federation Series on Coatings Technology has been published. "Coating Film Defects," by Percy E. Pierce and Clifford K. Schoff, of PPG Industries, Inc., explores the causes and cures of common surface appearance problems. Photographs and discussions focus on many defects, such as cratering, fish eyes, flooding, orange peel, telegraphing, and water spotting.

The booklet covers techniques for the characterization of defects and the measurement of surface properties, as well as general guidelines for the prevention/solution of defects.

The Series, which will total approximately 35 booklets, is designed to cover the major areas of coatings technology. Monographs which have been published include:

"Film Formation," by Zeno W. Wicks, Jr.;

"Introduction to Polymers and Resins," by Joseph Prane;

"Radiation Cured Coatings," by J.R. Costanza, A.P. Silveri, and J.A. Vona;

"Solvents," by William Ellis;

"Coil Coatings," by Joseph Gaske;

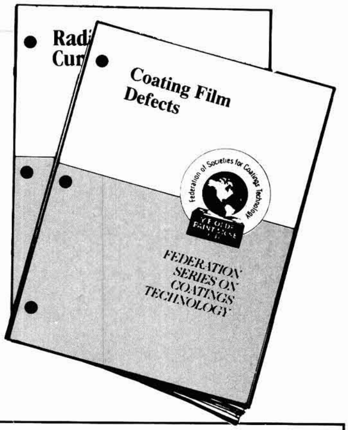
"Corrosion Protection by Coatings," by Dr. Wicks;

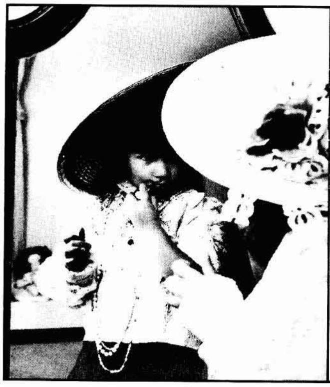
"Mechanical Properties of Coatings," by Loren W. Hill; and

"Automotive Coatings," by Bruce N. McBain.

Development of the Series is under the overall direction of an Advisory Board, whose members assist in selecting authors and reviewing manuscripts. Thomas J. Miranda, of Whirlpool Corp. and Darlene R. Brezinski, of DeSoto, Inc., are Editors of the Series.

The booklets are prepared in an attractive 8½ × 11 inch format, designed to fit in a three-ring binder. Each sells for $5.00. To order, contact Meryl Cohen, FSCT, 1315 Walnut St., Philadelphia, PA 19107.





# Changes in Oil-Base Paint Industry Caused by New EPA Regulations

New Environmental Protection Agency (EPA) regulations affecting California's oil-base paint industry may eventually affect retailers, manufacturers, contractors, and consumers nationwide.

According to a report recently issued by The O'Brien Corporation, S. San Francisco, CA, regulations controlling the manufacture, sale, and application of solvent-thinned, non-flat architectural coatings already affect the way Fuller-O'Brien Paints and most of its California customers do business.

The report traces the beginnings of the current scenario to the passage of the federal Clean Air Act ten years ago. Written into that law are national standards for air quality, including maximum emission levels of volatile organic compounds (VOC).

The EPA and the California Air Resource Board (CARB) districts first established VOC levels for oil-base paints in 1977 at 450 grams per liter. These maximum levels were reduced over the years, to 380 in 1979, and finally, to the ultimate goal of 250 grams per liter in 1981.

The earlier reductions were accomplished in oil-base paints by increasing the ratio of solids to solvents in the paint. However, the final reduction level, by which the EPA ordered California manufacturers to abide by July 1987 means great changes in some oil-base paints and may mean that some products can no longer be made.

The report states that, as of July 1, paint manufacturers can no longer make oil-base, non-flat architectural coatings, which includes eggshell alkyd enamels, in anything larger than quart-size containers. As of September 1, such products cannot be sold, and after December 31, these products cannot be applied in California. Violators face a fine of up to $25,000 per violation.

In addition, the Air Resource Districts of the San Francisco Bay and Southern California areas have adopted regulations banning the manufacture and use of specialty coatings, such as alkyd primers, lacquers, and varnishes. The rest of the districts have until 1989 to comply with similar EPA regulations.

This means that manufacturers can distribute some paints in one part of California, but not in others, and some paints that cannot be distributed in California can be sent to the rest of the country.

The EPA and CARB are serious about enforcement of these regulations. According to the report, several contractors have been spot-checked by the EPA, with the paint they were applying being tested on-site.

Although some manufacturers are working on alternate products where possible, reformulation of exterior oil-base products, such as primers, is more difficult. As a result, some products will exist, but with reduced quality and increased price. Some alternatives are three times more expensive than their oil-base counterparts, it was stated.

The Clean Air Act targets the most severe pollution areas first, such as major metropolitan areas. Regulations like those imposed by CARB may eventually show up in other urban areas as well.

For copies of the report, contact The O'Brien Corporation, 450 E. Grand Ave., S. San Francisco, CA 94080.

## Eastman Chemical to Halt Acetate Marketing in U.S.

Eastman Chemical Products, Inc., Kingsport, TN, has declared its intention to discontinue marketing ethylene glycol monoethyl ether and ethylene glycol monoethyl ether acetate in the United States effective immediately.

The decision to exit the markets is based on a number of considerations. The domestic market has been declining and is expected to continue to decline. In addition, the response to Eastman's replacements for these markets has prompted the company to place its emphasis on the new products.

## Interez and Arthur Holden & Sons Modify Cross-Licensing Agreement

Interez, Inc., Louisville, KY, has reached an agreement with Arthur Holden & Sons PLC to modify their long-standing container coating cross-licensing agreement.

The two companies have held an agreement since 1974 which spanned the complete container coatings technologies and product lines of both firms. According to the announced modifications, Interez will have continuing nonexclusive rights to manufacture and sell Holden's solvent-based container coatings in the U.S. Likewise, Holden and its licensees will have continuing nonexclusive rights to manufacture and sell Interez solvent-based container coatings anywhere in the world outside of the U.S.

In addition, Interez will possess the rights to manufacture and sell products based on Holden's electrocoating technology for food, beer, and beverage containers in the U.S. This will be an exclusive license through the end of 1992 and be nonexclusive thereafter.

Aside from the special case of the electrocoating technology for metal containers, neither company will retain rights to any of the other's water-based container coatings technology.

Interez, Inc. is a subsidiary of Interchem, the North American operating arm of RTZ Chemicals Ltd. With over 400 employees, Interez has manufacturing operations in Louisville, KY; Pampa, TX; and Los Angeles, CA.

## Grace & Co. Completes PVDC Plant Expansion

The Organic Chemicals Division of W.R. Grace & Co., Lexington, MA, has completed an expansion of the polyvinylidene chloride (PVDC) latex facility in Owensboro, KY. The new equipment will more than double production capacity at the plant.

In support of the plant expansion, Grace will also inaugurate a Statistical Process Control (SPC) program for the plant. The SPC program includes all specialty polymers produced at the facility.

The plant expansion allows Grace to expand into new markets and enables the company to produce new, specialized PVDC latexes.

## Morton Thiokol Plans Automotive Technical Center; Facility to Provide Research and Manufacturing

The Morton Thiokol Specialty Chemicals Group, Chicago, IL, has announced the planned construction of an $8.6 million automotive technical center 35 miles northwest of Detroit in Rochester Hills, MI.

Located on 6.5 acres, the center will combine all the Morton Thiokol product categories already engaged in the automotive business and will employ approximately 60 people. The new facility will span 64,000 square feet on a single-level and will have the capacity to expand another 50,000 square feet.

The technical center will support the efforts of the Bee Chemical Co., a manufacturer of coatings for plastics and supplier of liquid colorants for pigmenting plastics.

Other product categories to occupy the technical center include: powder coatings, industrial adhesives and sealants, passive restraint systems, and two joint ventures: Morton Yokohama, Inc. (windshield sealant and back-up lights) and Nippon Bee Chemical, Ltd. (coatings for plastics).

An important part of the facility is the application trial line which is capable of painting an entire automobile body and demonstrating production line feasibility to original equipment manufacturers.

A 350-ton injection molding machine, color styling laboratories, a "clean room," and a satellite operation for just-in-time delivery are also planned.

Ground breaking is scheduled for the spring, the expected completion date is one year later.

### Betz Laboratories Announces Major Plant Expansion

Betz Laboratories, Trevose, PA, has announced plans for a major plant expansion to serve their newly acquired coil and container coating industries.

Located in New Philadelphia, OH, the $5 million, 55,000 square foot addition to Betz' existing 50,000 square foot production plant will provide state-of-the-art manufacturing facilities for a specialized product line in coil and container treatment. The addition will also expand shipping and receiving facilities and provide more warehouse space. The expected completion date is early this year.

### Hercules Incorporated Opens Coatings & Additives Center

Hercules Incorporated, Wilmington, DE, has opened a new Coatings & Additives Center in Wilmington to centralize the business, marketing, technical, and sales staff of its Coatings & Additives Group.

The center is situated adjacent to the company's Marketing Center.

### Polyvinyl Chemicals Plans Third U.S. Polymer Plant

Polyvinyl Chemicals, Wilmington, MA, has announced the start-up of its third U.S. manufacturing plant for special-purpose polymers, located in Frankfort, IN. This new facility is intended to increase the company's capacity by 40%.

The plant will incorporate state-of-the-art computer control of the manufacturing process, which is expected to result in improved productivity, quality control, and environmental compliance. In addition, the plant will be fully dedicated to producing specialty latexes instead of commodity polymers.

The facility was designed with tank wagon loading from within the plant and overnight service capabilities to Detroit, Louisville, Chicago, and St. Louis.

Polyvinyl's polymers are also manufactured at plants in Wilmington, MA and Vallejo, CA.

## Inaugural Paint Show 5000 Draws 150 Runners; Planning Underway for Chicago Fitness Run

Organizers of the first "Paint Show 5000," a five kilometer fitness run held on October 6 in conjunction with the 1987 FSCT Annual Meeting and Paint Industries' Show, have declared the run a major success and have begun plans for a similar event to be held during the 1988 convention.

The race, which covered approximately 3.1 miles through the streets of downtown Dallas, began in front of the Hyatt Regency Hotel. Nearly 100 runners pre-registered for the event, but last minute registrations swelled the total to more than 150 runners.

Troy Chemical Company, the sponsor of the event, has begun planning for the 1988 "Paint Show 5000," scheduled to be held during the Chicago convention early on the morning of Thursday, October 20.

Proceeds of the event will be donated to the FSCT Coatings Industry Education Fund. Mort Spiegel, Director of Sales/Marketing for Troy recently presented a check for $500 to the Federation as a result of the 1987 Paint Show 5000.

For further information, contact Mort Spiegel at Troy Chemical Corp., One Avenue L, Newark, NJ 07105.

### Binks Manufacturing Acquires Sames S.A.

Binks Manufacturing Co., Franklin Park, IL, has purchased Sames S.A., Grenoble, a French manufacturer of equipment and systems for electrostatic spray application of powder coatings and liquid paints. The acquisition includes an American subsidiary, Sames Electrostatic, Inc., Stratford, CT and a branch office in Clawson, MI.

## NCCA Sponsors Study on Advantages of Coil Coatings

The National Coil Coaters Association (NCCA) is sponsoring a study on whether coil coating offers advantages over post-priming automotive sheet steel. The study is being conducted at the Ford Motor Co.'s Maumee stamping plant and a Ford assembly plant.

Pioneer Engineering and Manufacturing Co. was awarded the contract to conduct the study which began October 14, 1987 and will be completed in February.

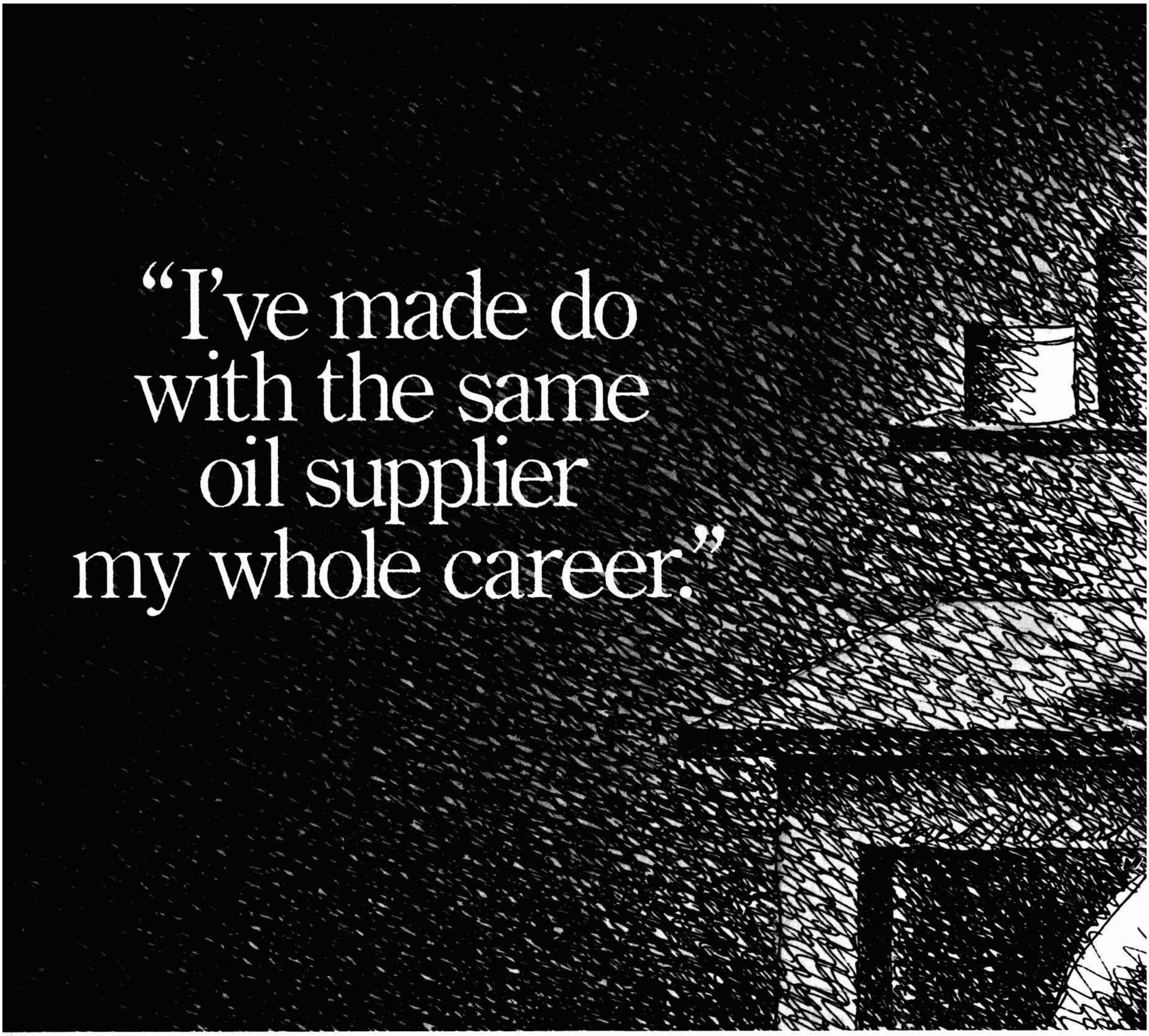
The study is designed to support the coil coating industry's stance that the automotive industry should consider the cost benefits of using steel that has already been cleaned, conversion coated, and pre-primed while still in coil form before any further processing of the steel.

The scope of this manufacturing engineering study includes analyzing costs of: material receiving and handling, blanking operations, stamping lines, priming systems, transportation, sub and final assembly, personnel, and other factors.

### Ball Transfers Interest In Metal Container Plant

Ball Corporation, Muncie, IN, has reached an agreement to transfer its 50% interest in PLM-Ball GmbH, a West Berlin metal container company, to PLM AB, its Swedish joint venture partner in the operation.

Under the same agreement, Ball will be relieved of its guarantees and obligations made in connection with its investment in the joint venture. The firm will also continue to provide technical assistance and technology to the West Berlin operation. Financial consideration of the agreement was not disclosed.



# See what you're missing.

If you're blindly hitched to a supplier whose line of solvents and oils is limited in hydrocarbon types, you can't see the formulating flexibility you're missing.

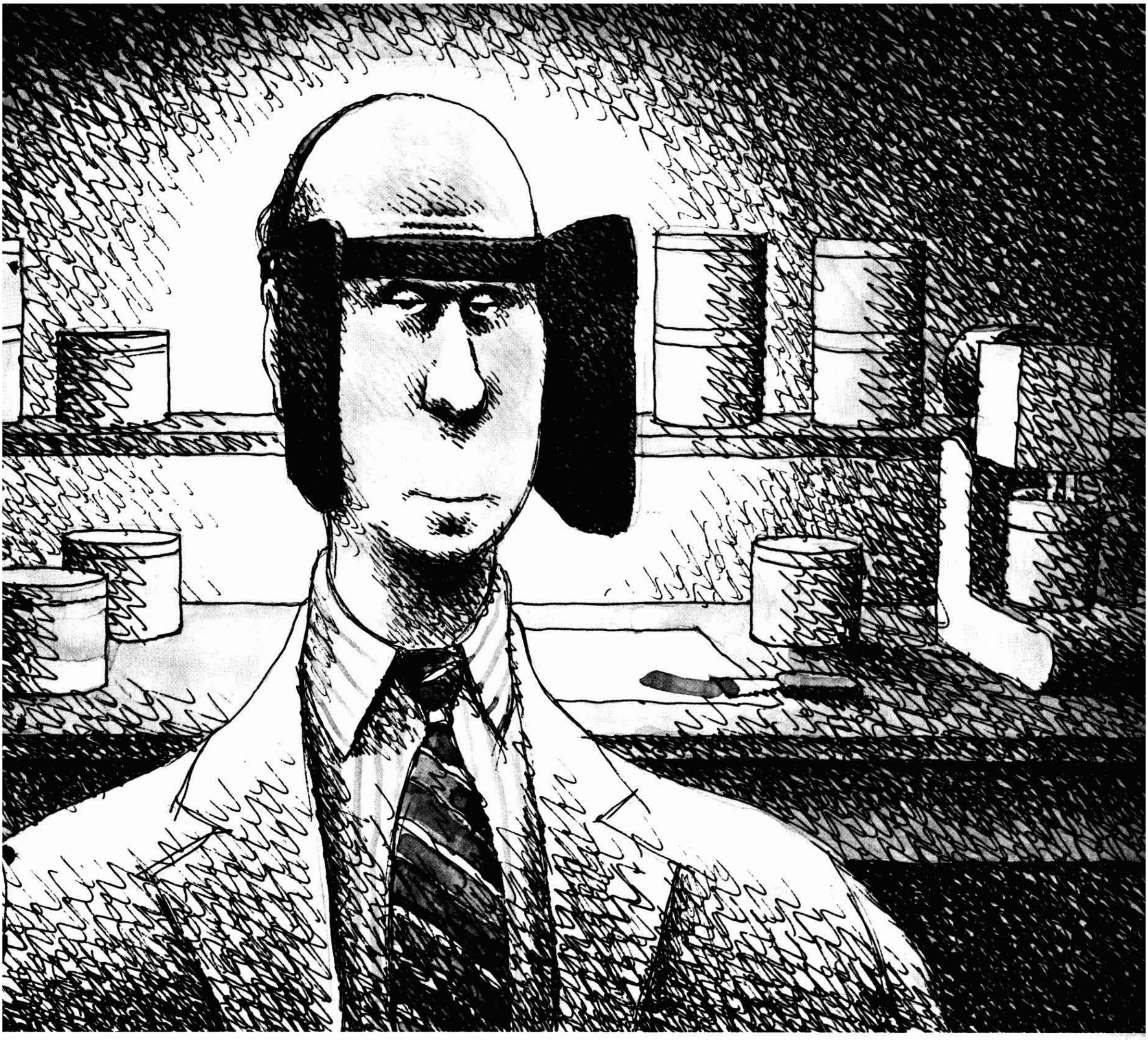
You never see how your supplier forces you to compensate for a limited line; the fewer options, the harder and longer you have to work. And a lack of formulating flexibility can prevent your inks, varnishes or flushes from meeting as wide a range of technical performance demands as possible.

It's high time you see what you're missing–a supplier with more hydrocarbon options. To help you get better technical and profit performance from your formulations.

Behold Exxon. Our EXX-PRINT™ line of solvents and oils for paste inks, varnishes and flushes provides an extensive scope of volatilities, solvencies, viscosities and molecular types. It offers a new standard of formulating flexibility. Making it easier than ever for you to minimize ink-related problems like picking and viscosity build.

EXX-PRINT solvents cover a wide range of hydrocarbon types. From fast evaporating cycloparaffins to tack stability-enhancing isoparaffins. From low-solvency normal paraffins to high-solvency heavy aromatics. Having this many options makes it easier and more economical to precisely customize the basic characteristics of your formulations, whether you're fine-tuning a heat-set ink's drying time or building a varnish's viscosity without increasing its resin content.

Our line of naphthenic and paraffinic oils offers you choices from a water-white process oil to a heavy black newsprint oil. Giving you the options you need for meeting your most demanding



| Resin | Betalite 248 | |
|---|---|---|
| Solvent | EXX-PRINT 283 D | Typical Heat-Set Ink Solvent |
| % Solids | 50 | 50 |
| Laray Viscosity (P) | 110 | 180 |
| Dilutability (gm/100 gm resin) | 200 | 170 |
| Yield Value (dyne/cm) | 250 | 330 |
| Shortness Ratio (yield/visc.) | 2 | 2 |
| Initial Tack (gm-m 400 rpm) | 6 | 6 |

*EXX-PRINT 283 D offers higher dilutability than a typical heat-set ink solvent at comparable initial tack.*

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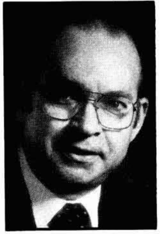
# Editorial Review Board

*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 continuation of that reputation than the JCT Editorial Review Board. Comprised of 22 highly qualified members, the Board operates under the general direction of Chairman Thomas J. Miranda. 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 two-part series, the Journal will highlight the accomplishments of this respected group.*

## Thomas J. Miranda, Chairman

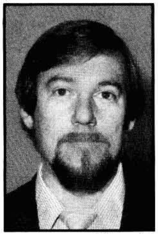


Dr. Miranda is a Staff Scientist for the Whirlpool Corp., Benton Harbor, MI. He attained the A.B. Degree in 1951 and M.A. Degree in 1953 from San Jose State College. In 1959, Dr. Miranda received the Ph.D. Degree from the University of Notre Dame. In 1980, he realized the M.B.A. Degree from Indiana University South Bend and currently is an Adjunct Professor of Chemistry at the university. Dr. Miranda is Chairman of the Federation's Publications Committee, Technical Editor of the Journal of Coatings Technology, and Co-editor of the new *Federation Series on Coatings Technology.* He is a past-Chairman of the Joseph J. Mattiello Memorial Lecture, George Baugh Heckel Award, Ernest T. Trigg Award, and Annual Meeting Program Committees. In 1984, Dr. Miranda was President of the Federation's Paint Research Institute (presently the Coatings Industry Education Fund). In addition, he presented the Mattiello Lecture in 1984, and has been awarded the Heckel (1980) and Trigg Awards. Dr. Miranda is a Past-President of the Chicago Society and was the recipient of their Outstanding Service Award in 1977. A contributor to over 50 publications in the coatings and polymers fields, he has secured 11 patents. Dr. Miranda was the recipient of the Whirlpool Corp.'s Elisha Gray II Award.

## H. Earl Hill

Now retired, Mr. Hill spent 30 years in the coatings industry. He worked for Lord Corp., Erie, PA, prior to retirement. Mr. Hill received the B.S. Degree in Chemistry from St. Francis College in 1950. At the present, he is affiliated with both the University of Detroit and Kent State University. Mr. Hill is active in the Gordon Research Conference and is a member of the Cleveland Society. His contributions to the JCT also include the monthly crossword puzzle, *CrossLinks*.

## F. Louis Floyd



Mr. Floyd has been with the Glidden Co. since 1972 and currently is Technical Manager, Coatings Research Department, Strongsville, OH. In 1967, he received the undergraduate degree in Chemistry from Kansas University. Prior to working for Glidden, Mr. Floyd worked five years for Rohm and Haas Company as a Chemist engaged in the research and development of coatings for the industrial, maintenance, and trade sales markets. He has served as Chairman of the Federation's Professional Development Committee (1985) and as a member of the Educational and Annual Meeting Program Committees. In addition, Mr. Floyd has been a Trustee and Honorary Trustee of the Coatings Industry Education Fund and has been the recipient of three Roon Foundation Awards (1979—Second Prize; 1982—Third Prize; and 1986—First Prize). He has 14 journal publications, one book, two book chapters, and 31 presentations to his credit. Mr. Floyd, a member of the Cleveland Society, has served on the Editorial Review Board since 1975. He is Chairman of the 1988 Gordon Research Conference on Coatings and Films.

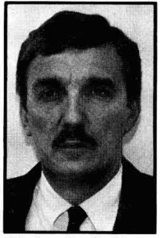
## Ronald D. Bakule

Dr. Bakule is Patent Liaison for the Rohm and Haas Company, Spring House, PA. He graduated from the Illinois Institute of Technology in 1957 with the B.S. Degree in Chemistry. In 1962, Dr. Bakule received the Ph.D. Degree in Chemistry from Cornell University. He has been associated with Rohm and Haas for 25 years and has worked on product development in a broad variety of the company's polymers, resins, and monomers, including synthesis, industrial and trade sales coatings, paper, non-woven, and textile coatings applications. Dr. Bakule's interests lie in polymer chemistry and water-borne, high-solids, industrial, and trade sales coatings.

## Paul R. Guevin, Jr.

Mr. Guevin, a veteran of 28 years in the coatings industry, is a Coatings Consultant for P.R. Guevin Consultant Associates based in Westerville, OH. He received the B.S. Degree in Chemistry from Fairfield University in 1954, and the M.S. Degree in Chemistry from Boston College in 1956. Mr. Guevin, a member of the CDIC Society and a Past-President of the Western New York Society, has served as Vice-Chairman of the Federation's Publication Committee. In 1976, he was the recipient of the Federation's Ernest T. Trigg Award (First Prize). In 1977, Mr. Guevin was named "Man of the Year" by the Erie Engineering Societies Council. His areas of interest include polyurethane coating chemistry, friction measurement, polyamide resins for thixotropy development, and epoxy curing.

### Gordon P. Bierwagen



Dr. Bierwagen is Director, Research and Development, Decorative Films Division, Avery International, Schererville, IN. He earned the B.S. Degree from Valparaiso University in 1964, and the Ph.D. in Physical Chemistry from Iowa State University in 1968. Dr. Bierwagen received the First Prize in the Federation's Roon Foundation Awards competition in 1972 and was a member of the Annual Meeting Program Committee in 1983 and 1987. He sits on the Industrial Advisory Board, Polymers and Coatings Program, of Eastern Michigan University and is a member of the Chicago Society.

### Robert F. Brady, Jr.

Head of the Coatings Section for the U.S. Naval Research Laboratory, Washington, D.C., Dr. Brady has been in the coatings field for 12 years. He received the B.S. Degree (1964) and Ph.D. Degree in Chemistry (1967) from the University of Virginia. Dr. Brady was instrumental in the formulation, laboratory work, and field development for the new nonskid coating used on all aircraft carrier flight and hangar decks. In 1979, he was given the Man-of-the-Year Award by the Washington Paint and Technical Group and, in 1986, was the recipient of the Naval Research Laboratory Publication Award. Dr. Brady is a Past-President of the Chemical Society of Washington (Washington Section, American Chemical Society). He is a member of the Baltimore Society and has been part of the Editorial Review Board since 1986.

### Darlene R. Brezinski

Dr. Brezinski is a 14-year employee of DeSoto, Inc., Des Plaines, IL, where she is Director, Analytical and Computer Applications Research. She received the B.S. Degree in Chemistry and Biology from Mundelein College in 1964, and the Ph.D. Degree in Chemistry from Iowa State University in 1969. Dr. Brezinski is a member of the Federation's Publications Committee and Co-editor of the new *Federation Series on Coatings Technology*. In addition, she has served as Chairman of the George Baugh Heckel and Roon Foundation Awards, and Joseph J. Mattiello Memorial Lecture and Annual Meeting Program Committees. In 1983, Dr. Brezinski, a member of the Chicago Society, was the recipient of the Heckel Award. Her interests include analytical and organic chemistry and computer science.

### Ray A. Dickie

Holding the title Principal Research Scientist for the Ford Motor Co., Dearborn, MI, Dr. Dickie is responsible for 35 patents and contributions to approximately 50 publications. In 1961, he realized the B.S. Degree in Chemistry from the University of North Dakota and, in 1965, received the Ph.D. Degree from the University of Wisconsin at Madison. In addition, Dr. Dickie has engaged in post-doctoral studies at the University of Glasgow (Scotland). Professional activities include sitting on the Editorial Review Board for *Progress in Organic Coatings* and the *International Journal of Adhesion Science and Technology*; and serving as Chairman of the American Chemical Society: Division of Polymeric Materials (1987). Dr. Dickie, a member of the Detroit Society, has been on the JCT Editorial Review Board since 1983.

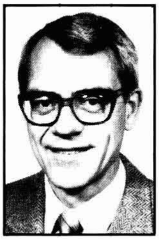
### Hugh W. Lowrey

A graduate of the Georgia Institute of Technology in 1949, Mr. Lowrey has been in the coatings industry for 38 years and currently is Technical Director, The Perry & Derrick Co., Inc., Cincinnati, OH. He organized the Industry Committee for the Department of Polymer Science at the University of Southern Mississippi, and served as its first Chairman. Mr. Lowrey is a past-Chairman of the Federation's Annual Meeting Program and A.F. Voss/*American Paint & Coatings Journal* Award Committees and has served on the Educational, Annual Meeting Host, Joseph J. Mattiello Memorial Lecture, Liaison, and Armin J. Bruning Award Committees. In addition, he is an active member of the Roon Foundation Awards Committee. Mr. Lowrey is a Past-President of the Southern Society and has served two terms as an at-large member on the Federation's Board of Directors. He is a member of the CDIC Society.

### Granville D. Edwards

Mr. Edwards is Product Development Manager, Shell Development Co., Houston, TX. He has been with Shell for 35 years and has been in the coatings industry for 20 years. Mr. Edwards attained the B.S. Degree in Chemistry from Texas A&M University in 1952. He served as a member of the Federation's Annual Meeting Program Committee in 1986. Mr. Edwards, a member of the Houston Society, is interested in epoxy resin castings and coatings, and solvents for coatings.

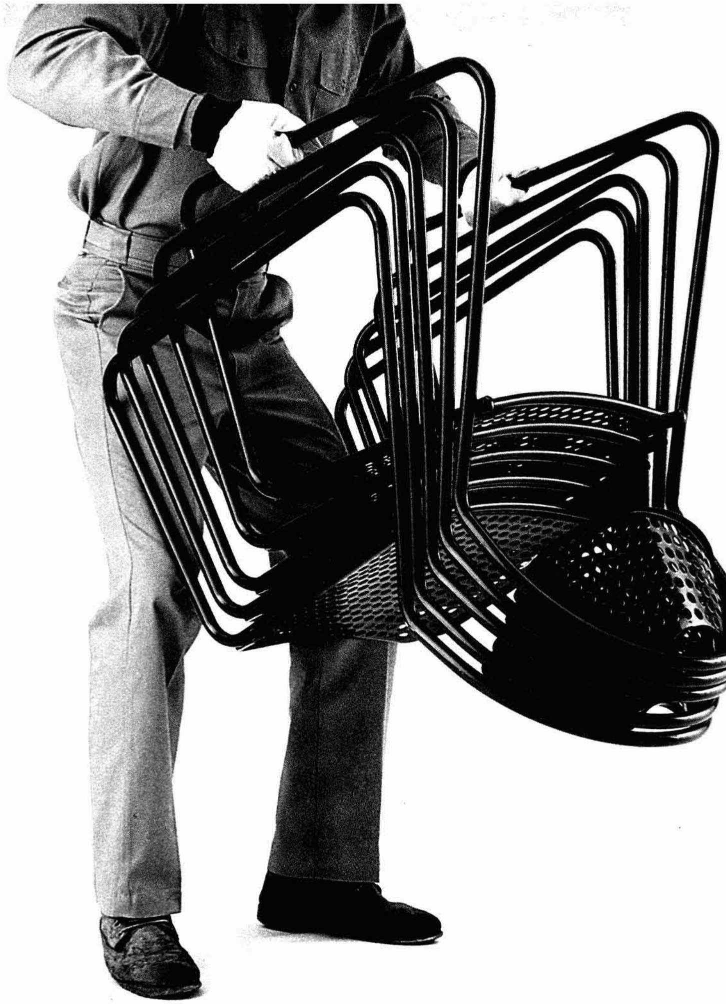
### Loren W. Hill



Dr. Hill is a Monsanto Senior Fellow in the Specialty Resins and Plasticizers Division, Monsanto Chemical Co., Springfield, MA. He received the B.S. Degree from North Dakota State University in 1961, and the Ph.D. Degree from Pennsylvania State University in 1965. Dr. Hill was a faculty member at NDSU for 15 years, teaching physical chemistry and polymers and coatings courses. He has authored or co-authored approximately 25 research papers, one of which was awarded First Prize in the Federation's 1980 Roon Foundation Awards competition. Dr. Hill is a member of the New England Society and serves on the Federation's Publications and Joseph J. Mattiello Memorial Lecture Committees. In addition, he sits on the Editorial Board of *Progress in Organic Coatings*. Subject areas of interest include coating properties, thermoset coatings, kinetics of crosslinking, and flow and leveling of paints. He is the author of "Mechanical Properties of Coatings"—the seventh monograph in the *Federation Series on Coatings Technology*.

### Francine Shuster

Ms. Shuster is Product Manager, Military Program, for the Midland Division, Dexter Corp., Waukegan, IL. She attained the B.S. Degree in Chemistry from the University of Illinois Chicago Circle in 1971 and has done graduate work in Chemistry at the University of Wisconsin. Ms. Shuster has been in the coatings business 15 years. Her areas of interest include urethane coatings, water-borne emulsions (industrial), heat resistant coatings, and high-solids polyester coatings. Ms. Shuster is a member of the Chicago Society.



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# Regulatory UPDATE

JANUARY 1988

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 Roy F. Weston, Inc., Washington, D.C.

**House Adopts, Senate Studies Tin Paint Ban**—The U.S. House of Representatives has passed a bill (H.R. 2210, Jones, D-NC) that bans use of tributyltin and other organotin paints on boats smaller than 65 feet. The tin based antifoulants inhibit barnacle and algae growth on boat bottoms but have also been shown to harm fish and shellfish. The Senate Environment and Public Works Committee has approved a similar bill (S.1788, Tribble, R-VA).

**EPA Begins Tributyltin Review**—EPA will allow continued registration of tributyltin antifoulant paints only under new terms and conditions. In addition, EPA has issued data call-ins for other uses. Registration of certain pesticide products, such as tributyltin antifoulant coatings, is required if the product is to be sold or distributed in the United States. Under a recently published Notice of Preliminary Determination, EPA would cancel registrations for paints that exceed short term cumulative and average daily release limits. The Agency would also prohibit use on non-aluminum vessels less than 65 feet long. Limitations on sales except to certain classes of users and labeling requirements are also proposed. Comments due by January 5, 1988 at: Docket Control Number OPP-30000/ 49A, Information Services Section, Program Management and Support Division (TS-757C), Office of Pesticide Programs, Environmental Protection Agency, 401 M St., S.W., Washington, D.C. 20460. Contact Janet L. Andersen, Special Review Branch, Registration Division (TS-767C), Office of Pesticide Programs, U.S. EPA, 401 M St., S.W., Washington, D.C. 20460. (703) 557-0276.

**California Proposition 65 List Grows**—California's Scientific Advisory Panel added 55 new chemicals to its controversial Proposition 65 list at the end of October. A number of dyes were among the chemicals added. The Advisory Panel also took steps that could quicken the pace of additions to the list. More than 100 additional chemicals identified by the National Toxicology Program and the International Agency for Research on Cancer await Advisory Panel review. The Panel has tentatively set meetings for March, June, September, and December of 1988. Requirements to provide warnings on products containing listed chemicals take effect on February 27, 1988 for the first 27 chemicals listed. A prohibition on the discharge of listed chemicals takes effect in November of 1988. Contact Advisory Panel Executive Secretary, Dr. Steven Book, (916) 445-6951.

**Effluent Guidelines for Organic Chemicals Issued**—Existing and new sources of water pollutants in the organic chemicals, plastics and synthetic fibers industrial category became subject to new effluent limitations on December 21, 1987. EPA's final rule establishes effluent limitations guidelines and standards that limit the discharge of pollutants into navigable waters and to publicly owned treatment works (POTWs). The rule establishes limitations guidelines attainable by the use of the best practicable control technology currently available (BPT) and the best available technology economically achievable (BAT). The rule sets pretreatment standards for existing and new discharges to POTWs, and new source performance standards attainable through use of the best available demonstrated technology. See 52 Federal Register 42522 (Nov. 5, 1987). For technical information, contact Elwood H. Forsht, Industrial Technology Division (WH-552), U.S. EPA, 401 M St., S.W., Washington, D.C. 20460 (202) 382-7190.

For the technical background documents, "Sampling and Analysis Procedures for Screening of Industrial Effluents for Priority Pollutants" and "Development Document for Effluent Guidelines, New Source Performance Standards, and Pretreatment Standards for the Organic Chemicals, Plastics and Synthetic Fibers Point Source Category," contact the National Technical Information Service, Springfield, VA 22161 (703) 487-4600.

**Sulfide Corrosion Study Underway**—EPA's Industrial Technology Division is studying the effects of sulfide corrosion on unlined reinforced concrete pipe, the effects of EPA's waste water pretreatment standards, and options available to reduce sulfide corrosion. Contact EPA's Tom O'Farrell, (202) 382-7137, for more information on the one year study.

**EPA Advisory Committee Urges Waste Minimization**—The Environmental Engineering Committee of EPA's Science Advisory Board has called for a rigorous waste minimization strategy that goes beyond hazardous waste. In its report, "Review of the Office of Research and Development's Waste Minimization Strategy," the Committee urged EPA to focus on any non-product substance including solids, liquids, and gases that leaves a production process or site of product handling or use. For copies, contact Cheryl Bently, EPA Science Advisory Board, Environmental Engineering Committee, 499 S. Capitol St., S.W. (A101F) Rm. 508, Washington, D.C. 20460 (202) 382-2552.

**EPA Proposes Post '87 Ozone Policy**—EPA published its proposed policy for bringing air quality non-attainment areas into compliance with the National Ambient Air Quality Standards for ozone. As part of the policy, EPA will issue notices to areas of the country where progress toward meeting the ozone standards is substantially inadequate. The notice, sometimes referred to as a State Implementation Plan (SIP) call may result in new enforcement efforts or revised SIPs. In anticipation of the SIP calls, a number of states are considering new limits on volatile organic compound emissions, including restrictions on VOC content in paints. The comment period on the Post 1987 ozone policy proposal ends January 25, 1988. See 52 Federal Register 45044 (Nov. 24, 1987). Contact Brock Nicholson, Office of Air Quality Planning and Standards (MD-15), U.S. EPA, Research Triangle Park, NC 27711 (919) 541-5517.

**VOC-Plastic Coating Rule Due**—A final EPA rule to limit volatile organic compound emissions from plants that apply plastic coatings to business machine parts is expected before the end of 1987 or in early 1988. The rule is intended to control emissions to the level achievable by use of the best demonstrated system of continuous emission reduction. Cost and environmental impacts would be considered. Contact Laura Butler, Standards Development Branch, (MD-13) U.S. EPA, Research Triangle Park, NC 27711 (919) 541-5267.

**EPA Finds More Toxics in Water**—In its 1986 Report to Congress—National Water Quality Inventory—EPA reports a substantial increase of toxics contamination in streams and lakes over the 1984 levels. Toxic pollutants were reported in 8,500 stream miles and 362,000 lake acres according to the 44 states providing data for the inventory. Among the most common surface water pollutants were suspended solids, materials with high biochemical oxygen demand, and metals. Among the most common sources of ground-water contamination are underground storage tanks, on-site industrial landfills, and surface impoundments. Synthetic organic chemicals are among the common ground-water contaminants. For copies, contact Alice Mayio, Monitoring Data and Support Division (WH-553), Office of Water Regulations and Standards, Office of Water, U.S. EPA, 401 M St., S.W., Washington, D.C. 20460 (202) 382-7018.

**One More Year Before New DOT Regulations**—It will be December 1988 before the U.S. Department of Transportation issues a new final rule on hazardous materials transportation. Proposed rules issued May 5, 1987 would streamline requirements, address the degree of hazard presented by materials in transport, and bring U.S. standards into line with international standards. The comment period on the proposed rule closed in November, 1987. Contact Edward Mazzullo, Standards Division, Office of Hazardous Materials Transportation, U.S. Department of Transportation, 400 Seventh Street, S.W., Washington, D.C. 20590. (202) 366-4488.

**EPA Proposes Tributyl Phosphate Test Rule**—EPA has proposed that manufacturers and processors of tributyl phosphate be required to test for a number of health and environmental effects. Testing would be required for neurotoxicity, developmental toxicity, reproductive toxicity, mutagenicity, oncogenicity, dermal sensitization, pharmacokinetics, environmental effects, and chemical fate. EPA estimates that up to ten percent of the tributyl phosphate produced is used in inks, lacquers, as a plasticizer, in textile sizers, and as a defoamer in the paper industry. Its principal use is in hydraulic fluids. See 54 Federal Register 43346 (Nov. 12, 1987). Comments in triplicate due by January 11, 1988 at: Docket Control Number OPTS 42100, TSCA Public Information Office (TS-793), Office of Pesticides and Toxic Substances, Environmental Protection Agency, Rm. NE-G004, 401 M St., S.W., Washington, D.C. 20460. Contact Edward A. Klein, Director, TSCA Assistance Office (TS-799), Office of Toxic Substances, Rm. E-543, 401 M St., S.W., Washington, D.C. 20460, (202) 554-1404.

**Comment Period Ends on Polymer Rule**—The comment period closed December 10 on EPA's proposed rule to limit volatile organic compound emissions from polymer production plants. The proposed rule is intended to require new, modified and reconstructed polypropylene, polyethylene, polystyrene, and polyester production plants to control VOC emissions to the level achievable by use of the best demonstrated system of continuous emission reduction. Look for a final rule from September to November 1988. Contact Sims Roy, Standards Development Branch (MD-13) U.S. EPA, Research Triangle Park, NC 27711 (919) 541-5263.

## SUMMARY CALENDAR OF REGULATORY ACTIONS

| | |
|---|---|
| December 21, 1987 | Effluent limits for organic chemicals, plastics and synthetic fibers take effect. (See this issue.) |
| January 5, 1988 | Comments due on EPA tributyltin restrictions. (See this issue.) |
| January 11, 1988 | Comments due on EPA proposed tributyl phosphate test rule. (See this issue.) |
| January 25, 1988 | Comments due on EPA Post '87 Ozone Policy. (See this issue.) |
| January 1988 | EPA VOC rule on plastic coated business machine parts expected. (See this issue.) |
| February 27, 1988 | Warnings required for first 27 chemicals listed under Calif. Proposition 65. (See this issue.) |
| March 1988 | Calif. Scientific Advisory Panel to consider additions to Proposition 65 list. (See this issue.) |

JOURNAL OF COATINGS TECHNOLOGY

# GUIDE FOR AUTHORS

## 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 the submission not only of regular research papers, but also *Open Forum* comments on subjects of relevant interest, and *Letters to the Editor.* All manuscripts will be assumed to be original work and to have been unpublished elsewhere; not under consideration for such publication; not copyrighted; and to have been submitted for appropriate clearance by the organization with which the author is affiliated if such clearance is necessary. 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 or regional meetings or symposia of the Constituent Societies. ***Papers in which proprietary products or processes are promoted for commercial purposes are specifically non-acceptable for publication.***

## SUBMISSION OF MANUSCRIPTS . . .

### . . . for the Journal

*Technical Papers:* Four complete copies should be sent to the Editor, JOURNAL OF COATINGS TECHNOLOGY, 1315 Walnut St., Philadelphia, PA 19107.

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 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.

Papers originally composed for oral presentation may have to be revised or rewritten by the author to conform to the style suitable for written publication.

*Open Forum:* Three complete copies should be sent to the Open Forum Editor, at the address listed above.

The same general rules as given for technical papers should be followed in the preparation of an Open Forum manuscript. However, the subject may be informally approached. Topics may be nontechnical in nature, dealing with any aspect of the coatings industry.

*Letter 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 above.

### . . . for Roon Foundation Award Competition

Ten complete copies of the manuscript are required, and should be submitted to the Chairman of the 1988 Roon Awards Committee, Gary Gardner, Tnemec Co., Inc., P.O. Box 1749, Kansas City, MO 64141. (For complete details, see "Roon Awards" section of the JOURNAL for January 1988.)

## 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).

Manuscripts should be typed with double spacing on one side of 8½ × 11 inch (22 × 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 × 7 inch (13 × 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

The headings and sub-headings in this Guide illustrate their use to divide the text into sections to improve readability for comprehension, and to break up typographical monotony; they may be used as a model for preparation of the text of a manuscript for publication. The text should *not* be presented as an alphanumeric outline.

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 non-photographic blue-lined 8½ × 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 for typesetting.

Graphs should not be used if they merely duplicate the data given in tables, or vice versa.

*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 × 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.

## Equations

These 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$^a$ and subscripts$_b$ 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).

## OTHER INFORMATION

Galley proofs will be sent to the author for checking about six weeks prior to publication.

Offprints may be purchased in quantities of 100 or more. Authors will receive price quotations. Each author will receive a complimentary copy of the Journal issue in which his or her paper was published.

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THIS PAPER WAS AWARDED FIRST PRIZE
IN THE 1987 ROON AWARDS COMPETITION

# Binders for Higher-Solids Coatings Part III: Model Alkyd Resins Modified By Liquid Crystalline Groups

Der-Shyang Chen and Frank N. Jones
North Dakota State University*

A new approach toward reducing VOC and improving properties of nonbake alkyd coatings is described. It involves grafting liquid crystalline (LC) segments to the alkyd resin. In this study, the LC segments were formed by grafting p-hydroxybenzoic acid (PHBA) or terephthalic acid (TPA) and PHBA to the alkyd. LC character is imparted only when two or more aromatic units are connected to form rod-like segments. Randomly copolymerized PHBA does not form liquid crystals.

Presence of LC segments has at least three substantial benefits: (1) viscosities are reduced by formation of nonaqueous dispersions; (2) dry-to-touch times are reduced as much as 1000-fold; and (3) films are both hardened (H-2H) and toughened (impact resistance >80 in.-lb).

## INTRODUCTION

Development of high-quality, one-package, low-VOC coatings for nonbake applications is one of the most difficult challenges facing coatings technologists. We have undertaken a long-term research program aimed at finding new ways to address this challenge. Higher-solids coatings are being emphasized. This paper is the third report of our findings.

In the first two papers, we described a method for synthesizing model alkyd resins and a study of film forming properties of the products.[1,2] The model alkyds were synthesized under conditions that yield predictable structures. Thus, it was possible to study systematically how alkyd structure affects viscosity and film properties of higher-solids coatings. Results were disappointing. Reducing number average molecular weight (Mn) and polydispersity index (PDI) had the desired effect of reducing viscosity, but it led to inferior film properties. We concluded that it is not feasible to make good higher-solids, air-dry alkyd coatings by the straightforward approach of reducing Mn and PDI. Alternative approaches are needed.

This paper describes a promising alternative approach. It involves grafting oligomeric esters of p-hydroxybenzoic acid (PHBA) or of PHBA/terephthalic acid (TPA) to alkyd resins in such a way that liquid crystalline (LC) phases are formed. We previously described a synthetic method to carry out the grafting reaction.[3]

It will be shown that presence of LC phases can provide at least three substantial benefits: (1) viscosity is reduced by formation of nonaqueous dispersions; (2) dry-to-touch times are sharply reduced; and (3) films are both hardened and toughened. A drawback is that the LC segments impart translucency to the films, but it is thought that this problem can be minimized or overcome.

This study concerns model alkyd resins made by a synthetic procedure that is unsuitable for large-scale production. Here the objective is to demonstrate the potential usefulness of LC alkyds. Production-feasible synthetic routes are being sought.

## EXPERIMENTAL DETAILS

### Materials

Linoleic acid (Emersol® 315, Emery Ind. Inc., equivalent weight 288) was dried with anhydrous $Na_2SO_4$. Pyridine (Aldrich) was distilled and dried with anhydrous

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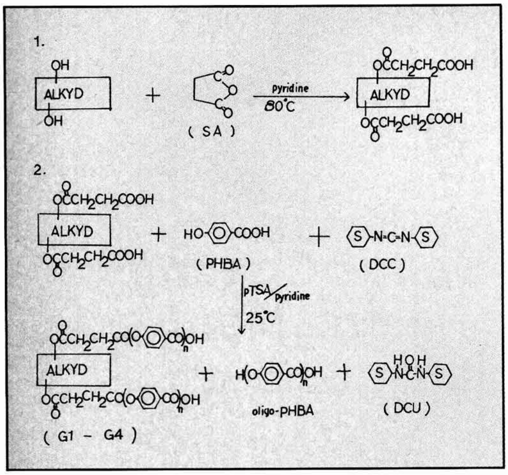

**Scheme 1—Synthesis of PHBA-modified alkyds G1–G4**

$Na_2SO_4$. All other materials (Aldrich) were used as received.

## Synthesis of Grafted Model Alkyds G1–G5

Synthesis of PHBA-modified alkyds is outlined in *Scheme* 1.

(A) Preparation of Unmodified Alkyd U1: A low molecular weight model alkyd with 55% oil length and 22% OH excess was prepared from 25.00 g (0.0868 mol) of linoleic acid, 10.70 g (0.0722 mol) of phthalic anhydride, and 12.61 g (0.094 mol) of trimethylolpropane using the DCC-pTSA process described by Kangas and Jones.[1] Yield was 85%. The OH value was 56 mg-KOH/g determined by the phthalic anhydride/pyridine method.

(B1) Modification with Succinic Anhydride: Alkyd U1 was heated with succinic anhydride (one mol per equiv OH) in pyridine at 80°C for 12 hr. The solution was concentrated; the residue was dissolved in $CH_2Cl_2$ and washed with 10% aq. HCl. The $CH_2Cl_2$ layer was concentrated and the residue was vacuum dried at 80°C. Yield of resin was above 90%, acid number was 64 mg-KOH/g.

(B2) Modification with Terephthalic Acid (TPA): A solution of 10.0 g (0.010 equiv) of alkyd U1, 8.51 g (0.050 mol) of TPA, 2.27 g (0.011 mol) of DCC, and 0.11 g of p-TSA in 150 mL of pyridine was stirred at 25°C for 12 hr. The mixture was filtered to remove DCU and excess TPA. The filtrate was concentrated, dissolved in $CH_2Cl_2$, washed with 10% aq. HCl, and concentrated as noted previously. Traces of crystalline material were removed by dissolving the residue in 1/1 pentane/ethyl acetate, cooling in a freezer, filtering, re-concentrating, and vacuum drying at 80°C. Yield was 9.62 g of resin; acid number was 62 mg-KOH/g.

(C) Grafting to Form Alkyds G1–G5: The succinic anhydride modified alkyd (from section B1) was grafted with PHBA using the DCC-pTSA/pyridine process. Weight ratios (PHBA/alkyd) of 0.1, 0.2, 0.3, and 0.5 gave alkyds G1–G4, respectively. For example, the synthesis of alkyd G2 is described: A solution of 10.0 g (0.0114 equiv) of carboxyl-terminated model alkyd (prepared as described in section B2), 2.0 g (0.0145 mol) of PHBA, 3.14 g (0.0152 mol) of DCC, and 0.16 g of p-TSA in 120 mL of pyridine was stirred at 25°C for 12 hr. The product (10.2 g, 85% yield) was isolated essentially as described previously (section B2).

TPA modified alkyd (from B2) was grafted by a similar process using a weight ratio (PHBA/alkyd) of 0.5 to give alkyd G5.

## Synthesis of "Random" Model Alkyds R1–R3

A series of random model alkyds R1, R2, and R3 containing 15%, 22%, and 27% by weight in the feed were prepared from linoleic acid, phthalic anhydride, trimethylolpropane, and PHBA in a single step by the DCC-p-TSA process. These wt% correspond roughly to the wt% of PHBA actually incorporated in alkyds G2, G3, and G4, respectively. For example, preparation of R3 is described: A solution of 5.50 g (0.0190 mol) of linoleic acid, 2.54 g (0.017 mol) of phthalic anhydride, 2.91 g (0.022 mol) of trimethylolpropane, 4 g (0.029 mol) of PHBA, 12.24 g (0.060 mol) of DCC, and 0.612 g of p-TSA in 200 mL of anhydrous pyridine were mixed in a 250 mL flask for 12 hr at 25°C. Alkyd R3 was isolated essentially as described in section B2.

## Alkyd Structure Characterization

$^1H$-NMR spectra were determined at 34°C using a Varian Associates EM 390 NMR spectrometer with $Me_4Si$ as internal standard. IR spectra were recorded on a Perkin-Elmer 137 spectrophotometer using 10 wt% solution in $CH_2Cl_2$.

Differential scanning calorimetry (DSC) was effected with a du Pont model 990 thermal analyzer at a heating rate of 20°C/min using samples that had been vacuum

**Table 1—Characterization of Ungrafted Alkyd U1 and PHBA-Grafted Alkyds G1–G4**

| | U1 | G1 | G2 | G3 | G4 |
|---|---|---|---|---|---|
| Wt ratio in feed PHBA/oligomer | — | 0.1 | 0.2 | 0.3 | 0.5 |
| Eq wt per COOH (g/eq) | 876[a] | 916 | 1014 | 1065 | 1080 |
| Wt% of PHBA in resin | — | 8.3 | 14.5 | 19.4 | 28.4 |
| GE% | — | 90 | 89 | 85 | 77 |
| Units of PHBA grafted per COOH | — | 0.4 | 1.15 | 1.58 | 1.96 |
| $M_n$ | 1425[b] | 1460 | 1582 | 1717 | 1935 |
| $M_w$ | 2086[b] | 2287 | 2418 | 2689 | 2910 |
| PDI | 1.46 | 1.57 | 1.53 | 1.57 | 1.50 |
| $T_g$ (°C) | −29 | −24 | −20 | −15 | −10 |
| $T_{cl}$ (°C) | — | — | — | — | 190 |

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(a) After modification with succinic anhydride.
(b) Before grafting with succinic anhydride.

**Table 2—Properties of "Random" Alkyds**

| | R1 | R2 | R3 |
|---|---|---|---|
| Wt% of PHBA in feed | 15 | 22 | 27 |
| $M_n$ | 1650 | 1720 | 1600 |
| $M_w$ | 2772 | 2597 | 2512 |
| PDI | 1.68 | 1.51 | 1.57 |
| $T_g$, °C | −23 | −18 | −12 |

dried at 80°C to constant weight. $T_g$ was assigned at the onset of the endothermic inflection. Clearing points ($T_{c1}$) of LC phases were assigned as the maxima of the endothermic peaks.

Equivalent weight per carboxyl group was determined by titration of pyridine solution with $KOH/CH_3OH$ to the phenolphthalein end point.

$M_n$, $M_w$, and polydispersity index ($PDI = M_w/M_n$) were measured by gel permeation chromatography (GPC) in tetrahydrofuran using a Waters model 510 pump, an R401 refractive index detector, and a model M730 data module; columns were Ultrastyragel 100 A, 500 A, $10^3$ A, and $10^4$ A. Monodisperse polystyrene calibration standards were used.

Optical textures were examined with a Leitz D-6330 polarizing microscope equipped with a Reichert hot stage.

Grafting efficiency (GE%) and average number of PHBA units per COOH were estimated from equivalent weight difference as described.[3]

### Measurement of Viscosity and Tests Of Films Properties

Solution viscosity was measured in xylene using an ICI cone and plate viscometer at 25°C. Films were prepared by dissolving or dispersing resins and driers in xylene and casting films on untreated rolled steel panels by a casting bar to give the dry thickness of 0.5 mil. Dry-to-touch time was measured according to ASTM D1640. Film properties were measured after seven days of drying at ambient temperature. Reverse impact resistance and pencil hardness were measured according to ASTM D2794 and D3363, respectively; resistance to acetone was measured by the number of double rubs to remove traces of film with paper tissue after the dropping of acetone on the dry film. Extractability was measured by subjecting cured films to 8 hr in a Soxhlet extractor using tetrahydrofuran.

## RESULTS

### Model Alkyd Synthesis

Synthesis of model PHBA-grafted alkyds G1, G2, G3, G4, (*Scheme* 1) and G5 is a convenient laboratory procedure. The by-products, DCU and oligo-PHBA, are insoluble and can be readily separated from the soluble or dispersable PHBA-grafted alkyds. Grafting efficiency (GE%, defined as the fraction of PHBA fed that is grafted to the alkyd) ranges from 77% to 90%. Predictably, GE% decreases as the PHBA/alkyd ratio in feed increases.[3]

The intermediate step of modifying alkyd U1 with succinic anhydride or with TPA is desirable to improve grafting efficiency. This step converts −OH groups of U1 to −COOH groups. While PHBA could, in theory, graft to −OH groups or −COOH groups, it was established previously that grafting to −COOH groups is more efficient.[3] Modification with TPA has the additional advantage of putting half the structure needed for liquid crystal formation (see the following) into place.

"Random" alkyds R1, R2, and R3 were synthesized by the convenient procedure developed previously.[1] Their compositions approximate the compositions of grafted alkyds G2–G4, respectively.

### Structure Characterization

The equivalent weight per carboxyl, $M_n$, $M_w$, PDI, and number average PHBA units per carboxyl of the control alkyd and the PHBA-grafted alkyds are shown in *Table* 1. As PHBA content increases equivalent weight, $M_n$ and $M_w$ increase in proportion to the mass of PHBA grafted (*Scheme* 1) but no more; PDI remains nearly constant. These results indicate that little or no coupling of molecules occurs during grafting. Data for "random" alkyds R1–R3 are shown in *Table* 2.

IR spectra of the PHBA grafted alkyds are characterized by two sharp peaks at 1610 and 1510 $cm^{-1}$. $^1H$-NMR spectra show complex peaks in the range of 7.0-8.0 ppm. These spectral features are characteristic of PHBA grafted polymers.[3] IR of random alkyds R1–R3 also showed two sharp peaks at 1610 and 1510 $cm^{-1}$.

Onset $T_g$ (by DSC) of the unmodified alkyd U1 was −29°C; PHBA-grafted alkyds G1–G5 had onset $T_g$ at −24, −20, −15, −10, and +17°C, respectively. DSC traces of the alkyd U1 and grafted alkyds G1–G3 were featureless except for the inflection assigned to $T_g$ and the broad exothermic peaks due to thermal crosslinking. DSCs of alkyds G4 and G5 had sharp endothermic peaks at 190 and 225°C, respectively; these peaks are attributable to the clearing temperature ($T_{c1}$, see Discussion Section) of the LC phases. The DSC thermogram of alkyd G4 is shown in *Figure* 1. DSC thermograms of random alkyds R1–R3 are similar to those of alkyds U1, G1, G2, and G3; no endothermic peaks appeared. $T_g$ of R1, R2, and R3 were −23, −18, and −12°C, respectively.

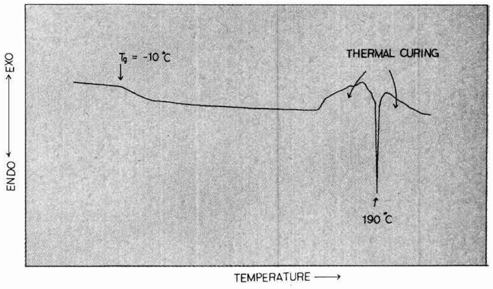

Figure 1—DSC thermogram of LC alkyd G4

Optical textures of the dried films were examined under a polarizing microscope with a hot stage. Films of alkyds U1, G1–G3, and R1–R3 had no visible LC phases. However, LC (mesomorphous) phases were clearly visible in films of alkyds G4 and G5 (photographs are shown in *Figure* 2). The LC phase in films of alkyd G4 disappeared when the specimen was heated above 190°C and reappeared quickly as it was cooled to around 190°C.

### Viscosity and Appearance of Solutions And Dispersions

Alkyds U1, G1–G3, and R1–R3 appeared soluble in commercial xylene at all concentrations. In contrast, alkyds G4 and G5 formed stable, opaque dispersions in xylene at concentrations of 5 wt% or higher.

The relationship between viscosity and PHBA content of 70/30 (w/w) mixtures of alkyds G1–G4 and R1–R3 in xylene are shown in *Figure* 3. Viscosity increases with increasing PHBA content for alkyds G1–G3, but it drops sharply for alkyd G4. This drop is presumably associated with the tendency of alkyd G4 to form nonaqueous dispersions. On the other hand, ''random'' alkyd R3, whose overall composition is similar to that of R4, has the highest viscosity in the series. The solids/viscosity relationship of alkyd G4 is shown in *Figure* 4.

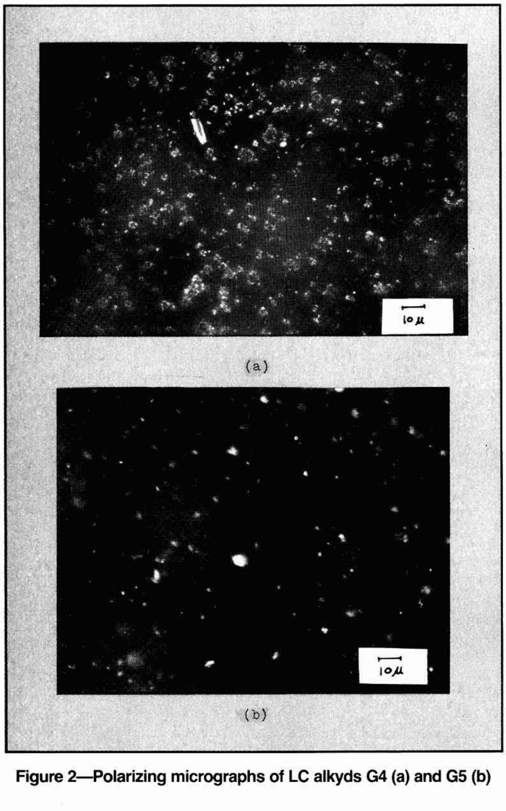

Figure 2—Polarizing micrographs of LC alkyds G4 (a) and G5 (b)

### Dry Time and Film Properties

As shown in *Table* 3, all PHBA-grafted alkyds dried faster than unmodified alkyd U1, and drying speed increased with PHBA content. Acceleration of drying is by far the greatest for LC alkyds G4 and G5. The latter dried very rapidly (in 5 min). As shown in *Table* 4, the drying speed of ''random'' alkyds R1–R3 also increased with the PHBA content, but the effect was much smaller than observed for their grafted counterparts G2–G4.

Coatings made from all alkyds had good adhesion. Films made from alkyds U1, G1–G3, and R1–R3 were glossy and transparent, while film from alkyds G4 and G5 were glossy and translucent.

As shown in *Table* 3, seven-day old films of PHBA-grafted alkyds G1–G5 had better reverse impact resistance, were harder, and had slightly better acetone resistance than alkyd U1. All these film properties are favored by higher PHBA content. Alkyd G4 had the best balance of properties, while alkyd G5 was the hardest.

Hardness and solvent resistance of films made from ''random'' alkyds R1–R3 improved with increasing PHBA content (*Table* 4). On the other hand, impact strength decreased with increasing PHBA content.

Extraction of films made from alkyd G5 with tetrahydrofuran removed 20% of the mass. The remaining 80% was insoluble, translucent material.

## DISCUSSION

### Polymers Containing Liquid Crystalline Phases

Crystalline solids have three-dimensional order while liquids and glasses are disordered. Liquid crystalline (LC) materials have intermediate degrees of order and have been known since 1888. Among the structures that tend to form liquid crystals are molecules containing a sequence of two or more aromatic rings connected in the para position by rigid or semi-rigid linkages. Such structures are called ''mesogenic,'' and LC materials are called ''mesomorphous.''

Recently, there has been widespread interest in the properties of polymers that contain LC regions in solution and/or in the bulk polymer. The mesogenic groups that form the LC regions can be in the main chain[4] or in side chains.[5] LC regions impart a variety of unusual and potentially useful properties to polymers. For example, inclusion of LC regions can impart toughness and thermal stability to amorphous polymers. More information about LC polymers is available in recent books[6,7] and reviews.[8,9]

Common methods of characterizing LC materials include DSC and polarizing microscopy. DSC study of LC materials reveals at least one, and often more than one, endothermic peaks attributable to phase changes. The highest temperature phase change is called the clearing temperature ($T_{cl}$). $T_{cl}$ is analogous to the melting point ($T_m$) of crystals. Above $T_{cl}$ or $T_m$ the materials are liquids. Other phase changes of LC materials, if present, are attributed to changes in the degree of order. DSC of LC alkyds G4 (*Figure* 1) and G5 are typical for amor-

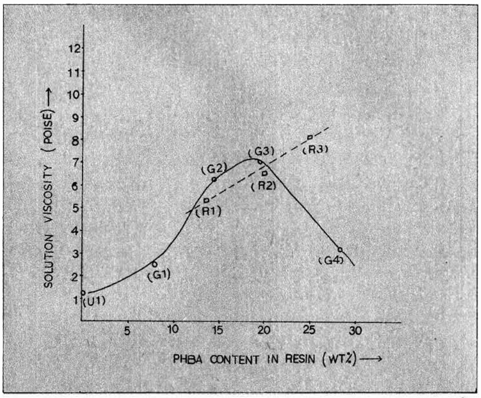

Figure 3—"Solution" viscosity vs PHBA content of alkyds G1–G4 (— o —) and R1–R3 (- - - □ - - - -)

phous polymers that have LC regions. They show a $T_g$ and a single phase change, attributed to $T_{c1}$.

Under a microscope with crossed polarizers liquid crystals appear as bright domains; amorphous materials are dark. Examples are shown in *Figure* 2, where the birefringent liquid crystals appear as bright spots or domains suspended in a dark background of amorphous polymers.

## Grafting PHBA to Form Liquid Crystalline Polymers

Esters of the commercially available monomer p-hydroxybenzoic acid (PHBA) are among the most widely studied mesogenic structures. PHBA is a component of commercially available LC plastics. For example, Xydar (Dartco) is a PHBA copolymer used in microwave cookware and in engineering applications. The PHBA imparts physical toughness and temperature resistance. However, use of PHBA to build LC regions into coatings binders has received little or no attention.

We previously developed a method for grafting PHBA segments to polymer backbones and confirmed by IR, NMR, increase in $T_g$, $M_n$, and titration that grafting occurs.[3] The present study concerns application of this grafting technique to alkyd resins, and it addresses key questions about the effects of PHBA grafts on properties.

The first question to be addressed is whether PHBA grafting can impart LC character to alkyd resins. It can. Both DSC (*Figure* 1) and polarizing microscopy (*Figure* 2) confirm the presence of LC regions in alkyds G4 and G5. However, liquid crystallinity is detected only when the alkyd is made by a process that assures a substantial population of connected PHBA or PHBA/TPA mesogenic units. An average length of PHBA grafts of about 2.0 (alkyd G4) apparently yields a large enough population of mesogenic groups to cause formation of LC regions, and average graft length of about 1.5 (alkyd G3) apparently does not.

Alkyd G5 has an average of two PHBA ester units connected to a TPA unit to form mesogens, having an average of three aromatic rings per mesogenic unit. Unsurprisingly, it appears to have a higher population of LC regions than G4; properties are affected proportionately.

"Random" alkyds R1–R3 apparently lack sufficient population of mesogenic units to cause the formation of detectable LC regions. The amorphous nature of these materials confirms that PHBA must be linked to itself to impart liquid crystallinity. When randomly copolymerized, PHBA functions as an ordinary, rather rigid monomer.

## Viscosity and Appearance of Solutions and Dispersions

A second key question concerns the effects of mesogenic units on rheology. The effects are dramatic. Amorphous alkyds U1, G1–G3, and R1–R3 behave like normal alkyds, forming apparently homogeneous solutions in xylene. LC alkyds are different. G4 and G5 form nonaqueous dispersions in xylene when concentrations are higher than 5% by weight. This behavior is typical of LC polymers.

The tendency of LC alkyds to form nonaqueous dispersions is one of the most significant findings of this study. Without this tendency, solution viscosities of LC alkyds would probably be too high for practical application. However, with the tendency, LC alkyd G4 forms a nonaqueous dispersion in xylene having lower viscosity than xylene solutions of amorphous alkyds G2 and G3 (*Figure* 3). As shown in *Figure* 4, the viscosity of NADs of alkyd G4 fall in the range 0.1-0.2 Pa.s at 45-57 wt% solids, indicating that application of medium to high solids formulations would be possible. It seems almost certain that solids/viscosity relationships could be further improved by structure and formulation refinements.

The rising trend in solution viscosity of alkyds G1–G3 and R1–R3 is attributable to a combination of increasing $T_g$ and increasing molecular weight. The observed viscosity increase appears out of proportion to the modest increase in molecular weight. Therefore, the predominant factor is probably increasing $T_g$ (*Table* 1) imparted by

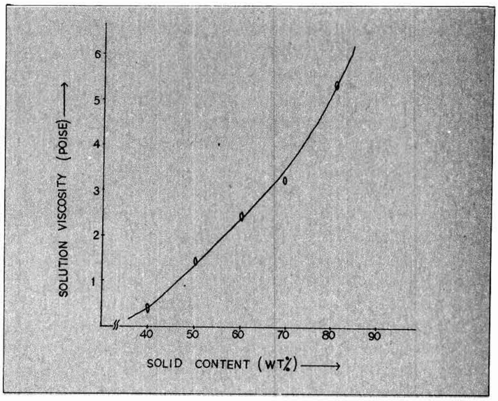

Figure 4—"Solution" viscosity vs solid content of alkyd G4

**Table 3—Dry-to-Touch Times and Film Properties Of U1 and Grafted Alkyds G1–G5**

| | U1 | G1 | G2 | G3 | G4 | G5 |
|---|---|---|---|---|---|---|
| **Dry Time**[a] | **>10D**[b] | **5D** | **7H** | **5.5H** | **1H** | **5M** |
| **Film Properties** | | | | | | |
| Hardness | 5B | 3B | 2B | B | H | 2H |
| Reverse impact strength (in.-lb) | 35 | 35 | 40 | 65 | >80 | 45 |
| Crosshatch adhesion | 100% | 100% | 100% | 100% | 100% | 100% |
| Resistance to acetone (rubs) | 3 | 5 | 5 | 6 | 8 | 8 |
| Film | GL[c] | GL | GL | GL | GL | GL |
| Appearance | TP | TP | TP | TP | TL | TL |

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(a) Dryers = 0.05% Co-naphthenate + 0.15% Zn-naphthenate by weight per resin.
(b) D = day, H = hour, and M = minute.
(c) GL = glossy, TP = transparent, and TL = translucent.

incorporation of rigid PHBA into the structure. The strong effect of $T_g$ on solution viscosity of oligomers is well known.[10]

## Dry Time

A third important question is: Can liquid crystallinity contribute to resolution of the $T_g$ vs dry time tradeoff? It can. Dry times of nonbake alkyds are governed by the rates of solvent evaporation (lacquer dry) and of oxidative crosslinking. It is estimated that alkyds having $T_g$ below $-29°C$ are tacky even after all solvent has evaporated and that a $T_g$ of $+4°C$ is required to pass a specified block resistance test.[10] When $T_g$ is low, oxidative crosslinking is the principal drying mechanism. However, oxidative crosslinking is relatively slow, and efforts to accelerate it often lead to formation of a surface skin that impedes through drying.

Long-oil and high-solids alkyds have low $T_g$. Therefore, they usually dry slowly—far too slowly for many industrial applications. The problem with high-solids, nonbake alkyds has proved to be particularly difficult. Modifications of resin structure that increase $T_g$ tend to increase solution viscosity so much that high-solids formulations become impractical. An example of the problem is found in the "random" alkyds studied here. The stiffness of PHBA monomer increases $T_g$ (*Table* 2) and causes a substantial increase in viscosity (*Figure* 3).

Liquid crystallinity might improve dry times simply by increasing $T_g$. Further, it might reduce dry times by providing quick physical crosslinking through LC phases. Such crosslinking could supplement oxidative crosslinking, reducing the number of covalent crosslinks required to reach a given total crosslink density.

The present results strongly suggest that both mechanisms operate. The dry-to-touch time of LC alkyds G4 (1 hr) and especially G5 (5 min) are much faster than those of amorphous alkyds R1–R3 (5-3.5 hr). If the rate differences were simply a $T_g$ effect, alkyds G4 ($T_g$, $-15°C$) would dry no faster than R3 ($T_g$, $-12°C$). Thus, the data support the hypothesis that physical crosslinking plays a substantial role in shortening dry-to-touch times.

Even if the improved dry times were attributable only to increased $T_g$, liquid crystallinity offers a potential way to make high-solids, high-quality alkyds because formation of nonaqueous dispersions (noted earlier) eliminates the viscosity/$T_g$ tradeoff.

## Film Properties

A fourth key question concerns what effect liquid crystallinity may have on film properties. Based on the limited results presented here, the effect appears very positive.

An important finding of this study is that grafting LC segments to alkyd backbones improves both toughness and hardness. LC alkyd G4 has a superior combination of reverse impact resistance and hardness (*Table* 3). LC alkyd G5 is very hard for a nonbake coating and has fairly good reverse impact resistance (45 in.-lb).

In contrast, amorphous alkyds U1, G1–G3, and R1–R3 had mediocre properties. Film property trends followed the normal pattern: As $T_g$ is increased, hardness improves, but elasticity (reflected by impact resistance) suffers. The difficulty of trying to make coatings both hard and impact resistant is well known to formulators. These properties are usually antagonistic.

The improved hardness and toughness of LC alkyds is not surprising in view of the properties of LC plastics; they are both hard and tough.[11] The property enhancement by LC phases is attributed to physical crosslinking of the plastic by association of mesogenic units from different molecules into microscopic LC phases. Materials that use this principle are sometimes called "self-reinforcing polymers." LC crosslinks are partly solid and partly liquid at the molecular level. Perhaps they can toughen materials by providing a stress relief mechanism (slippage) along the liquid planes or by impeding crack propagation.

## Comparison of This Approach to Others For Improving Higher-Solids Alkyds

As in all high-solids coatings, resin viscosity is an important variable in high-solids alkyds. Viscosity is usually reduced by reducing molecular weight and $T_g$. It is especially important to reduce the proportion of soluble high molecular weight molecules in the resin.[12] However, reduction of molecular weight and $T_g$ usually results in slow drying and poor film properties. The high

**Table 4—Dry-to-Touch Times and Film Properties Of "Random Alkyds" R1–R3**

| | R1 | R2 | R3 |
|---|---|---|---|
| **Dry Time**[a] | **5 H** | **4.5 H** | **3.5H** |
| **Film Properties** | | | |
| Hardness | HB | HB | H |
| Reverse impact strength (in.-lb) | >80 | 45 | 20 |
| Crosshatch adhesion | 100% | 100% | 100% |
| Resistance to acetone (number of rubs) | 3 | 4 | 4 |
| Film | GL | GL | GL |
| Appearance | TP | TP | TP |

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(a) Dryers = 0.05% Co-naphthenate + 0.15% Zn-naphthenate by weight per resin.

molecular weight fractions present in most alkyds are especially beneficial to film properties.[13]

Several approaches are known to overcome the earlier noted problems:

(1) Use of reactive diluents,[14-16] auxiliary cross-linkers,[17] and special autooxidative catalysts[18];

(2) Introduction of reactive C = C bonds to alkyd backbones by modifying the alkyds with acrylic acid or methacrylic acid[16];

(3) Modification of the alkyd backbones by radical copolymerization with olefinic monomers[19,20] such as styrene, acrylic or methacrylic monomers, acrylonitrile, and vinyl toluene;

(4) Copolymerization ("chain stopping") with aromatic monobasic acids[21,22] such as 2,4-dimethylbenzoic acid, p-t-butylbenzoic acid, or isomers of hydroxybenzoic acids; and

(5) Incorporation of reactive microgels.[23,24]

The above approaches usually have drawbacks of extra cost (1,2,5), inferior film properties (3,4), reduced package stability (1,2,5), and increased viscosity (2-4).

In this study, a sixth approach is introduced. As demonstrated previously, modification of alkyds with LC segments offers potential for reduced viscosity, improved dry time, and improved film properties. If PHBA is used to introduce the LC segments, raw material cost can be reasonable. PHBA is now a moderately priced commercial monomer, and its price would be further reduced if demand increased.

Of course, much research will be needed to commercialize coatings based on LC alkyds. Careful study will be needed to optimize compositions and structures. Probably the key problem will be to develop a practical process for commercial production. Further studies along this line are planned.

## CONCLUSIONS

Grafting oligomeric segments derived from PHBA or TPA/PHBA onto alkyd resins yields alkyds that contain liquid crystalline (LC) phases. These phases impart at least three benefits: "solution" viscosity is reduced by the formation of nonaqueous dispersions; dry-to-touch times are sharply reduced; and films are both hardened and toughened.

LC alkyds offer a promising new technological approach to nonbake coatings having low VOC and excellent properties.

## ACKNOWLEDGMENT

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# Thirteen degrees, 13 new mayor of Clute, Texas.

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## 1987 CONSTITUENT SOCIETY PAPER

# Quantifying Pigment Dispersion

J.E. Hall, R. Benoit, R. Bordeleau, and R. Rowland
Montreal Society for Coatings Technology
Technical Committee

One of the most important steps in the manufacture of any surface coating is the combining of pigment and resin by the process of dispersion. Successful dispersion is imperative if optimum optical properties are to be obtained. An infrared scattering technique has been successfully used to measure the degree of dispersion in paint systems containing titanium dioxide pigments. The literature contains many examples of how this "flocculation gradient technique" can be used to determine the influence of pigment dispersion on optical properties and exterior durability.

This method has now been applied to simple alkyd paint systems containing other white pigments, calcium carbonate extenders, red iron oxide pigments, or colored organic pigments. The results obtained indicate that the technique is of value in studying the degree of dispersion of a wide range of pigments, although it is particularly applicable to those having a high refractive index.

## INTRODUCTION

One of the most important steps in the manufacture of any surface coating is the dispersion of pigment particles within the resinous component of the system. However, in actual paint systems, the dispersion process is always incomplete in that the pigment is never entirely present as single discrete crystals, but as groups of crystals (particles) referred to as either aggregates, agglomerates, or flocculates.[1] Even with a readily dispersible pigment such as titanium dioxide, in a simple alkyd paint system prepared under optimum conditions, it has been estimated that only about 30% of the pigment particles were present as single crystals, the remainder being present as groups of two, three, or more.[2] Thus, it is more correct to talk in terms of the degree of pigment dispersion achieved, rather than simply referring to a system as "well" or "poorly" dispersed.

Determining the degree of pigment dispersion is of fundamental importance, since it affects both the optical and rheological properties of a paint system. The coatings manufacturer, when working with practical systems, usually considers dispersion to be related to the number of oversized particles detected on a fineness of grind gauge. However, this simple, nonquantitative technique gives only an indication of particles whose dimensions are about 10 μm or greater. Since many commercial pigments have a mean particle size of about 0.5 μm or less, the grind gauge is clearly an insensitive method by which to assess pigment dispersion. While it is known that giant oversized particles can have a detrimental effect on the

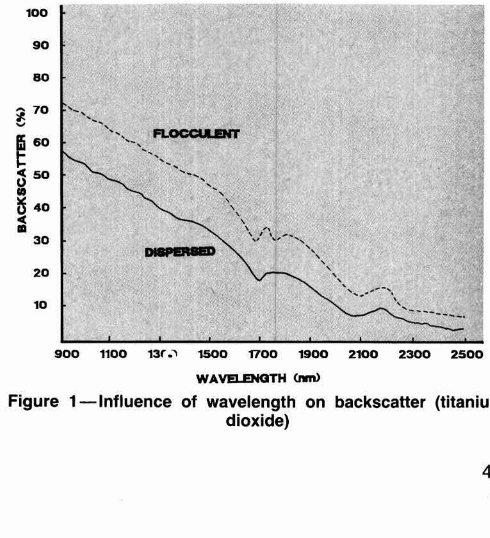

Figure 1—Influence of wavelength on backscatter (titanium dioxide)

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Presented by Mr. Hall at the 65th Annual Meeting of the Federation of Societies for Coatings Technology, in Dallas, TX, on October 5, 1987.

This paper was awarded first prize in the 1987 A.F. Voss/*American Paint & Coatings Journal* Award competition.

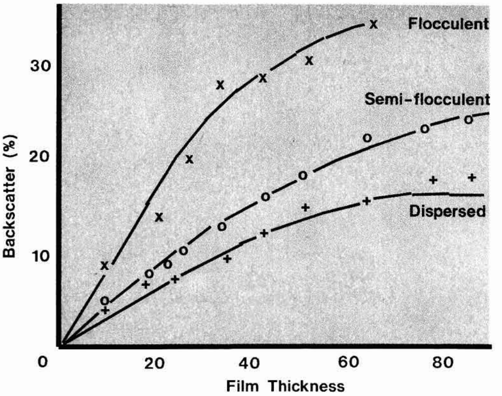

Figure 2—Effect of film thickness on backscatter (after Balfour)

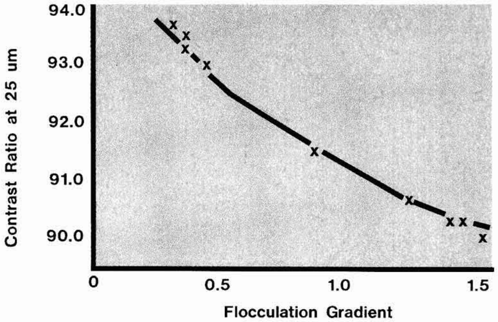

Figure 3—Effect of flocculation on opacity

appearance of the final paint film, they often have a less than significant effect on the overall optical properties of the system, due to their relatively low concentration. Indeed, Blakey demonstrated that, in the case of titanium dioxide, only approximately 0.1% of the total pigmentation of a paint system was responsible for an unacceptable fineness of grind rating.[3]

In more fundamental terms, the state of dispersion can be considered as the pigment particle size distribution within the medium and, hence, is concerned with particles of various dimensions. A number of techniques have been applied to measure the degree of pigment dispersion in coatings systems. These include various sedimentation techniques,[4-6] chromatography,[7] electron microscopy (TEM and SEM),[5,6] light scattering methods,[8] contact microradiography,[9] rub out numbers,[10,11] and color strength.[11,12] However, observing the particle size distribution in liquid systems without prior dilution is difficult, while assessing dispersion in dry films is often tedious and generally requires expensive instrumentation.

Table 1—Influence of Milling Time on Degree of Dispersion And Optical Properties of Alkyd Paints Containing Titanium Dioxide Pigment

*Well Dispersed*

| Milling Time (hr) | Fineness of Grind (µm) | Contrast Ratio at 25 µm | Gloss 20° | Flocculation Gradient | $R_w$40 |
|---|---|---|---|---|---|
| 0 | >50 | 91.5 | 53 | 0.85 | 21.6 |
| 0.5 | 18-38 | 93.0 | 91 | 0.45 | 14.5 |
| 2.0 | 8-18 | 93.2 | 90 | 0.40 | 13.9 |
| 8.0 | 8-12 | 93.4 | 89 | 0.40 | 13.0 |
| 48.0 | 8-12 | 93.5 | 88 | 0.38 | 13.0 |

*Flocculent*

| Milling Time (hr) | Fineness of Grind (µm) | Contrast Ratio at 25 µm | Gloss 20° | Flocculation Gradient | $R_w$40 |
|---|---|---|---|---|---|
| 0 | >50 | 90.0 | 63 | 1.50 | 26.0 |
| 0.5 | 20-38 | 90.2 | 84 | 1.44 | 26.0 |
| 2.0 | 8-18 | 90.2 | 83 | 1.41 | 24.4 |
| 8.0 | 8-12 | 90.5 | 75 | 1.39 | 24.9 |
| 48.0 | 8-12 | 90.7 | 78 | 1.25 | 24.0 |

## FLOCCULATION GRADIENT TECHNIQUE

One of the few approaches to be developed, which is both quantitative and can be adapted to study the degree of pigment dispersion in both the liquid phase and dry paint films, is the flocculation gradient technique. This quantitative, though empirical method, was originally developed by Balfour and Hird[13] specifically to study systems containing titanium dioxide pigments.

Titanium dioxide pigments impart opacity by scattering visible radiation. By producing pigments with a mean crystal size of about 0.23 µm, optimum scattering is obtained after incorporation into actual paint systems at practical concentrations. However, if the mean particle size of the pigment is increased, as for example by flocculation, longer wavelength radiation is preferentially scattered, and optical properties deteriorate. The flocculation gradient technique considers pigment flocculates as single particles which scatter infrared radiation more effectively than they do visible radiation. The amount of radiation backscattered by a paint film, relative to barium sulphate, as a function of wavelength, is shown in *Figure* 1. Two simple alkyd paints are shown, both containing titanium dioxide at 20% PVC. However, in Paint A the pigment was known to be well dispersed, while in Paint B the pigmentation was present in a flocculated state. At wavelengths in the region of 2500 nm, the amount of radiation backscattered by either paint does not very significantly with wavelength, although the well dispersed paint scatters much less of this longer wavelength radiation than the flocculent system. By determining the amount of radiation scattered at 2500 nm for a series of paint film thicknesses, flocculation gradients can be constructed, as shown in *Figure* 2. The higher the level of flocculation in the paint, the larger the flocculation gradient value. Balfour and Hird found that this relationship was generally linear up to film thicknesses of about 40 µm, although as the degree of flocculation increased

Table 2—Influence of Mean Crystal Size On Flocculation Gradient and $R_w40$ Values

| Mean Crystal Size (μm) | Inorganic Coating | Flocculation Gradient | $R_w40$ |
|---|---|---|---|
| 0.10 | $Al_2O_3$ and $SiO_2$ | 0.20 | 9.9 |
| 0.22 | $Al_2O_3$ | 0.32 | 13.9 |

nonlinearity was observed. Thus, the technique became based on films applied at thicknesses of up to 30 μm.

Relationships between flocculation gradient value and the optical properties of various paint systems, including alkyd,[13–16] latex, [17,18] and baking enamels[19] have been established. Paints with high flocculation gradients have been shown to be deficient in opacity, gloss and color,[13–19] and in some cases, exterior durability.[14] Unfortunately, it is not possible to directly calculate the mean particle size of the pigment within the paint matrix from these infrared scattering values, nor can the technique differentiate between agglomerates or flocculates, but considers them both as oversized particles, regardless of their mechanism of formation. However, a visual representation of the flocculation gradient can be obtained using scanning electron microscopy, if the films have been previously etched with excited oxygen.[15,16]

Infrared scattering measurements have also been carried out on liquid paint samples. This initially involved determining a "wet" flocculation gradient,[20] but was subsequently modified[15] to consist of a single reflectance value termed $R_w40$ (the reflectance of a wet film of 40 μm thickness). The advantage of the $R_w40$ value is that it is a rapid measurement by which pigment dispersion can be described, and it has proven useful as a quality control tool.

Initially all flocculation gradient determinations were carried out using a spectrophotometer fitted with an integrating sphere. Since, in essence, the technique requires only monochromatic radiation, a relatively simple instrument called the Flocculation Gradient Monitor (FGM) was constructed to carry out the measurements required.[15] The values reported in this paper at a wavelength of 2500 nm were obtained using the FGM, while those determined at other wavelengths were measured using the spectrophotometer.

Following examples of how the technique can be used to study systems containing titanium dioxide, the potential of the method to study systems containing other pigments will be explored. Unless otherwise stated, all the pigments evaluated were incorporated in simple alkyd paints, by ballmilling for 16 hr, to produce a final pigment volume concentration (PVC) of 20% and, since all the paints were manufactured under efficient conditions, they were considered to be well dispersed.

Table 3—Flocculation Gradient and $R_w40$ Values Of Alkyd Paints Containing Various White Pigments

| Pigment | Refractive Index | Particle Size | Flocculation Gradient | $R_w40$ |
|---|---|---|---|---|
| Barytes | 1.63 | 0.9 | 0.08 | 2.5 |
| Zinc oxide | 2.01 | 0.23 | 0.60 | 12.3 |
| Zinc oxide | 2.01 | 1.0 | 1.30 | 18.9 |
| Antimony oxide | 2.04 | 1.0 | 1.30 | 20.0 |
| Antimony oxide | 2.04 | 1.9 | 1.82 | 23.6 |

**Montreal Society Technical Subcommittee**

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| R. Benoit | NL Chem Canada Inc. |
| R. Bordeleau | Tioxide Canada Inc. |
| R. Rowland | White Pigment Corp. |

### Titanium Dioxide

It is possible to induce flocculation in systems containing titanium dioxide pigments by the addition of certain anti-settling additives. A series of alkyd paints was prepared containing a commercial, surface treated, titanium dioxide pigment. The pigment had a mean crystal size of 0.22 μm (in the dry powder form), an inorganic coating of alumina and a polyol organic treatment. *Table* 1 shows fineness of grind ratings, opacity, and gloss values as a function of milling time in the presence and absence of a suitable anti-settling agent. Flocculation gradient and $R_w40$ values are also given. These results not only demonstrate the limitations of a fineness of grind rating to assess pigment dispersion, but also how pigment flocculation adversely affects optical properties. Similar results have been presented by other authors.[13,21]

It can be seen that the degree of pigment dispersion, as determined by the flocculation gradient technique, changes very little with milling time of two hours or greater. Similar trends were observed with the optical properties of the paint systems. No indication of the high level of flocculation present in some of the systems could be deduced from the fineness of grind readings. The relationship between flocculation gradient value and the

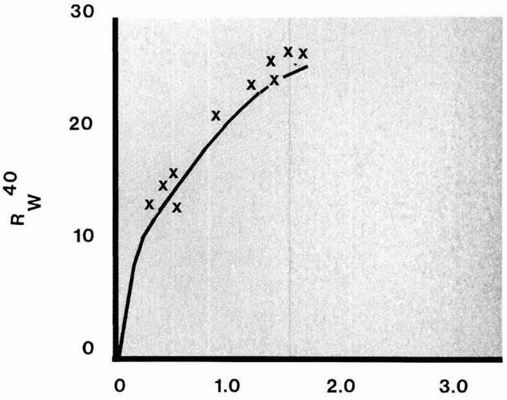


Figure 4—Relationship between $R_w40$ and flocculation gradient

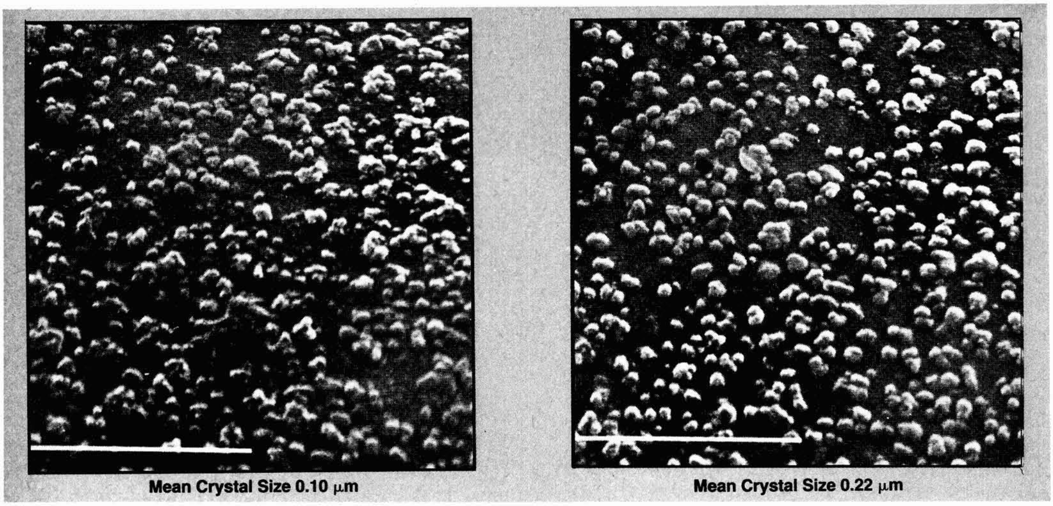


Figure 5—Level of dispersion in alkyd paints containing titanium dioxide pigments

opacity of the prepared paints is shown in *Figure* 3. It can be seen that, as the flocculation gradient value increases, a corresponding decrease in opacity resulted. The relationship between flocculation gradient and $R_w40$ values is shown in *Figure* 4. These results demonstrate the suitability of the $R_w40$ value as a quality control tool since it produces values which are proportional to the degree of dispersion in the dry film.

The effect of pigment particle size upon flocculation gradient was also investigated. Unfortunately, titanium dioxide pigments are manufactured commercially in only a relatively narrow range of crystal sizes. However, samples with similar surface treatments and crystal sizes of 0.1 and 0.22 µm (as determined by TEM in the dry powder form) were procured. A series of simple alkyd paints was prepared and the results obtained are shown in *Table* 2. A visual examination of the films using scanning electron microscopy, after prior etching with excited oxygen,[22] suggested that both paints contained pigment in a relatively well dispersed state (see *Figure* 5). However, it is known that as a result of deficiencies in the dispersion process, titanium dioxide pigments with a mean crystal size of about 0.22 µm in the powder form, have an ultimate mean particle size of about 0.28 µm (as determined by light scattering measurements) when incorporated into alkyd paints under optimum conditions.[21] The flocculation gradient values obtained were found to decrease as the mean crystal size of the pigment decreased. This is in agreement with the idea that the infrared backscatter values are proportional to the mean particle size of the pigment within the paint matrix.

## Other White Pigments

Although titanium dioxide is by far the most important opacifying pigment used by the coatings industry, other prime pigments are still employed, albeit in relatively

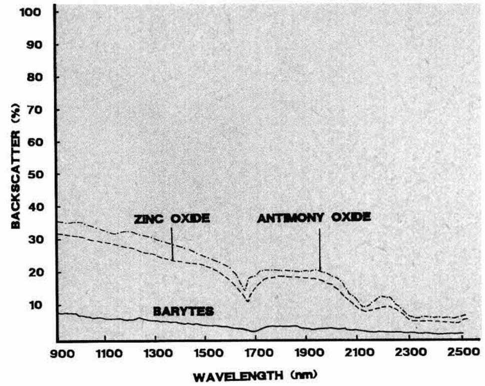


Figure 6—Influence of wavelength on backscatter (various white pigments)

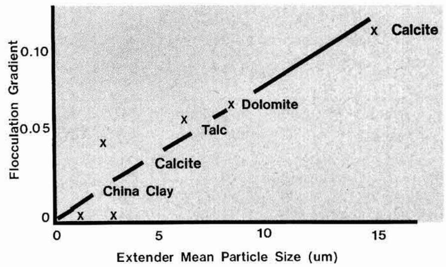


Figure 7—Influence of particle size on flocculation gradient for low refractive index materials

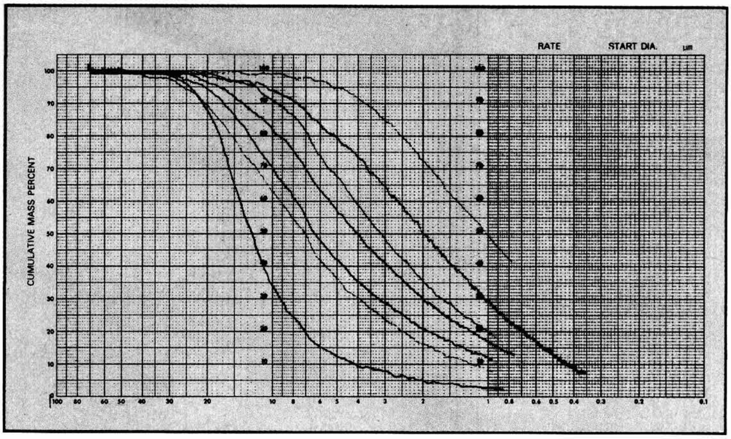


**Figure 8—Sedigraph profiles of calcium carbonate extenders**

minor quantities. Such pigments include antimony oxide, zinc oxide, and barium sulphate. Reflectance curves of simple 20% PVC alkyd paints containing these pigments, as shown in *Figure* 6, suggested that it should be possible to determine flocculation gradient values by measuring backscatter values at 2500 nm. Hence, flocculation gradient and $R_w40$ values were determined on each of the resultant paints, as shown in *Table* 3.

The results obtained indicate that with white pigments of similar mean particle sizes (in the powder form), the higher the refractive index, the higher the observed flocculation gradient value. Similarly, when pigments with equivalent refractive indices are compared, the larger the mean particle size, the higher the observed flocculation gradient value. This, of course, assumes that all of the pigments evaluated were of similar inherent dispersibility. However, an SEM examination of the resultant etched paint films tended to support this assumption.

## Calcium Carbonate

A limited amount of work has been carried out applying the flocculation gradient technique to systems containing extenders only.[15,21] An analysis of results presented by Rutherford and Simpson[15] is shown in *Figure* 7. These results suggest that flocculation gradients of such systems can be correlated with mean particle size (in the dry powder form), although at 10% PVC the values obtained tend to be very low. To further investigate these findings, a series of calcium carbonates was prepared with equivalent spherical diameters varying from 1 to 12.5 µm. The particle size values were determined using a Sedigraph Particle Size Analyzer Model 5000D. A small sample of each of the calcium carbonates was dispersed as an aqueous slurry and transferred to the sedigraph, where the sedimentation of the particles was detected by X-rays. The particle size distribution of the samples evaluated is shown in *Figure* 8.

Thus, a series of simple alkyd paints was prepared based on each of the extender samples at 10% and 20% PVC. An infrared backscatter profile was determined on each of the resultant paints, and selected results are shown in *Figure* 9. The profiles suggest that the larger the mean particle size of the calcium carbonate, the greater the amount of infrared radiation backscattered. Flocculation gradient and $R_w40$ values were also determined on each paint, as shown in *Table* 4. However, since some of the film thickness vs backscatter plots were not linear over the entire range of film thicknesses, reflectance values at 10 µm dry film thickness (termed $R_D10$) were recorded, as shown in *Table* 4. This $R_D10$ value was found to be proportional to the mean particle size of the extender, as shown in *Figure* 10. The results obtained with these low refractive index materials suggest that if the mean particle size of the extender is 6 µm, or less, the amount of infrared radiation scattered is relatively small, so that it would become negligible if the system contained a high refractive index pigment such as titanium dioxide.

## Iron Oxide Pigments

Significant quantities of iron oxide pigment are consumed in the coatings industry, primarily for inclusion in maintenance and marine paints. These high refractive index pigments are produced in various particle sizes and can be either natural or synthetic in origin.

A series of simple alkyd paints was prepared based on micronized, red synthetic iron oxide pigments, in the

**Table 4—Relationship Between Mean Particle Size, Flocculation Gradient and $R_w40$ Values of Alkyd Paints Containing Calcium Carbonate**

| Equivalent Spherical Diameter (µm) | 10% PVC | | 20% PVC | |
|---|---|---|---|---|
| | $R_D10$ | $R_w40$ | $R_D10$ | $R_w40$ |
| 1 | 0.20 | 0.8 | 0.6 | 1.5 |
| 2 | 0.30 | 1.1 | 0.9 | 2.0 |
| 3 | 0.35 | 1.2 | 1.2 | 2.2 |
| 4 | 0.40 | 1.2 | 1.2 | 2.1 |
| 6 | 0.40 | 1.4 | 1.4 | 2.2 |
| 7 | 0.50 | 1.5 | 2.5 | 2.5 |
| 12.5 | 1.00 | 1.7 | 3.7 | 2.8 |

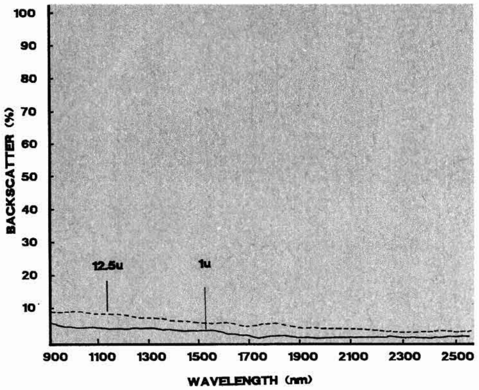


Figure 9—Influence of wavelength on backscatter (calcium carbonate extenders)

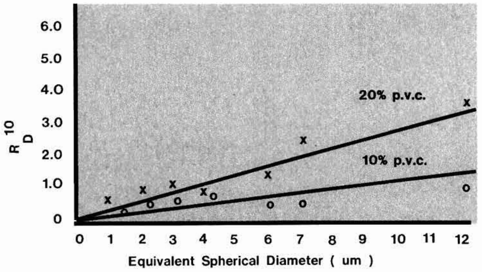


Figure 10—Influence of particle size on $R_D10$ (calcium carbonate extenders)

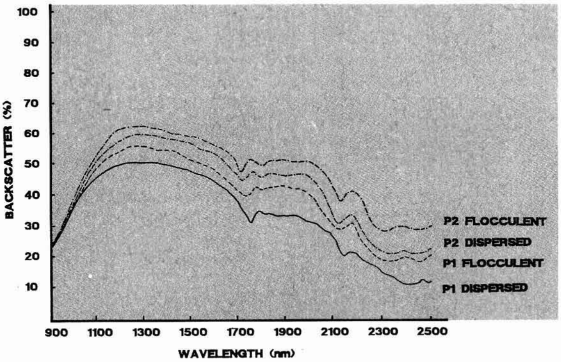


Figure 11—Influence of wavelength on backscatter (iron oxide pigments)

**Table 5—Synthetic Red Iron Oxide Pigments**

| Reference # | Origin | % $Fe_2O_3$ | % $SiO_2$ + $Al_2O_3$ | Density | Shape | Predominant Particle Size μm |
|---|---|---|---|---|---|---|
| P1 ... | Synthetic | 94 | 4 | 5.0 | Spherical | 0.09 |
| P2 ... | Synthetic | 96.5 | 3 | 5.0 | Spherical | 0.22 |

**Table 6—Effect of Pigment Dispersion on Optical Properties Of Alkyd Paints Containing Iron Oxide Pigments**

| Pigment | Reference | Color Strength L | a | b | Gloss 20° | Flocculation Gradient | $R_w40$ |
|---|---|---|---|---|---|---|---|
| P1 ..... | Well dispersed | 58.8 | 21.1 | 9.9 | 68 | 0.58 | 16.2 |
| P2 ..... | Well dispersed | 56.6 | 18.8 | 4.4 | 69 | 1.20 | 23.8 |
| P1 ..... | Flocculent | 60.5 | 19.5 | 7.5 | 8 | 1.25 | 24.9 |
| P2 ..... | Flocculent | 60.6 | 14.9 | 0.5 | 32 | 1.74 | 27.3 |

**Table 7—Effect of Milling Time on Pigment Dispersion (Iron Oxide Pigment P2)**

| Milling Time (hr) | Color Strength L | a | b | Flocculation Gradient | $R_w40$ |
|---|---|---|---|---|---|
| 2.... | 57.4 | 18.0 | 3.3 | 1.3 | 24.9 |
| 4.... | 57.2 | 18.2 | 2.6 | 1.3 | 24.4 |
| 16.... | 56.9 | 18.0 | 4.1 | 1.25 | 24.9 |
| 24.... | 56.3 | 18.9 | 4.8 | 1.10 | 23.2 |
| 48.... | 56.1 | 19.4 | 5.6 | 1.0 | 21.9 |

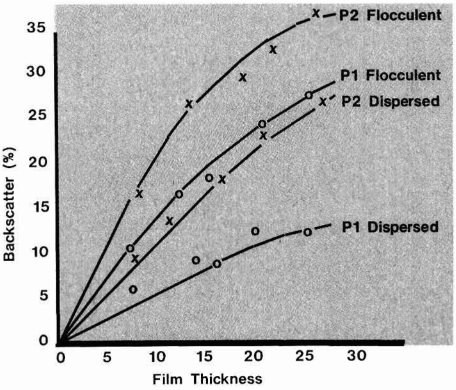


Figure 12—Effect of film thickness on backscatter (iron oxide pigments)

presence and absence of an anti-settling agent at a final concentration of 20% PVC. Details of the pigments evaluated are shown in *Table* 5. Backscatter profiles over the wavelength range 900-2500 nm were determined on the resultant paints, as shown in *Figure* 11. On the basis of these profiles, infrared backscatter measurements from dry and wet films were carried out at 2500 nm. The effect of film thickness on infrared scattering from dry films is shown in *Figure* 12. Smooth curves have been drawn for each paint, and the absence of any scatter by the substrate to which the paints were applied justifies extrapolation through the origin. The relationship between infrared backscatter and film thickness was found to be linear up to 20 μm and hence flocculation gradient values were calculated over this film thickness range. Flocculation gradient and $R_w40$ values are shown in *Table* 6.

The results obtained indicate that paints including the anti-settling agent contained pigment in a relatively poorly dispersed (i.e., flocculated) state. This was confirmed by a visual examination of the films using scanning elec-

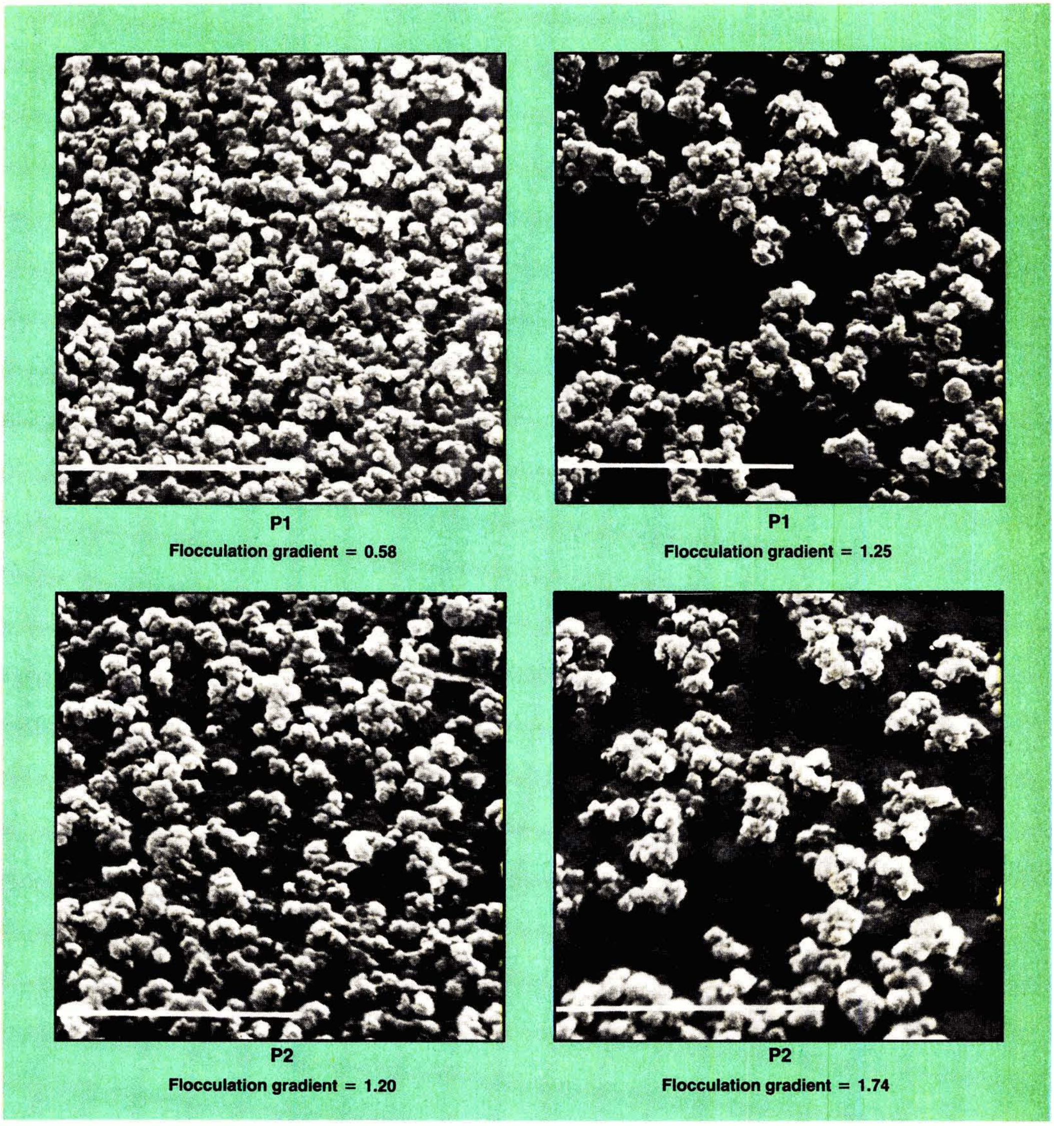
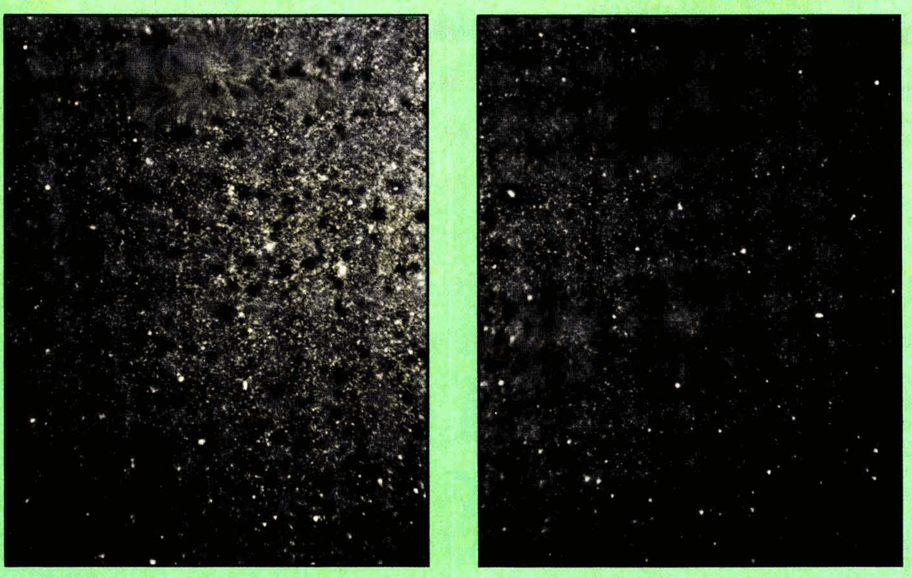
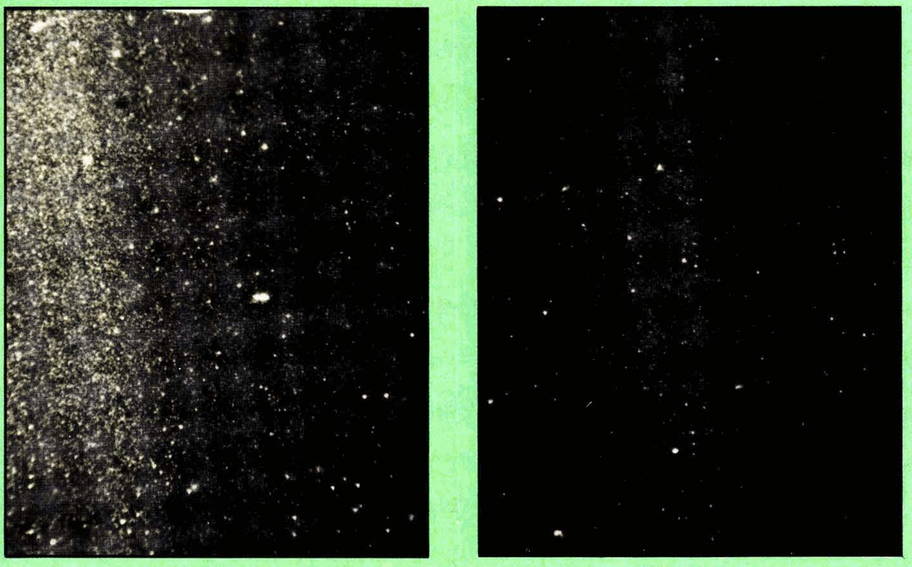


**Figure 13—Relationship between pigment dispersion and flocculation gradient (iron oxide pigments)**



**(a) 2 Hours**

**(b) 4 Hours**



**(c) 24 Hours**

**(d) 48 Hours**

**Figure 14—Optical micrographs of iron oxide dispersions at various milling times**

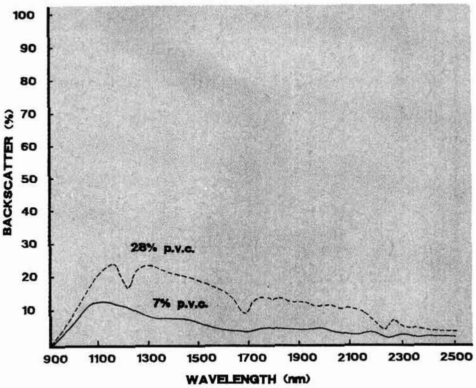


Figure 15—Influence of wavelength on backscatter (phthalocyanine blue)

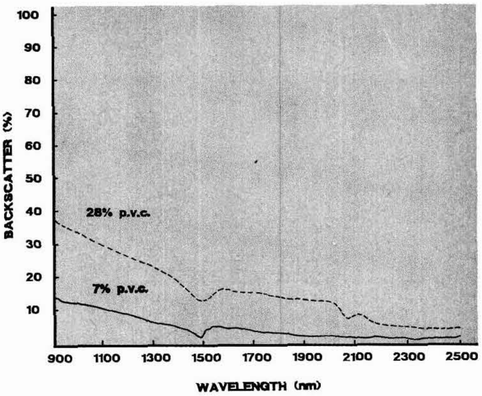


Figure 16—Influence of wavelength on backscatter (toluidene red)

tron microscopy, after prior etching with excited oxygen.[21] Relevant micrographs are shown in *Figure* 13. The optical properties of the resultant paints were also evaluated. Color strength was determined by reducing the iron oxide pigment 10:1 with titanium dioxide, while gloss values were determined on the initial 20% PVC systems. The values obtained are also given in *Table* 6.

Synthetic iron oxide pigments having a small particle size (i.e., < 1μm) tend to produce a red with a yellowish shade. However, as the mean particle size increases, the color moves more to the blue end of the spectrum, producing a purplish shade. This effect can be seen in *Table* 6, where the mean particle size of the pigments is increased due to flocculation. This results in a decrease in both *a* value (i.e., the film appears less red) and *b* value (i.e., the film appears less yellow, more blue). The end result was that the flocculated dispersions did indeed have a definite purple cast although their brightness values were found to increase slightly. The gloss values of the nonreduced flocculent dispersions were also found to be significantly lower than their well dispersed equivalents, which again was attributed to the increase in mean particle size resulting from flocculation.

An attempt was made to follow the milling process using infrared reflectance measurements, in alkyd paints based on one of the iron oxide pigments. The results obtained, as shown in *Table* 7, indicate that an acceptable level of pigment dispersion was reached fairly rapidly, although a slight improvement was achieved after prolonged milling periods. This was confirmed by the color strength of the dispersion, which also showed some increase after prolonged milling periods. Optical transmission micrographs suggested no significant decrease in the number of oversized particles after milling periods of greater than 24 hr (see *Figure* 14).

## Colored Organic Pigments

It is well known that colored organic pigments are relatively difficult to disperse, even in simple alkyd systems. Thus, any technique which would help to describe the state of dispersion in such systems could be of great value, particularly if it could also be used as a quality control tool. As previously indicated, the flocculation gradient technique involves the measurement of radiation of 2500 nm scattered from the specimen under test. This was the experimentally determined optimum wavelength for systems containing titanium dioxide, and was also suitable for systems containing other white pigments, extenders, and red iron oxide pigments. However, for systems containing low refractive index, colored organic pigments, the situation is somewhat different, as shown in *Figures* 15 and 16. Backscatter vs wavelength profiles for phthalocyanine blue and toluidene red, suggest that two suitable regions exist at which flocculation gradients could be determined (1700-1900 nm and 2400-2500 nm).

Thus, a series of simple alkyd paints was prepared based on phthalocyanine blue (P3) and a toluidene red (P4) pigment, at concentrations ranging from 7 to 28% PVC. The paints were dispersed by ballmilling for 48 hr. Flocculation gradient values at both 2500 and 1850 nm, and $R_w$40 values at 2500 nm were determined on the resultant paints. The flocculation gradient and $R_w$40 values obtained were found to increase as a function of PVC, as shown in *Table* 8. This appears to be contradictory to results obtained with titanium dioxide pigments[15] where,

**Table 8—Effect of PVC on Flocculation Gradient and $R_w$40 Values for Alkyd Paints Based on Colored Organic Pigments**

| | Pigment Volume Concentration | Flocculation 1850 nm | Gradient 2500 nm | $R_w$40 |
|---|---|---|---|---|
| Phthalocyanine Blue (P3) | 7 | 0.45 | 0.16 | 4.2 |
| | 14 | 0.54 | 0.20 | 5.4 |
| | 21 | 0.60 | 0.22 | 6.4 |
| | 28 | 0.70 | 0.24 | 7.4 |
| Toluidene red (P4) | 7 | 0.60 | 0.23 | 5.4 |
| | 14 | 0.74 | 0.29 | 6.7 |
| | 21 | 0.89 | 0.34 | 8.3 |
| | 28 | 1.0 | 0.40 | 9.8 |

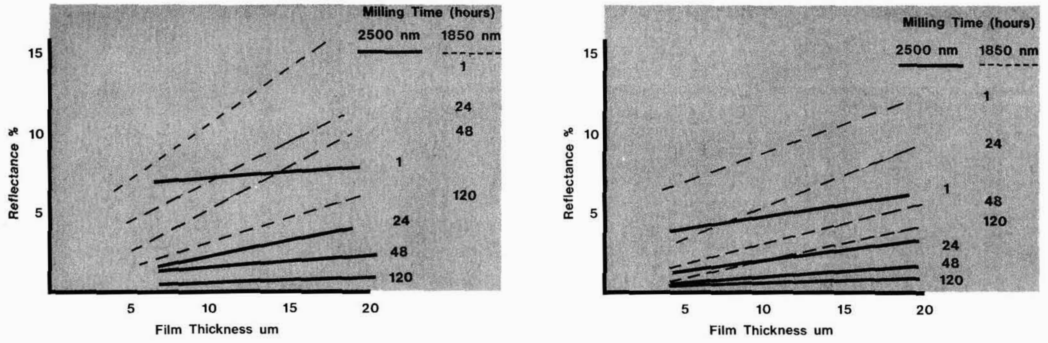


**Figure 17—Effect of film thickness on backscatter at various milling times for phthalocyanine blue**

with well dispersed systems, flocculation gradient values were independent of PVC. Increasing concentration only resulted in increased flocculation gradient values, where the systems were flocculent. However, it may suggest that even after prolonged milling periods, under optimum conditions, the resulting colored pigment dispersions were still relatively flocculent in nature. On comparing the flocculation gradient values at both 2500 and 1850 nm, it can be seen that the absolute values are greater at the latter wavelength. The sensitivity of the technique can therefore be increased by operating at 1850 nm, rather than 2500 nm, when colored organic pigments are evaluated.

The effect of milling time on pigment dispersion was studied by evaluating the performance of two different phthalocyanine blue pigments (P3 and P5). Although both pigments were solvent stable, alpha-form, copper phthalocyanine blues, P5 was heavily surface modified (resinated) to improve its dispersibility and flocculation resistance. Paints were prepared from a common millbase, after various milling periods, such that the final PVC of each system was 14%. Backscatter measurements from the subsequent dry films (at 2500 and 1850 nm) and $R_w40$ values on the liquid samples were determined, as illustrated in *Figure* 17. It can be seen that the backscatter vs film thickness plots suggest a nonlinear relationship at low film thicknesses, with milling times of less than 48 hr. Thus, the level of pigment dispersion in the dry film was described by an $R_D10$ value, as previously used for paints containing calcium carbonate, rather than a flocculation gradient value. The $R_D10$ values obtained are shown in *Table* 9. As previously observed, greater differentiation between the samples was possible when backscatter values were determined at 1850 rather than 2500 nm. The relationship between $R_D10$ and $R_w40$ values is shown in *Figure* 18. These results suggest that $R_w40$ values, as recorded directly from a liquid sample, could be used to describe the level of pigment dispersion in systems containing phthalocyanine blue pigments. The infrared backscatter values obtained indicate that the heavily surface modified phthalocyanine blue was better dispersed than the unmodified pigment.

To confirm that the infrared reflectance parameters shown in *Table* 9 could be correlated with the actual state

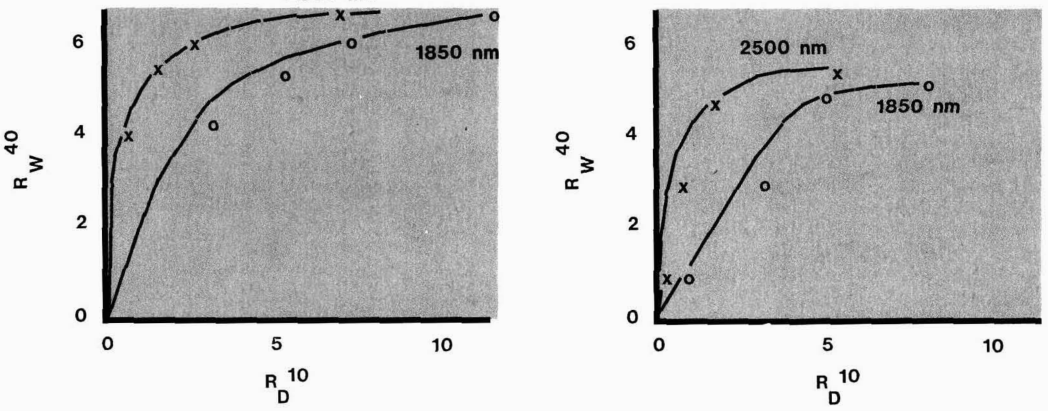


**Figure 18—Relationship between $R_W40$ and $R_D10$ for phthalocyanine blue**

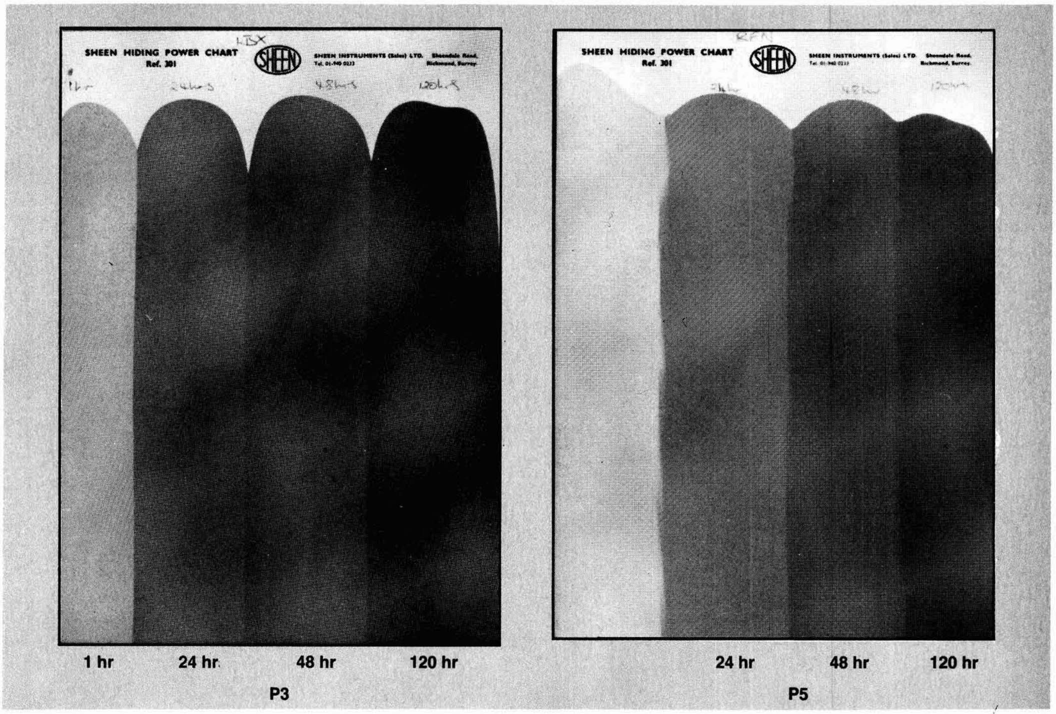


Figure 19—Effect of milling time on color strength

of pigment dispersion, the color strength of each of the dispersions was determined by reducing them 25:1 with titanium dioxide. The brightness and blueness (i.e., L and b values) of the resultant paints were determined, as shown in *Table* 10. The color strength of the dispersions was found to increase with milling time, even after prolonged milling periods (i.e., 48 hr). This progressive increase in color strength is indicated in *Figure* 19. A progressive reduction in the concentration of oversized particles, as a function of milling time, was also indicated in optical transmission micrographs (see *Figure* 20). The micrographs show that the surface modified pigment appeared to be better dispersed than the unmodified pigment.

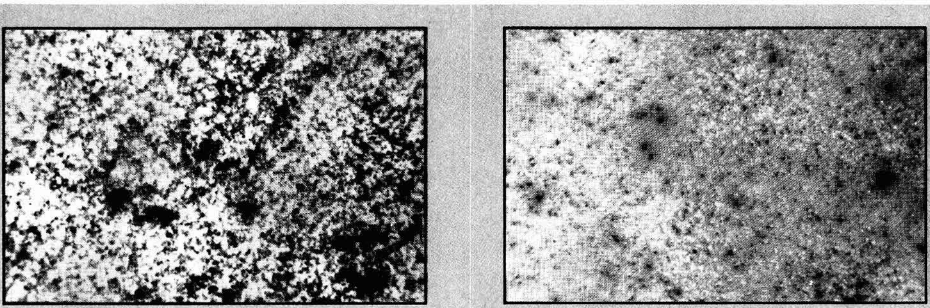
While both the infrared scattering results and the optical microscopy suggested that the heavily surface modified phthalocyanine blue was better dispersed than the unmodified pigment, the tinting strength values obtained conflict with this conclusion. If the level of flocculation in a phthalocyanine blue dispersion were reduced, then a significant increase in color strength would be expected. These apparently conflicting results can be explained[23] by the fact that the more flocculation resistant pigment was developed by the application of a very high level of

**Table 9—Effect of Surface Modification on Pigment Dispersion**

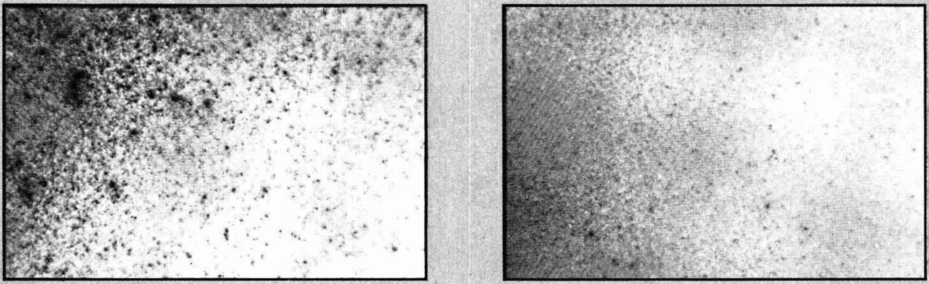
| | Milling Time | $R_D10$ 1850 nm | $R_D10$ 2500 nm | $R_w40$ |
|---|---|---|---|---|
| Phthalocyanine Blue (P3) | 1 | 11.6 | 6.9 | 6.6 |
| | 24 | 7.1 | 2.5 | 6.0 |
| | 48 | 5.0 | 1.8 | 5.4 |
| | 120 | 2.8 | 0.6 | 3.9 |
| Phthalocyanine (P5) | 1 | 8.6 | 5.2 | 5.1 |
| | 24 | 5.0 | 1.7 | 4.8 |
| | 48 | 2.8 | 0.6 | 2.7 |
| | 120 | 0.5 | 0.2 | 0.7 |

**Table 10—Influence of Pigment Dispersion on Color Strength**

| Phthalocyanine Blue | Milling Time | Color Strength L | Color Strength b |
|---|---|---|---|
| P3 | 1 | 70.81 | −21.29 |
| | 24 | 60.47 | −33.75 |
| | 48 | 56.67 | −37.94 |
| | 120 | 54.26 | −41.47 |
| P5 | 1 | 74.51 | −18.63 |
| | 24 | 60.01 | −32.20 |
| | 48 | 58.17 | −34.22 |
| | 120 | 55.84 | −37.06 |

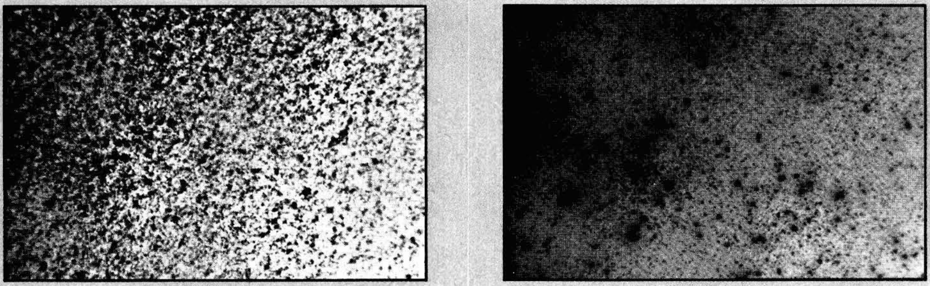


(a) 1 Hour (b) 24 Hours

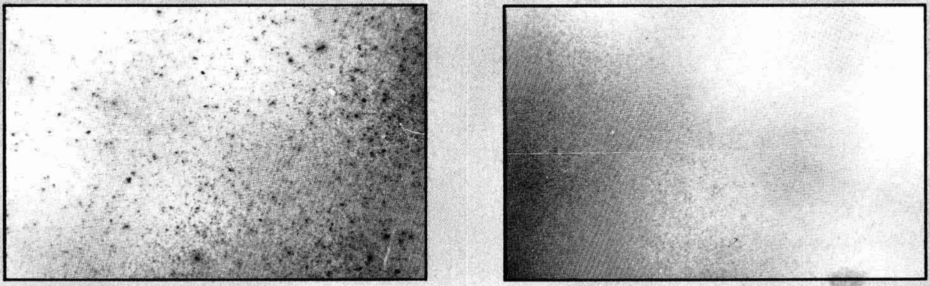


(c) 48 Hours (d) 120 Hours

P3



(a) 1 Hour (b) 24 Hours



(c) 48 Hours (d) 120 Hours

P5

Figure 20—Optical micrographs of phthalocyanine blue dispersions at various milling times

surface modification (in the region of 30%). Thus, the actual chromophore content of the pigment is reduced. Such pigments are well known to be tinctorially weak, despite their superior dispersion characteristics, and until recently had limited industrial applications. However, recent research has enabled flocculation resistant behavior to be imparted at lower levels of surface treatment, allowing a full strength, flocculation resistant, phthalocyanine blue pigment to be available commercially.

## CONCLUSION

An infrared scattering technique has been used to study the degree of dispersion in systems containing various inorganic and organic pigments. The results obtained indicate that this technique is of value in studying the degree of dispersion of a wide range of pigments, although it is particularly applicable to those having a high refractive index. Mean particle size, surface treatment, and PVC, as well as the level of dispersion, were also found to affect the amount of infrared radiation backscattered. Pigments evaluated included titanium dioxide, other white pigments, calcium carbonate extenders, iron oxide pigments, toluidene red, and phthalocyanine blue.

The presence of flocculation was found to have an adverse effect of important optical properties such as opacity, gloss, and color strength. A visual appreciation of the infrared backscatter values was obtained using scanning electron or optical microscopy.

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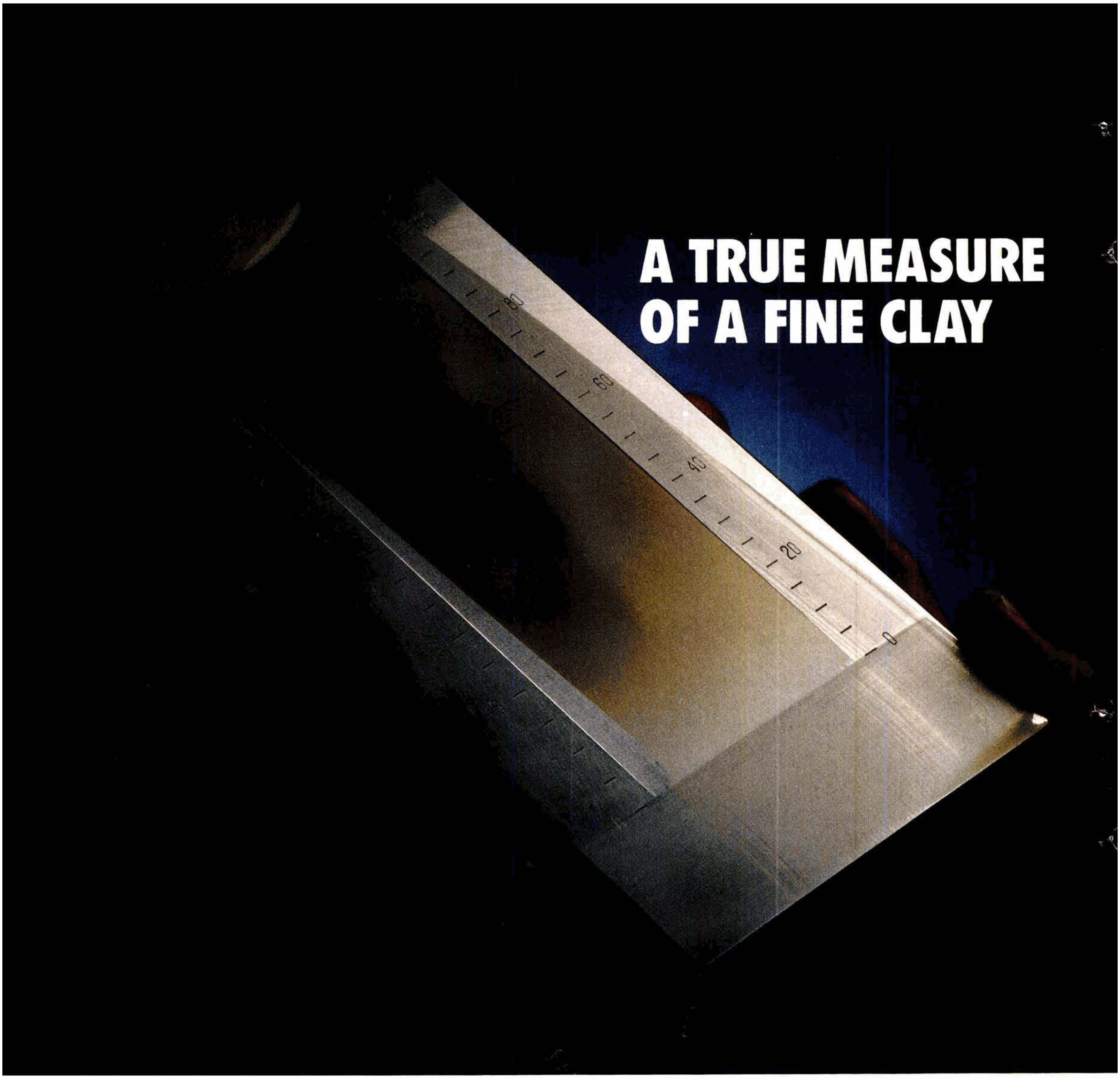
A TRUE MEASURE
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THIS PAPER WAS AWARDED SECOND PRIZE
IN THE 1987 ROON AWARDS COMPETITION

# Polyallyl Glycidyl Ether Resins for Very Fast Curing High Performance Coatings

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Monsanto Chemical Company*

Described herein are the characteristics of a model polyallyl glycidyl ether resin that significantly accelerates free radical curing of very high solids acrylate and methacrylate coating compositions. Suitably formulated compositions will cure at low temperature in air or under practical anaerobic conditions. The resulting coatings are saturated, solvent resistant, and have other properties that depend in large measure on the nature of the co-ingredients. This allows curing and performance versatility not previously possible with acrylate functionality.

An autooxidative mechanism is postulated to account for the ability of polyallyl glycidyl ether resins to overcome oxygen inhibition and to become incorporated in the films that are produced.

## INTRODUCTION

With the exception of radiation curing, free radical chemistry is not used in industrial coating applications requiring a rapid output of finished products. One reason for this is that atmospheric oxygen seriously retards the curing process.[1] Oxygen inhibited coatings cure at a low rate, often remain tacky, and exhibit poor tensile strength and durability.

On the other hand, free radical chemistry is capable of achieving coating performance that is difficult to obtain by other chemistries. Versatility, remarkable speed, and the ability to cure 100% reactive formulations without reaction by-products are advantages routinely attained by curing acrylate coatings by ultraviolet and electron beam radiation.[2]

Ultraviolet curing of acrylate films in air is practical because the high density of initiating radicals generated during irradiation consumes dissolved oxygen faster than oxygen can diffuse back into the film. During irradiation polymerization proceeds in a quasi-anaerobic environment.

Despite the high concentration of radicals generated during irradiation, oxygen does affect cure speed and film properties, especially at the film's surface.[3] Where enhanced speed and coating performance justifies it, inerting or other techniques are used to lower the concentration of oxygen in the curing environment.

Despite the advantages of radiation curing, it is not suitable for many industrial finishing operations. Attempts to derive the benefits of free radical chemistry by thermally curing thin, high solids acrylate coatings similar to those used in radiation curing have produced, at best, undercured films with marginal solvent resistance.[4] This is true even under practical anaerobic conditions (*vide infra*). In practice, the total exclusion of oxygen is difficult in commercial coating operations.

The use of allyl functionality to promote autooxidative curing of drying oils, unsaturated polyesters, and alkyds is well known.[5] Nevertheless, cure speed limitations and concerns about color stability, odor, and durability have precluded the use of conventional allyl systems for finishing applications that require a rapid output of cured coated products.

The work summarized herein describes the properties of a model allyl ether functional resin derived from allyl glycidyl ether. Polyallyl glycidyl ether (PAGE) resins have been found to exhibit a marked accelerating effect on the curing of thin (meth)acrylate films at low temperature in air and under practical anaerobic conditions. Like their radiation cured counterparts, these coatings are saturated, solvent resistant, and exhibit other properties that depend in large measure on the nature of the (meth)acry-

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**Table 1—Selected Properties of Polyallyl Glycidyl Ether-10**

| | |
|---|---|
| Initiating alcohol | *Ethylene gylcol* |
| AGE/hydroxyl[a] | 5 |
| AGE/molecule[a] | 10 |
| Molecular weight[a] | 1200 |
| Allyloxy equivalent weight[a] | 120 |
| Color (Gardner) | <1 |
| Viscosity (cps at 25°C) | 140 |
| Flash point (Cleveland Open Cup, °C) | >150 |

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(a) Average value.

**Table 3—Effect of PAGE-10 Concentration On Selected Film Properties[a]**

| PAGE-10 (%) | 5 | 10 | 15 | 25 | 35 | 45 |
|---|---|---|---|---|---|---|
| MEK rubs (4 hr) | <5 | 300+ | 300+ | 300+ | 300+ | 300+ |
| Knoop hardness (4 hr) | — | 4.3 | 9.5 | 9.0 | 7.5 | 3.8 |
| Knoop hardness (7 days) | — | 14.0 | 15.6 | 15.1 | 12.0 | 8.6 |
| Appearance | — | E[b] | E | E | H | H |

---

(a) RF-2527 (80% in MEK), 100 parts; cobalt octoate, 200 ppm metal. Draw-down on glass panels to 1.5 mil (dft). Cured 15 min at 85°C.

(b) E, excellent; H, hazy.

late ingredients. This permits formulating and coating performance latitude not previously possible.

## EXPERIMENTAL

Unless otherwise noted, all reagents were used as received from the suppliers. The cobalt catalysts, cobalt octoate, and cobalt-potassium complex (Nuocure® CK), were 10% metal solutions from Nuodex Inc. They were usually diluted to 1.0% metal with methyl ethyl ketone (MEK) to aid dispersion in the formulations. The catalyst solution was always added to the mixed formulation last.

Polyallyl glycidyl ether-10 was prepared by a proprietary process. RF-2527 is an experimental acrylated urethane made for internal use. It was prepared by reacting the biuret trimer of 1,6-hexamethylene diisocyanate (Desmodur® N, Mobay Chemical Corp.) with 2.5 equivalents of 2-hydroxypropyl acrylate and 0.5 equivalents of cyclohexanol. The product was used as an 80% reactive solution in MEK.

Dynamic mechanical analysis (DMA) was carried out with an Autovibron® instrument from Imass, Inc. Free films for DMA were obtained by mercury amalgamation of coated 3 × 6 × 0.01 in. tin panels from Q-Panel Company. Strips of film 0.4 × 3.5 cm, were clamped in the jaws of the instrument, placed under sufficient tension to avoid flapping, and exposed to an oscillating tensile deformation at a frequency of 11 cycles per sec. Storage modulus (E′), loss modulus (E″), and loss tangent (tan δ) were determined at 1°C intervals during temperature scans of 1°C/min. The glass transition temperature ($T_g$) was taken to be the temperature at which the tan δ peak had reached a maximum value.

Infrared analysis was carried out on a Nicolet 20DX Fourier transform instrument at a resolution of two wavenumbers. A sodium chloride disk was coated on one side with the coating formulation and placed in a heated cell during data acquisition.

MAS $^{13}C$ NMR analysis was performed on a Jeol FX60QS instrument with a resonance frequency of 15 MHz. Cross polarization time was 4 msec. Hexamethylbenzene was used as an external standard.

QUV® (Q-Panel Company) accelerated weathering was carried out with eight Westinghouse FS40 sunlamps. Illumination time was eight hours at 70°C followed by four hours at 50°C without illumination under moisture condensation conditions.

QCT® (Q-Panel Company) condensing humidity aging was carried out at 50°C.

Gloss was determined with a Byk-Mallinkrodt Model 4060 reflectometer at the 20° and 60° positions.

Impact testing was carried out with a Gardner Laboratory impacter and a Monsanto designed inverted dart impacter using a 0.5 in. dart at 4000 in./min.

Anaerobic curing took place in a specially constructed 20 cm × 10 cm × 4.5 cm clear plastic box with a hinged door. The inerting gas enters the chamber through a fit-

**Table 2—Effect of System Ingredients On Ambient Temperature Aerobic Curing[a]**

| PAGE-10[b] | Peroxide[c] | Catalyst[d] | Tack-Free Time (hr) | MEK Double Rubs | Pencil Hardness |
|---|---|---|---|---|---|
| — | — | — | >24 | — | — |
| — | — | 400 | >24 | — | — |
| — | 2 | — | >24 | — | — |
| — | 2 | 400 | >24 | — | — |
| 20 | — | — | >24 | — | — |
| 20 | 2 | — | >24 | — | — |
| 20 | — | 400 | 4.5 | 300+ | 4H |
| 20 | 2 | 400 | 2.2 | 300+ | 3H |

---

(a) Novacure 3701 (80% in MEK), 100 parts. Ingredients mixed just prior to application by draw-down (1.5 mil, dft) on glass panels. Properties on coatings aged 24 hr at ambient conditions following tack-free state.

(b) Parts.

(c) *Tert*-butyl hydroperoxide, parts.

(d) Nuocure CK, ppm metal.

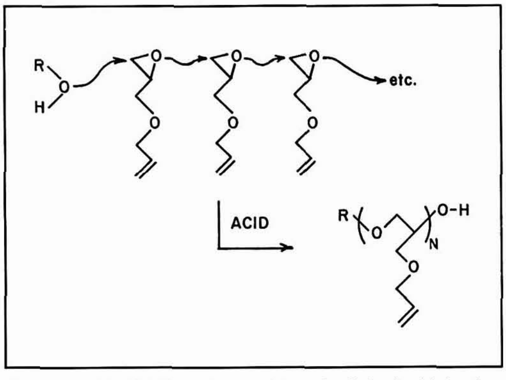

**Figure 1—Synthetic scheme for polyallyl glycidyl ether resins**

**Table 4—Effect of Temperature and Peroxide On Selected Properties[a]**

| | Peroxide | | |
|---|---|---|---|
| Cure Temperature | None | TBHP | BP |
| 24°C | | | |
| TFT (H) | 15 | 3 | 5 |
| KHN (1D/7D) | 2.5/4.2 | 4.3/4.6 | 4.7/5.5 |
| 45°C | | | |
| TFT (M) | >60 | 25 | 40 |
| KHN (1D/7D) | — | 4.2/5.5 | 4.7/5.6 |
| 65°C | | | |
| TFT (M) | 50 | 14 | 18 |
| KHN (1D/7D) | 2.8/4.5 | 4.6/5.4 | 5.2/5.6 |
| 85°C | | | |
| TFT (M) | 35 | 7 | 7 |
| KHN (1D/7D) | 4.5/5.2 | 5.4/5.4 | 5.6/5.4 |
| Pot life at 24°C (H) | 10 | <0.2 | 3 |

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(a) *Key:* TFT, tack-free time; KHN, Knoop hardness number; H, hours; D, days; M, minutes; TBHP, *tert*-butyl hydroperoxide; BP, benzoyl peroxide; TEGDA, tetraethylene glycol diacrylate.

*Formulation:* Uvithane 893/TEGDA (70/30), 80 parts; PAGE-10, 20 parts; Nuocure CK, 500 ppm metal; peroxide, 1.0 part; draw-down on glass to 1.5 mil (dft). Cured coatings exhibit 300+ MEK rubs 24 hr after the tack-free state.

ting at the back of the box and exits through perforations in the door at the front of the box. Nitrogen was piped to the inerting chamber from an in-house nitrogen generator. The oxygen concentration varied from 0.5 to 2 ppm as measured with an in-line DVP oxygen analyzer.

Tack-free times were determined by the finger print method or, in the case of films cured anaerobically, with a glass stylus inserted through a hole in the chamber door. In the latter case, a film was considered to be tack-free when a mark could not be detected after drawing the stylus across the coating.

A Tukon® (Page Wilson Corp.) Model 300 hardness tester was used to determine the Knoop hardness number of a film (ASTM #D1474-85). Pencil hardness was carried out according to ASTM #D3363-74 and crosshatch adhesion according to ASTM #3359-83B. MEK solvent resistance was measured by counting the number of back and forth cycles made by a solvent soaked felt pen. Counting was stopped at the first indication that the pen had rubbed through the surface to the substrate.

## SYSTEM COMPONENTS

### Polyallyl Glycidyl Ether-10 (PAGE-10)

PAGE resins can be prepared by the alcohol initiated, acid catalyzed oligomerization of allyl glycidyl ether (*Figure* 1). The amount of branching is controlled by the functionality of the alcohol selected. The degree of oligomerization is determined by the ratio of allyl glycidyl ether to alcohol. Therefore, the structure and the concentration of the alcohol used in the synthesis provides control over the reactivity and physical properties of the product.

In general, the reactivity of model PAGE coating formulations increases with increasing degree of functionality for a given equivalent weight of both the PAGE resin and the coreactants. But as the molecular weight of a series of PAGE resins increases, formulation viscosity increases and the incremental benefit in cure response decreases. The compatibility of the system ingredients also declines with increasing molecular weight of the PAGE component.

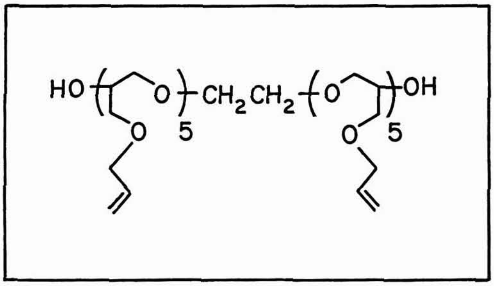

Figure 2—Polyallyl glycidyl ether-10

PAGE-10 (*Figure* 2) is used for the examples used in this work because of its high cure activity, low viscosity, and its good solubility in a wide variety of solvents, reactive oligomers, and other formulation ingredients.

PAGE-10 is a clear, colorless, nearly odorless liquid with indefinite shelf stability when stored in air-tight containers (*Table* 1). Its viscosity is low enough that it can function as a reactive diluent. It is prepared by copolymerizing 10 moles of allyl glycidyl ether with one mole of ethylene glycol.

The critical importance of the PAGE-10 component in an acrylated epoxy formulation cured in air at ambient temperature is illustrated in *Table* 2. The optimum concentration of PAGE-10 in a coating formulation will depend somewhat on the system performance requirements. However, maximum cure speed and film hardness is generally achieved at a concentration of 15-25% of the total reactive ingredients (*Table* 3).

*Table* 2 also illustrates the importance of the cobalt metal ion catalyst. Soluble cobalt (II) salts have proved to be the most reactive catalysts for PAGE-10 coating formulations. They are generally most effective at concentration of about 0.02% of total reactive ingredients.

**Table 5—Effect of System Ingredients On Ambient Temperature Anaerobic Curing[a]**

| PAGE-10 | Peroxide | Catalyst | Tack-Free Time (min) | MEK Double Rubs | Pencil Hardness |
|---|---|---|---|---|---|
| — | — | — | >30 | — | — |
| — | — | 400 | >30 | — | — |
| — | 2 | — | >30 | — | — |
| — | 2 | 400 | 14 | 60 | F |
| 20 | — | — | >30 | — | — |
| 20 | 2 | — | >30 | — | — |
| 20 | — | 400 | >30 | — | — |
| 20 | 2 | 400 | 1.5 | 300+ | 3H |

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(a) *Formulation:* See *Table* 2. Ingredients mixed just prior to application by draw-down (1.5 mil, dft) on glass plates. There was a 15 min flash period before the coated panels were put into an enclosed chamber that was continuously flushed with house nitrogen. Properties were determined on coatings aged 24 hr at ambient conditions following tack-free state.

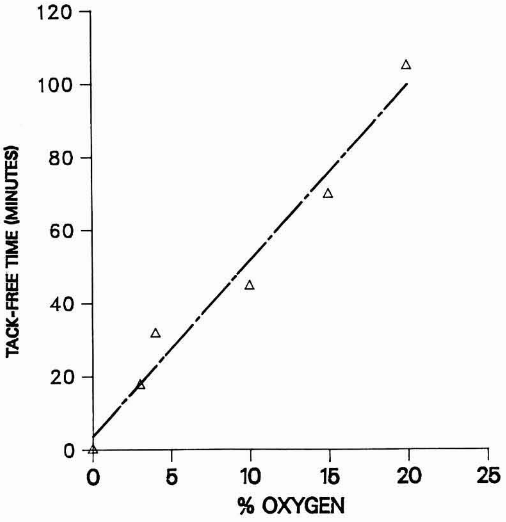

**Figure 3—Tack-free time vs oxygen content at high oxygen levels. Chempol® (Freeman Chemical Corp.) 19-5858, 80 parts; PAGE-10, 20 parts; *tert*-butyl hydroperoxide, 2 parts; Nuocure CK, 400 ppm metal. Draw-down on glass to 1.5 mils (dft) and then placed in an enclosed chamber continuously flushed with a proportioned mixture of air and nitrogen**

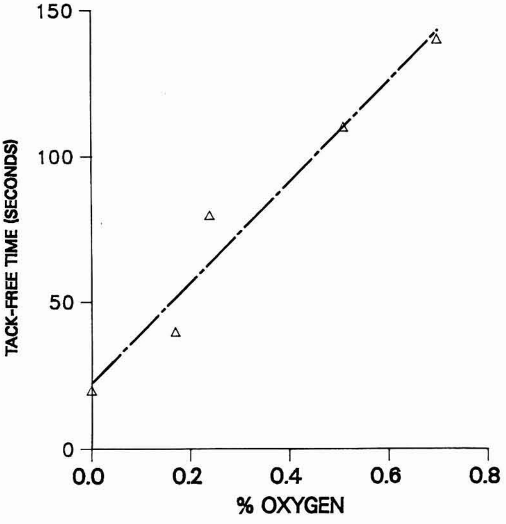

**Figure 4—Tack-free time vs oxygen content at low oxygen levels. Conditions same as that of *Figure* 3**

The influence of cure temperature on the tack-free time of a series of formulations with and without an initiator is illustrated in *Table* 4. Though not critical for cures that take place in air (*Table* 2), conventional peroxide or hydroperoxide initiators reduce the cure time. *Tert*-butyl hydroperoxide is a more reactive initiator than benzoyl peroxide near ambient temperatures. This enhanced reactivity is obtained at the sacrifice of formulation pot life. That all these films attain similar Knoop hardness levels after several days aging at ambient temperature is noteworthy (see the following).

## Effect of Oxygen

PAGE-10 can promote curing under anaerobic conditions (*Table* 5). In the absence of sufficient oxygen to generate initiating radicals, the hydroperoxide initiator added to these formulations becomes an important factor governing cure speed.

**Table 6—Effect of Temperature On Anaerobic Tack-free Time**[a]

| Temperature (°C) | Tack-free Time (sec) |
|---|---|
| 26 | 60 |
| 48 | 30 |
| 68 | *ca* 10 |

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(a) *Formulation:* Chempol 19-5858, 80 parts; PAGE-10, 20 parts; *tert*-butyl hydroperoxide, 2 parts; Nuocure CK, 400 ppm metal; draw-down on glass panels to 1.5 mils (dft) and placed in an enclosed chamber continuously flushed with heated nitrogen.

The results shown in *Figures* 3 and 4 indicate that the tack-free time of a hydroperoxide initiated acrylated urethane formulation is proportional to the amount of oxygen in the curing environment. This means that extraordinary means are not required to eliminate small quantities of oxygen from the inerting media in order to obtain rapid curing.

*Table* 6 illustrates the effect that temperature has on the tack-free time of a formulation cured under anaerobic conditions. Cure speeds approaching those attainable by radiation curing are possible.

## Formulation Latitude

The major component by volume in PAGE-10/acrylate compositions is the acrylate coreactant. It determines to a large extent the processing characteristics of the formulation and the performance of the cured coating. Suitable coreactants include monomers and oligomers with acrylic, methacrylic, acrylamide, and maleate functionality. The present study focuses on the type of acrylate and methacrylate oligomers and reactive diluents used in radiation curing formulations.[6]

*Table* 7 lists a small sample of potentially useful, commercially available, system compatible coreactants arranged according to the contribution they make to the hardness of the coatings produced with PAGE-10. The ability to use mono and multifunctional acrylate derivatives with ether, epoxy, acrylate, ester, and urethane backbones suggests broad performance capability.

When methacrylate functional reactants are used, there is some sacrifice in cure response, especially at lower temperatures. This is illustrated (*Table* 8) for several 100% reactive compositions cured in air and under anaerobic conditions.

**Table 7—Some PAGE-10 System Compatible Coreactants Arranged According to Film Hardness**

| | Supplier |
|---|---|
| **Very Hard** | |
| Pentaerithritol triacrylate | Interez, Sartomer |
| Dipentaerithritol hydroxypentaacrylate | Sartomer |
| Trimethylolpropane triacrylate[a] | Interez, Sartomer |
| Chempol 19-5858 (acrylated urethane) | Radcure Specialties |
| **Intermediate Hardness** | |
| Novacure 3701[a] (acrylated epoxy) | Interez |
| Tetraethylene glycol diacrylate[a] | Alcolac, Sartomer |
| Tripropylene glycol diacrylate[a] | Alcolac, Sartomer |
| N-vinyl-2-pyrrolidinone | GAF |
| Derakane® 411 (unsaturated polyester/styrene) | Dow |
| Hexanediol diacrylate[a] | Interez, Sartomer |
| Kayrad® HX-220 (polyester diacrylate) | Chugai |
| **Extensible** | |
| Uvithane 893 (acrylated urethane) | Morton-Thiokol |
| Chemlink® 9503 (acrylated urethane) | Sartomer |
| Polyethylene glycol diacrylate | Sartomer |

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(a) Available in the methacrylated versions.

However, not all commercially available acrylate and methacrylate functional reactants exhibit a useful cure response in PAGE-10 coating formulations. Sluggish cure behavior, especially at low cure temperatures, can be attributed to high levels of process and shelf-life stabilizers that are often found in the commercial product. The retarding effect of hydroquinone type stabilizers such as methyl hydroquinone (MEHQ) is consistent with their ability to inhibit free radical polymerization.[7] These substances can usually be tolerated at levels up to 200 ppm. The inhibiting effect of larger quantities can often be overcome by adding peroxide or hydroperoxide initiators to the coating formulation.

Amine antioxidants like the hindered amine light stabilizers (HALS)[8] are more efficient inhibitors of free radical polymerization and cannot be used effectively in PAGE-10/acrylate formulations. However, latent hindered amine stabilizers such as Tinuvin® 440 (CIBA-GEIGY)[9] can be added at levels up to three percent without significant cure retardation.

Other possible sources of cure inhibition in PAGE-10 formulations are substances that strongly interact with the cobalt catalyst. For example, benzotriazole[10] UV absorbers, and polyacrylic acid alter the reactivity of the catalyst by forming unreactive complexes with it. Oxalanilide UV absorbers such as Sanduvor® 3206 (Sandoz)[11] have little effect on the cure rate and can be used as substitutes for the benzotriazoles.

**Table 8—Some 100% Reactive Formulations Cured in Air and in Nitrogen[a]**

| | Nitrogen | Air | |
|---|---|---|---|
| Cure temperature | 25°C | 25°C | 65°C |
| Reactive diluent | | | |
| HDDA | | | |
| TFT | 1.5M | 6H | 10M |
| KHN (1D/7D) | 10/13 | 6/11 | 12/13 |
| HDDMA | | | |
| TFT | 9M | 18H | 15M |
| KHN (1D/7D) | 12/16 | 5/10 | 14/13 |
| TEGDA | | | |
| TFT | 1M | 3H | 10M |
| KHN (1D/7D) | 10/12 | 6/11 | 11/12 |
| TEGDMA | | | |
| TFT | 5M | 15H | 15M |
| KHN (1D/7D) | 12/14 | 6/11 | 13/14 |

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(a) Key: TFT, tack-free time; KHN, Knoop hardness number; D, days; H, hours; M, minutes; HDDA, hexanediol diacrylate; HDDMA, hexanediol dimethacrylate; TEGDA, tetraethylene glycol diacrylate; TEGDMA, tetraethylene glycol dimethacrylate.

*Formulation:* Novacure 3701/reactive diluent (3/1), 80 parts; PAGE-10, 20 parts; *tert*-butyl hydroperoxide, 2 parts; Nuocure CK, 400 ppm metal; draw-down to 1.5 mils (dft) on glass panels. All coatings exhibit 300+ MEK rubs after aging 24 hr at ambient temperature following the tack-free state.

## CURED FILM PROPERTIES

The ability to prepare coatings with a range of film properties is characteristic of PAGE-10/acrylate chemistry. One example of this versatility is illustrated in *Table* 9 which lists some of the formulation and cured properties of a flexible, impact resistant coating and a hard, abrasion resistant coating. Each contains an antioxidant and UV absorber. Both films were cured in air at 80°C. The harder coating was produced by replacing a portion of the flexible component (Uvithane 893) used in the softer film with a component (dipentaerythritol hydroxy pentaacrylate) that produces very hard films. The flexibilizing component in the hard film provides enough resiliency to prevent brittleness at 1.5 mils film thickness.

The potential to tailor-make a coating to meet a specific property requirement is also illustrated in *Table* 10 which summarizes some of the properties of coatings intended to impart solvent resistance to Xenoy® plastic. The harder film (B) reduces the ability of the substrate to withstand impacts at low temperature. The coated substrate fails catastrophically in a brittle mode during the impact. This is probably caused by a crack propagation mechanism that begins in the coating. On the other hand, the softer

**Table 9—Soft and Hard Coatings Cured in Air at 80°C[a]**

| Formulation | Parts | |
|---|---|---|
| Uvithane 893 (75% in MEK) | 54 | 12.5 |
| Dipentaerythritol hydroxy pentaacrylate | — | 30 |
| PAGE-10 | 10 | 10 |
| Benzoyl peroxide (10% in MEK) | 5 | 5 |
| Tinuvin 440 (10% in MEK) | 10 | 10 |
| Sanduvor 3206 (10% in MEK) | 10 | 10 |
| BYK® 341[b] | 0.3 | 0.3 |
| Nuocure CK (diluted to 1.0% metal) | 0.7 | 0.7 |
| **Properties** | | |
| Total solids (%) | 60 | 70 |
| Tack-free time (min) | 15 | 20 |
| Pot life (hr) | 4 | 3 |
| DFT (mils) | 1.5 | 1.5 |
| MEK rubs | 300+ | 300+ |
| Knoop hardness | 6 | 20 |
| Pencil hardness (ASTM) | B | 6H |
| Gardner impact (forward/reverse, in.-lbs) | 150/140 | 20/1 |
| Gloss (20°/60°) | 81/89 | 79/90 |

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(a) Coatings were drawn down on Imron® (DuPont) primed Bonderite® 37 (Parker Chemical Co.) panels. Cure time—30 min. Properties determined after seven days aging at ambient conditions.

(b) BYK® is a registered trademark of Byk-Mallinckrodt International GmbH.

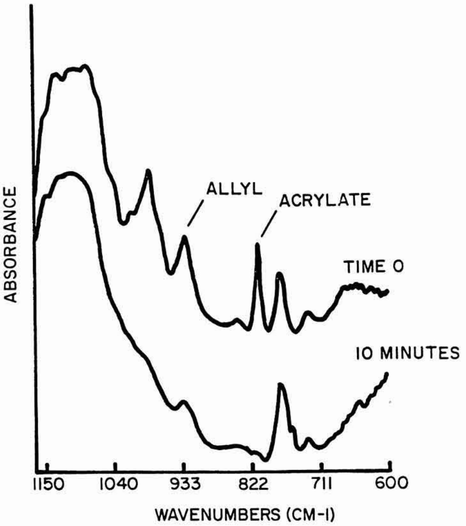

**Figure 5—FTIR spectra before and after baking at 85°C for 10 min. RF-2527 (80% in MEK), 100 parts; PAGE-10, 20 parts; cobalt octoate, 400 ppm. Coated on NaCl disks**

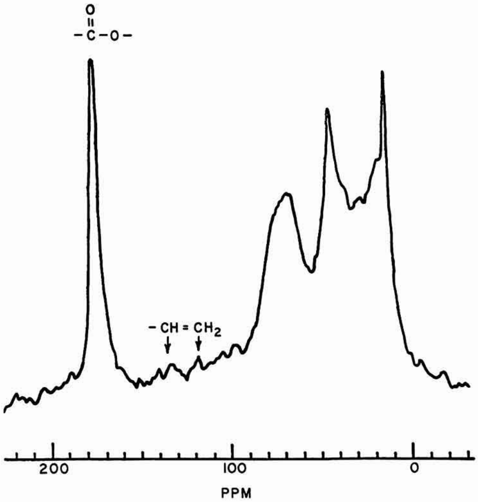

**Figure 7—MAS $^{13}C$ NMR spectrum. Celrad® CMD 1700 (Celanese)/butanediol diacrylate (66/33), 75 parts; PAGE-10, 25 parts; cobalt octoate, 200 ppm metal. Cured 20 min at 85°C., aged 10 days, ambient conditions**

coating (A) actually improves the substrate's impact strength compared to the uncoated control. Ethanol was chosen as the solvent for these formulations because it is less aggressive to the substrate's surface than some other choices.

That PAGE-10/acrylate films may reach very low degrees of unsaturation after curing can be deduced from FTIR, NMR, and DMA and from the stability of film properties during a variety of aging experiments.

*Figure* 5 compares the FTIR spectrum of a film before and after curing for 10 min in air at 85°C. There is a significant reduction in the peak area for both the acrylate carbon-carbon double bond absorption at 812 wavenumbers and the allyl double bond absorption at 925 wavenumbers. However, the rate of disappearance of the two types of unsaturation are not the same. A plot of peak area vs time over a 20 min cure span at 75°C shows that while the acrylate double bonds have disappeared, about 50% of the allyl double bonds remain (*Figure* 6). This probably reflects the greater reactivity of the acrylate functionality, compared to the allyl double bonds, towards addition reactions. MAS $^{13}C$ NMR spectrum of a

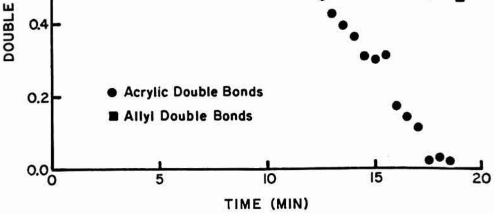

**Figure 6—Disappearance of acrylate (812 $cm^{-1}$) and allyl (925 $cm^{-1}$) unsaturation. Formulation same as that of *Figure* 5**

**Table 10—Effect of Formulation on the Impact Strength Of Coated Xenoy® Plaques[a]**

| | A | B | C[b] |
|---|---|---|---|
| Chempol 19-4830 (80% in ethanol) | 100 | — | — |
| Chempol 19-5858 (80% in ethanol) | — | 100 | — |
| PAGE-10 | 20 | 20 | — |
| *Tert*-butyl hydroperoxide | 2 | 2 | — |
| Nuocure CK (1% metal in MEK) | 4 | 4 | — |
| MEK rubs | 300+ | 300+ | — |
| Knoop hardness | 4 | 14 | — |
| IDI impact at −29°C (in.-lbs, forward/reverse)[c] | | | |
| Energy (maximum) | 452/496 | 89/80 | 418 |
| Energy (failure) | 583/581 | 90/85 | 513 |
| Failure mode | Ductile | Brittle | Ductile |

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(a) Draw-down (wire wound rod) to 1.5 mil (dft) on 5″ × 5″ × 0.10″ Xenoy (General Electric Co.). Plaques from Standard Plaque, Inc. (#CX1101A 5017 W031). Flash time, 15 min; cured 30 min at 65°C. Properties determined 14 days after curing.

(b) Uncoated plaques.

(c) Average of three impacts.

model cured film (*Figure* 7) indicates that the allyl unsaturation (117 and 136 ppm) has all but disappeared within 10 days at ambient conditions after the baking cycle. The disappearance of allyl unsaturation is discussed below.

That curing may not be completed in the baking cycle is reflected by the change in film hardness after baking. For some formulations, Knoop hardness continues to increase for several days at ambient conditions (*Tables* 3, 4 and 8) before it reaches a value that is fairly stable even during prolonged heating in air (*Table* 11). In other cases, ultimate hardness is reached during, or shortly after baking (*Table* 11, Chempol 19-4858; *Table* 12; *Table* 8, 65°C data). Cracking, crazing, or delamination are not observed in any of the aged films.

DMA with an Autovibron instrument reveals important information about a film's $T_g$ and its crosslink density.[12] *Table* 13 shows that the storage modulus (E′) at 140°C (a measure of crosslink density) and the $T_g$ are similar for PAGE-10/acrylated urethane films aged for two weeks at ambient conditions after being cured in different ways. This suggests that the films have reached a similar degree of curing regardless of the cure method. At temperatures above the $T_g$, the storage modulus response (E′) is relatively flat for these films (*Figure* 8). This means that further crosslinking is not taking place during the scan to high temperature. A flat E′ response at temperatures above the film's $T_g$ is in marked contrast to acrylic/melamine, epoxy, and some other coatings where the storage modulus rises as the scanning temperature increases above the $T_g$.

Though unstabilized with antioxidants or UV stabilizers, the clear films described in *Table* 14 exhibit very high levels of gloss retention after 5000 hr of exposure to condensing humidity and QUV accelerated weathering. Similar experience was obtained by the films described in *Table* 13. In all cases, failures during QUV testing shortly after the recorded data points were due to delamination of the topcoat from the primed metal surface. Loss of intercoat adhesion appeared to be caused by radiation induced degradation of the primer at the primer-topcoat

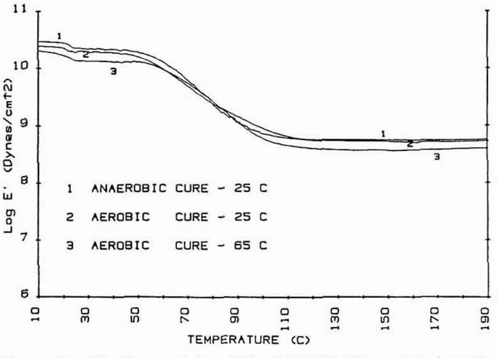


**Figure 8—Elastic modulus (E′) of PAGE-10/acrylated urethane films cured in different ways. Chempol 19-5858, 80 parts; PAGE-10, 20 parts; *tert*-butyl hydroperoxide, 2 parts; Nuocure CK, 200 ppm metal**

**Table 11—Effect of Aging in Air on the Knoop Hardness Of Two PAGE-10/Acrylate Films[a]**

| Temperature | Time | Chempol 19-5858 | Uvithane 893 |
|---|---|---|---|
| Ambient | 30 min | 21.1 | 5.6 |
| Ambient | 6 mo | 19.2 | 7.8 |
| 45°C | 6 mo | 22.5 | 8.7 |

(a) Resin (80% in MEK), 100 parts; PAGE-10, 20 parts; *tert*-butyl hydroperoxide, 1 part; Nuocure CK, 400 ppm metal; draw-down on glass to 1.5 mils (dft); cured at 65°C in air for 30 min.

**Table 12—Effect of PAGE-10 Concentration on the Knoop Hardness of Films Aged for Six Months in Air[a]**

| PAGE-10 (%) | 11 | 20 | 33 |
|---|---|---|---|
| Temperature | | | |
| Ambient | 19.5 | 19.2 | 18.8 |
| 65°C | 21.1 | 20.7 | 19.9 |

(a) Formulation and conditions; see *Table* 11 (Chempol 19-5858).

**Table 13—Effect of Cure Conditions on Selected Properties[a]**

| Cure Conditions | Air | | Nitrogen |
|---|---|---|---|
| Temperature (°C) | 27 | 65 | 27 |
| Tack-free time | 3H | 15M | 0.5M |
| MEK double rubs | 300+ | 300+ | 300+ |
| Knoop hardness | 15 | 15 | 14 |
| Cross-hatch adhesion (ASTM) | Pass | Pass | Pass |
| Glass transition temperature (°C) | 88 | 96 | 85 |
| $10^{-8} \times E'$ (dynes/cm$^2$) | 4.9 | 3.5 | 5.4 |
| % Gloss retention after 2600 hr (20°/60°) | | | |
| Condensing humidity | 98/99 | 91/99 | 97/99 |
| QUV | 67/85 | 78/93 | 65/84 |

(a) *Formulation:* Chempol 19-5858 (89% in MEK), 4.5 parts; PAGE-10, 1 part; *tert*-butyl hydroperoxide, 2 parts; Nuocure CK, 440 ppm metal; BYK 341, 0.2 parts. Draw-down to 1.5 mil (dft) over a pigmented epoxy primer. DMA analysis 14 days after curing; other film testing after 24 hr.

**Table 14—Selected Properties of a PAGE-10/Acrylate Functional Urethane Coating[a]**

| | |
|---|---|
| MEK rubs | 300+ |
| Knoop hardness | 15 |
| Pencil hardness | 3H |
| Gardner impact (in.-lbs, forward/reverse) | 40/2 |
| Gloss (20°/60°) | 82/91 |
| % Gloss retention after 5000 hr (20°/60°) | |
| Condensing humidity | 66/86 |
| QUV | 30/70 |

(a) *Formulation and cure conditions:* see *Table* 3 (25% PAGE-10). Draw-down to 1.5 mils (dft) on a pigmented epoxy primer. Tests performed seven days after curing for 15 min at 85°C.

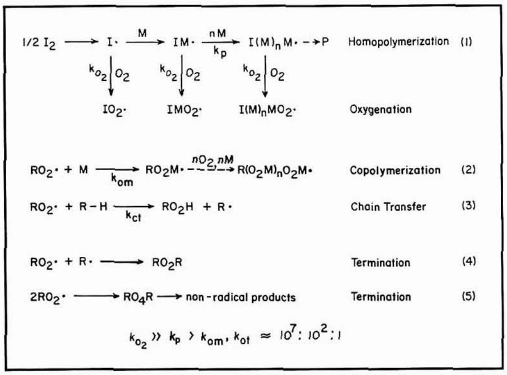


**Figure 9—Oxygen inhibition.** $I_2$, initiator; M, monomer; P, polymer, $RO_2\cdot$ is $IO_2\cdot$, $IMO_2\cdot$, or $I(M)_nO_2$; k, rate constant

$$\mathrm{ROOH} + \mathrm{Co}^{+2} \longrightarrow \mathrm{RO}\cdot + \mathrm{Co}^{+3} + \mathrm{OH}^-$$

$$\mathrm{ROOH} + \mathrm{Co}^{+3} \longrightarrow \mathrm{ROO}\cdot + \mathrm{Co}^{+2} + \mathrm{H}^+$$

Summary

$$2\mathrm{ROOH} \xrightarrow{[\mathrm{Co}]} \mathrm{RO}\cdot + \mathrm{ROO}\cdot + \mathrm{H_2O}$$

**Figure 10—Cobalt catalyzed decomposition of hydroperoxides**

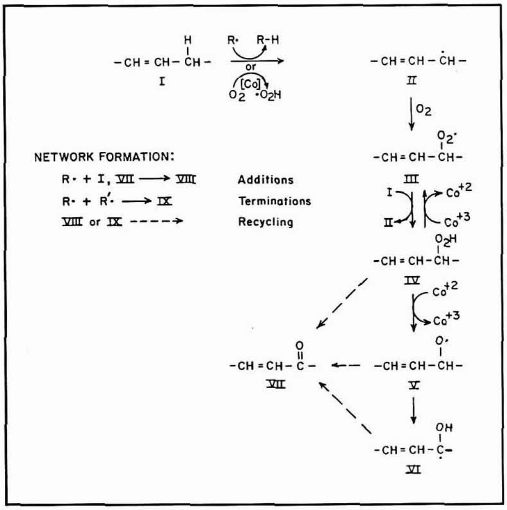


**Figure 11—Autooxidative Curing.** R· is II, III, V, VI; R'· is any carbon or oxygen centered free radical

interface. This would be expected if radiation passed through the clear topcoat and interacted with a more radiation sensitive primer layer.

## DISCUSSION

In order to use free radical curing to advantage for preparing thin films, it is necessary to overcome oxygen inhibition. The main steps involved in the oxygen inhibition process are summarized in *Figure* 9. The salient point is that the rate of bonding to oxygen by initiating or propagating free radicals ($k_{o2}$) is several orders of magnitude greater than homopolymerization ($k_p$) of the monomer (Step 1).[13] The resulting oxygenated intermediates, which react with monomer at a comparatively low rate ($k_{om}$), determine the rate of curing and affect the properties of the resultant film. When oxygen inhibition occurs, peroxy radical intermediates add to unsaturated bonds (Step 2) or abstract hydrogen atoms (Step 3) in chain transfer steps to produce peroxy copolymers and hydroperoxide functionality. As the concentration of oxygenated intermediates increases and the overall rate of polymerization slows, chain transfer and termination reactions become more important (Steps 3-5). This results in lower molecular weight fragments and poor film quality.

Coating derived from drying oils, polydienes, and some other allyl unsaturated systems cure by an autooxidative free radical process.[14] Unlike acrylate formulations cured by radiation or thermal means, inhibition of polymerization by oxygen is not a concern in coatings that cure by autooxidation because the long cure times are acceptable for the applications where they are used. Indeed oxygen is required for propagation of the curing process. The oxygen-carbon bonds that are generated this way form the main links in the crosslinked network.

Autooxidative curing systems often contain cobalt and other transition metal "driers" to catalyze the curing process. These catalysts are usually added as system compatible carboxylate salts at levels up to 0.1% on resin solids. The mechanism of cobalt ion catalysis is multifold and complex.[15] Cobalt ions increase the rate of oxygen up-take by the system. They activate hydrogen atoms towards abstraction and carbon-carbon double bonds towards addition. They also accelerate the decomposition of hydroperoxide groups (*Figure* 10).

Autooxidative curing begins when an allylic hydrogen of the drying resin is abstracted by adventitious radicals (*Figure* 11). The radical center generated in this step (II) quickly reacts with oxygen to give a peroxy radical (III) that can add to double bonds, couple with other radicals, or abstract hydrogen atoms.[16] The latter reaction results in the formation of hydroperoxide functionality (IV) and subsequently, in the generation of new free radicals that continue the cycle. Competing with the generation of hydroperoxide intermediates are steps leading to the formation of α,β-unsaturated carbonyl groups (VII).[17]

Since the allylic carbon-hydrogen bonds are among the best hydrogen atom donor centers in coating formulations, hydrogen abstraction usually results in the regeneration of another allylic radical (II).[18] The allylic oxygenation-hydrogen abstraction cycle is a chain sequence that feeds a pool of radicals and insures oligomerization and crosslinked network formation.

Molecular weight buildup is usually a slow process because there is low probability that two radicals, or a radical and a vinyl group, randomly distributed in time and space will encounter each other (VIII and IX). Nevertheless, successive oxidation-abstraction-coupling steps result in high molecular weight, highly crosslinked films.

That PAGE-10 can accelerate free radical curing of acrylate films in air is surprising at first because allyl ether monomers do not undergo homopolymerization easily and attempts to copolymerize allyl ethers with acrylates generally give unsatisfactory results. Oligomerization is self-limited by the high chain transfer activity of allylic hydrogen.[19]

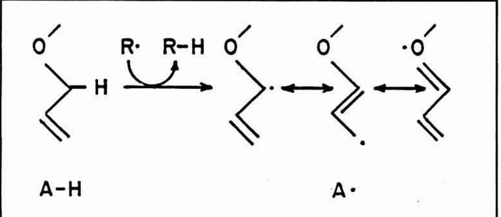
The allylic carbon-hydrogen bond of allyl ethers is estimated to be about 79-84 kcal/mole (*Table* 15). In comparison, the bond energy for covalent bonds to hydrogen in ethers, alcohols, esters, and other unsaturated molecules likely to be present in paint formulations is 85-105 kcal/mole.[20] This makes an allyl ether group one of the better hydrogen atom donors in a coating formulation.

When the allylic hydrogen is abstracted, the allyl radical that is produced is stabilized by delocalization involving the ether oxygen and the vinyl group (*Figure* 12). This stabilization reduces the rate of addition of allyl ether radicals to double bonds (Step 6). In the absence of oxygen chain transfer to the allyl ether group from an initiating fragment, or from the growing oligomeric radical, competes effectively with homopolymerization of the acrylate monomer (Step 7). This reduces the monomer to monomer chain length. If the allyl ether component has low allyl functionality, its involvement in this process results in lower cure rates and reduced polymer molecular weight.

In contrast, PAGE-10 has sufficient allyl functionality to take part in multiple chain transfer events and a significant proportion of the allylic radicals generated this way become involved in chain extension and network formation with acrylate functionality despite low monomer to monomer chain length.

When curing takes place in air, PAGE-10 readily takes part in autooxidation chain steps (*Figure* 13). Autoacceleration occurs as the oxygen dissolved in the film is consumed. Hydroperoxide groups generated in the presence of cobalt ions provide an ample supply of multifunctional initiating radicals to replace those lost in termination steps. These radicals participate in crosslinking reactions when they terminate or add to acrylate or allyl unsaturation. In addition, the quasi-anaerobic environment that is created should begin to favor the more rapid homopolymerization reactions, like those in Step 1 (*Figure* 9). This would lead to further acceleration and longer monomer-monomer chain lengths.

The scheme outlined in *Figure* 13 becomes more complicated at higher conversions due to the accumulation of oxidation and termination by-products. For example, competing with oxidation and crosslinking reactions previously mentioned are metal catalyzed oxidations that produce acrylate and other carbonyl functionalities (*Figure* 14).[21] Copolymerization of acrylate groups formed *in*



$$A\cdot + nM \xrightarrow{\text{slow}} A\text{–}(M)_n\cdot \qquad (6)$$

$$A\text{–}H + I(M)_n\cdot \longrightarrow I(M)_n\text{–}H + A\cdot \qquad (7)$$

Figure 12—Stabilization of an allyloxy radical generated during chain transfer. R·, any radical from *Figure* 9; M, monomer; AH, allyloxy group; I(M)$_n^{\cdot}$, propagating radical from homo polymerization

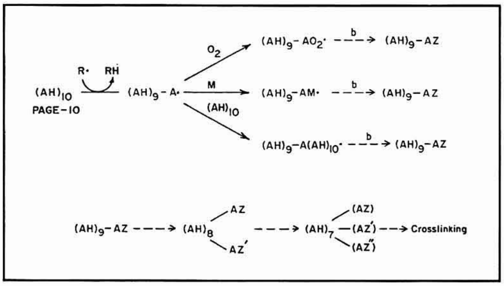


Figure 13—Copolymerization and crosslinking. (AH)$_{10}$, PAGE-10; (AH)$_9$A·, PAGE-10 radical after chain transfer; M, monomer; Z is O$_2$, M or (AH)$_{10}$ adducts and subsequent reaction products thereof; (b) O$_2$, M or (AH)$_{10}$

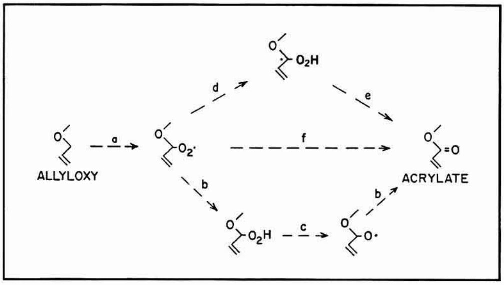
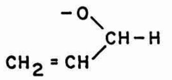


Figure 14—*In situ* acrylate formation from allyloxy: (a) oxidation, (b) hydrogen abstraction, (c) peroxy oxygen cleavage, (d) rearrangement, (e) β-cleavage, (f) termination

**Table 15—Bond Energies (kcal/mole) of Selected Covalent Bonds to Hydrogen**

| | | | |
|---|---|---|---|
| $CH_3CH_2$-H | 98 | $HOCH_2$-H | 94 |
| Ph-H | 103 | HO-H | 119 |
| $CH_2$=CH-H | 105 | $HO_2$-H | 90 |
| $CH_2$=$CHCH_2$-H | 89 | $CH_3O$-H | 105 |
| $CH_3OCH_2$-H | 93 | $CH_3CO_2$-H | 112 |
| $CH_3COCH_2$-H | 92 | PhO-H | 88 |
| $CH_3CO$-H | 86 | PhNH-H | 80 |



79-84 (est.)

*situ* and both inter- and intramolecular additions to the allyl double bond are some of the ways that may account for the disappearance of allyl double bonds during and after the cure cycle.[22]

## SUMMARY

Polyallyl glycidyl ether resins significantly accelerate the curing of thin acrylate and methacrylate films at low temperature in air and under practical anaerobic conditions. Two component, 100% reactive compositions are readily achievable. A spectrum of coating performance capability is attainable because of the broad formulation latitude that is possible. The cured coatings are saturated, solvent resistant, and durable. A mechanistic scheme based on the ability of the model resin to take part in oxygen consuming, chain transfer steps leading to multiple crosslinking reactions with the (meth)acrylate component is postulated to explain its efficacy.

## ACKNOWLEDGMENT

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# Atmospheric Oxidation of Cellulose Nitrate Lacquers

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Cellulose nitrate film and solution were readily autooxidized in air to produce hydroperoxide. Gradual denitration and decrease in molecular weight of pure cellulose nitrate film and solution were observed during autooxidation. Ferric and ferrous ions, phenol, and lignin had no adverse effect on the nitrogen content of cellulose nitrate film. However, with the exception of ferrous ions, the other reagents did promote denitration of cellulose nitrate in solution. The presence of ferric ions, phenol, and lignin also promoted the rate of oxidation. Due to a high acidity from degradation products during autooxidation, cellulose nitrate solution suffered more denitration and decrease in molecular weight than the cellulose nitrate films.

## INTRODUCTION

Cellulose nitrate, an inorganic ester of cellulose mixed with camphor, was the first man-made plastic.[1] It was developed originally as an explosive during the last century, but eventually found use in the manufacture of photographic film, ink, lacquers, adhesives, and some molded objects. Since the advent of polymer science, cellulose nitrate has been supplanted largely by synthetic polymers, but still is used extensively in the coatings industry because of its unique properties such as durability, toughness, solubility, and fast solvent release under normal drying conditions. In spite of these advantages, the even wider application of lacquers has been restricted by its low stability when exposed to heat and light.

The exposure of cellulose nitrate to high temperature and to sunlight or ultraviolet light results in a number of physical and chemical changes.[2,3] It has been perceived by many technologists and practitioners in the coating and wood furniture industries that cellulose nitrate discolors and decomposes at room temperature. Notwithstanding, no documentation is available on the practical stability of cellulose nitrate films and its solutions. In view of this, oxidizability or autooxidizability of cellulose nitrate, either in the solid (film) form or in the liquid form, at 25°C was studied. Autooxidation can be defined as a radical-chain reaction between molecular oxygen and organic compounds at low or moderate temperatures. This reaction almost invariably results in the formation of hydroperoxides. The following kinetic scheme illustrates the various stages of free radical chain reactions encountered in an organic polymer such as cellulose nitrate (RH):

$$
\begin{array}{ll}
\mathrm{RH} + \mathrm{O_2} \longrightarrow \mathrm{R\cdot} + \mathrm{H} + \mathrm{O_2} & \text{Initiation} \\
\mathrm{RH} \longrightarrow \mathrm{R\cdot} + \mathrm{H} & \\
\mathrm{RONO_2} \longrightarrow \mathrm{RO\cdot} + \mathrm{NO_2} & \\
\mathrm{R\cdot} + \mathrm{O_2} \longrightarrow \mathrm{ROO\cdot} & \text{Propagation} \\
\left.\begin{array}{l}
\mathrm{ROO\cdot} + \mathrm{RH} \longrightarrow \mathrm{ROOH} + \mathrm{R\cdot} \\
\mathrm{ROOH} \longrightarrow \mathrm{RO\cdot} + \mathrm{\cdot OH} \\
\mathrm{RO\cdot} + \mathrm{RH} \longrightarrow \mathrm{ROH} + \mathrm{R\cdot} \\
\mathrm{\cdot OH} + \mathrm{RH} \longrightarrow \mathrm{H_2O} + \mathrm{R\cdot} \\
\mathrm{ROO\cdot} + \mathrm{RH} \longrightarrow \mathrm{ROOH} + \mathrm{R\cdot} \\
\mathrm{NO_2} + \mathrm{RH} \longrightarrow \mathrm{HNO_2} + \mathrm{R\cdot}
\end{array}\right\} & \text{Chain reaction}
\end{array}
$$

The oxidation of polymers with an elemental oxygen is an autocatalytic process (autooxidation) in which the primary product of the reactions is a hydroperoxide. It is a relatively unstable compound that is readily decomposed by heat, light, and certain metal ions to generate free radicals to initiate free radical chain reactions.[4]

During oxidation, the effect of metal ions (i.e., ferrous and ferric ions), lignin, and phenol, which are active inherent elements in wood, on the stability of cellulose nitrate was examined using nitrogen content and molecular weight as criteria.

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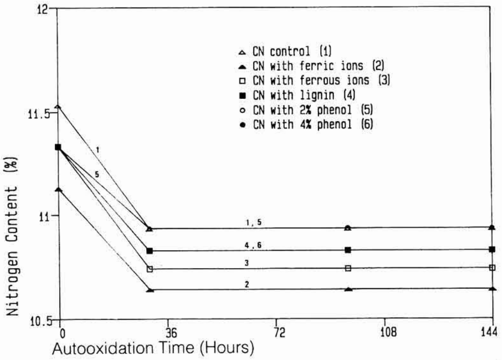

**Figure 1—Effect of autooxidation on nitrogen content of cellulose nitrate films**

## EXPERIMENTAL

### Materials

Commercially available cellulose nitrate (coating grade, RS 1/2) obtained from Hercules Incorporated was used for this work. Cellulose nitrate films were made by dissolving the flakes in acetone and casting the solution on a glass plate. After careful evaporation of the acetone, the clear films were peeled carefully off the plate. The reaction solution was prepared by dissolving cellulose nitrate in ethyl acetate. Reagent grade ferric chloride, ferrous chloride, and phenols were used as received without further purification. Milled wood lignin was prepared by milling wood chips of red oak in the laboratory using a modified Bjorkman procedure.[5]

### Method

Evaluation of the change in molecular weight during oxidation was made from intrinsic viscosity values ($\eta$) obtained using a capillary viscometer. The measurements of the cellulose nitrate ethyl acetate solution were carried out in a viscosity jar thermostated at 25.00 ± 0.05°C and converted to molecular weight by using the Mark-Houwink equation:

$$[\eta] = KM^a$$

in which $K = 2.5 \times 10^5$ and $a = 1.00$.

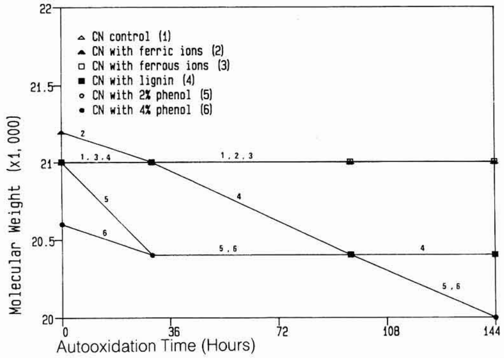

**Figure 2—Effect of autooxidation on molecular weight of cellulose nitrate films**

Denitration was deduced from the changed cellulose nitrate nitrogen content, which was determined by micro-Kjeldahl analysis. The precision of the nitrogen analysis is very good. The standard deviation is usually less than 0.1%.

The hydroperoxide content in cellulose nitrate was analyzed using a spectrophotometric technique by dissolving cellulose nitrate in acetone or ethyl acetate and treating it with sodium iodide. The iodine, liberated by the reaction of sodium iodide with hydroperoxide, was measured quantitatively by means of an ultraviolet-visible spectrophotometer (Perkin-Elmer Lambda 3A) at 360 nm for the amount of peroxides generated.[6]

## RESULTS AND DISCUSSION

### Cellulose Nitrate Films

PEROXIDE FORMATION: When cellulose nitrate films were exposed to air, a long time was required to accumulate sufficient hydroperoxide detectable by an ultraviolet absorption spectrophotometer at 360 nm. However, cellulose nitrate films with ferric ions exposed to air within 48 hr produced enough hydroperoxide to be easily detected. This observation suggests that ferric ion-treated cellulose nitrate oxidizes more easily than cellulose nitrate.

DENITRATION: When pure cellulose nitrate films, with or without ferric and ferrous ions, phenol, and lignin, were exposed to air at room temperature in the dark, denitration reaction took place slowly. The results are summarized in *Figure* 1. The nitrogen content of untreated cellulose nitrate films decreased from 11.53% to 10.93%, a change of 5% relative to the original nitrogen content, after 144 hr of air exposure. The chemically treated films exhibited the same nitrogen loss, i.e., 4-5% relative to the original content. This fact suggests that cellulose nitrate itself is susceptible to oxidation, and ferric and ferrous ions, phenol, and lignin exert no additional effect on nitrogen loss.

MOLECULAR WEIGHT: Although cellulose nitrate films lost about 5% relative to the original nitrogen content during 144 hr of oxidation, and the chemicals used did not exert any adverse effect on nitrogen loss, the molecular weight loss was observed for some samples when exposed to air at ambient temperature (see *Figure* 2).

When the pure cellulose nitrate films were exposed to air at room temperature for 144 hr, no change in molecular weight was noticed. Likewise, no change was noticed with films containing ferrous ions. However, with ferric-ion films, there is a 1% reduction in the first 30 hr of exposure, but no further reduction in molecular weight thereafter. The molecular weight of cellulose nitrate containing lignin, 1% based on film weight, remained stable during the initial 30 hr of exposure, but to 97% of the original value during the next 66 hr of exposure; the molecular weight remained constant to the end of the test. The presence of phenols (2 and 4%) also led to a reduction in molecular weight during the same exposure. Essentially, films treated with 2% phenol lost 3% molecular weight during the initial 30 hr of exposure and remained constant during the additional 66 hr of exposure; however, they lost an additional 2% molecular weight during the next 48 hr of exposure. Films with 4% phenol lost 1% molecular weight during the initial 30 hr of exposure, and remained constant during the additional 66 hr of exposure. They also lost an additional 4% molecular weight during the next 48 hr of exposure.

Based on these experimental data, it is evident that pure cellulose nitrate films denitrated slowly during 144 hr of oxidation at ambient conditions. The molecular weight was intact during oxidation. Ferric ions, ferrous ions, lignin, and phenol did not exert any adverse effect on nitrogen content. Nevertheless, with the exception of ferrous ions, all other chemicals led to loss of molecular weight during identical oxidation exposure.

Although phenol and lignin are known to have been acceptable antioxidants for many polymers, this study revealed that they are not suitable antioxidants for cellulose nitrate films. This fact also implies that, unfortunately, cellulose nitrate coating for furniture application will suffer such deterioration from oxidation because of the presence of lignin and phenolic moieties in wood.

## Cellulose Nitrate Solution

DENITRATION: In addition to oxidation of cellulose nitrate films at wood surfaces, it should be noted that cellulose nitrate in solution may degrade during storage; that would lead to loss of nitrogen (see *Figure* 3) and reduction of molecular weight (see *Figure* 4).

When the pure cellulose nitrate, dissolved in ethyl acetate, was stored at room temperature without light for 144 hr, a reduction of 3% relative in nitrogen content was observed. In the presence of ferrous ions, the reduction was only 1%. The presence of lignin led to 1, 2, and 3% reduction of nitrogen content after storing the solution for 30, 96, and 144 hr, respectively. The presence of ferric ions also led to 3, 3, and 5% reductions for the same periods.

The presence of phenol appeared to facilitate the denitration reaction. For cellulose nitrate films with 2% concentration, the nitrogen content reductions after 30, 96, and 144 hr of storage were 4, 4, and 5%; and with 4% concentration, were 5, 11, and 15%, respectively.

It is noteworthy that the nitric ester, i.e., nitrate group in cellulose nitrate, tends to hydrolyze in solution to produce nitric and nitrous acids. In effect, the acidity of cellulose nitrate solutions increased as a function of aging time. The presence of ferric ions, phenol, and lignin further increased the acidity of the cellulose nitrate solution. For example, cellulose nitrate solution with ferric ions exhibited lower pH than unmodified cellulose nitrate solution during 48 hr of aging. Unlike their presence in cellulose nitrate films, ferric ions, lignin, and phenol (particularly at higher concentration) in cellulose nitrate solutions appeared to promote hydrolysis of nitrate group, which in turn converted into nitric and nitrous acids that have significant influence on the stability of cellulose parent molecules (i.e., hydrolytic depolymerization).

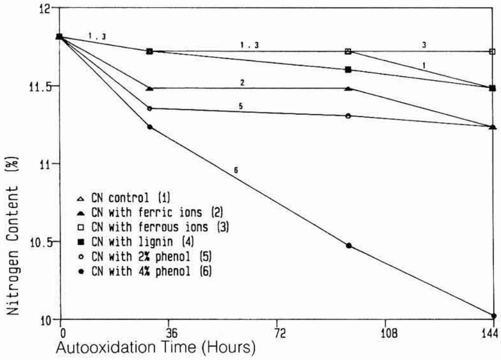

**Figure 3—Effect of autooxidation on nitrogen content of nitrate solutions**

## Change in Molecular Weight

In addition to denitration, the cellulose nitrate solution also suffered reductions in molecular weight of 5 and 10% during 30 and 96 hr of storage, respectively, but remained constant thereafter. Cellulose nitrate solution containing ferric chloride lost 6% of its molecular weight during the initial 30 hr and remained constant thereafter, while the ferrous solution lost only 2% of its molecular weight during 144 hr. The solution with lignin lost 2, 5, and 7%, respectively, of its molecular weight at 30, 96, and 144 hr of storage. Although cellulose nitrate solution with 2% phenol lost only 2% of its molecular weight during the initial 30 hr of storage, it lost 8 and 12% of its molecular weight during 96 and 144 hr, respectively. Likewise, the solution with 4% phenol lost 4, 5, and 14%, respectively, during the same period of storage.

Comparison of the changes in molecular weight between cellulose nitrate films and cellulose nitrate solu-

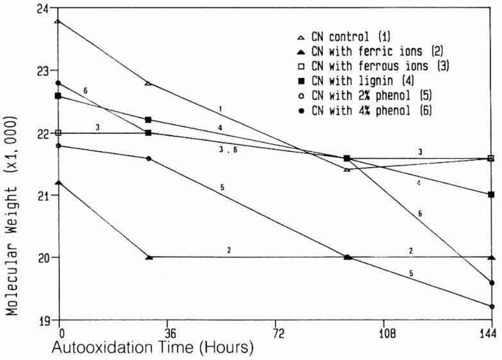

**Figure 4—Effect of autooxidation on molecular weight of cellulose nitrate solutions**

tions indicates that the latter suffers more molecular weight reduction. This can be attributed to the high acidity of the cellulose nitrate solution which would contain nitric and nitrous acid degradation products. There is little doubt that the acidic nature of the solution hydrolyzed cellulose polymer during aging led to further reduction of molecular weight. It is probable that the oxides of nitrogen formed in films evolved rapidly before they could be trapped in the films to generate any nitric and nitrous acids. Consequently, cellulose nitrate films suffered less reduction of molecular weight.

## SUMMARY

Cellulose nitrate films and solutions are oxidizable in air to produce hydroperoxide, and to reduce nitrogen content and molecular weight. Ferric and ferrous ions, phenol, and lignin do not adversely affect the nitrogen content of cellulose nitrate films during oxidation. However, with the exception of ferrous ions, ferric ions, phenol, and lignin promote denitration of cellulose nitrate in solution. Reduction of molecular weight of cellulose nitrate film and solution was also recognized. The rate of reduction was accelerated in the presence of ferric ions, phenol, and lignin. Due to the acidity of the degradation products, cellulose nitrate solution suffered more denitration and degradation, i.e., reduction of molecular weight, than the cellulose nitrate film. Since ferric ions, phenol, and lignin are inherent elements in wood, they may have negative effect on the properties and performance of cellulose nitrate lacquers applied to the wood surfaces.

## ACKNOWLEDGMENTS

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# Electric Discharges During Electrodeposition of Organic Coatings

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Electric discharges (sparks) are shown to occur during the cathodic electrodeposition of organic coatings. The occurrence of electric discharges is demonstrated in three ways: by direct visual observation using a special transparent resin solution; by detection of spikes in the electric current over short (millisecond) intervals; and by measurement of acoustic emission. The acoustic technique is especially easy to use and may be useful on a production line to monitor the electrodeposition process. On galvanneal zinc-iron alloy coated steel, discharges occur at relatively low voltage (270 volts) and cause undesirable crater-like defects in the coating. On nongalvanized steel, discharges are observed visually at higher voltage (c. 330 volts), do not necessarily cause visible defects, and are accompanied by acoustic emission but without current spikes. Rather, a continuous, broad peak is observed in the current-time measurement, interpreted to mean that a large number of sparks occur simultaneously.

Discharges are fewer in number but more intense on galvanneal than on nongalvanized steel. The results suggest that the long-standing problem of "rupture," which occurs during deposition at high voltage and is usually ascribed merely to gas evolution from the electrolysis of water, is actually caused by electric discharge.

## INTRODUCTION

Cathodic electrodeposition is used to apply the first layer of organic coating to most automobiles and a wide variety of other metal products. In general, electrodeposition is a trouble-free, automated process, but certain problems can develop when high voltage is used or when the anode/cathode distance is short. Under such severe conditions, ''rupture'' of the coating can occur. This is a general term for breakdown of the coating, and the result is a rough or otherwise undesirable appearance. Rupture can occur with both anodic and cathodic electrodeposition, on a variety of substrates, and is commonly attributed to gas evolution.

Recently, with increased use of zinc-coated steels of various types, another problem has developed that is related to deposition voltages and geometry. On some zinc-coated steels, notably galvanneal zinc-iron alloy, a particular type of defect is likely to occur unless deposition conditions are carefully controlled.[1-5] The defects are in the form of small craters or pinholes, and are more severe at higher voltages or when the distance between substrate and anode is short. Their occurrence is also quite dependent on the type of metal substrate. Galvanneal is especially prone to this problem, hot-dipped galvanized is intermediate, and nongalvanized steel usually does not produce craters of this type.

Cratering can occur in most organic coatings and is most often due to contamination.[6] The craters that appear on galvanneal are different, however. It has been suggested that electric discharges (sparks) during electrodeposition are the cause of the craters.[1-5] The most convincing evidence so far for such discharges is a photograph of bright flashes of light observed during electrodeposition.[4] The sparks apparently cause crosslinking of the organic resin at the point of discharge, resulting in poor flow during the subsequent oven bake. The discharges are also capable of melting metal, such that round beads of metal have been observed after removal of the organic coating.[1,2]

Cratering of this type is undesirable for two reasons. One is appearance: Even though the outer surfaces of an automobile will receive topcoats over the electrodeposition coating, the effect of the craters will ''telegraph''

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through the topcoats resulting in nonuniform appearance. It has also been shown that paint that is electrocoated under conditions that produce cratering is less resistant to corrosion.[7]

In this study, we have verified the occurrence of electric discharges during electrodeposition. The results indicate that sparking is the cause both of the pinhole defects that can occur on galvanneal, and also the more universal problem of rupture. Verification was accomplished visually, essentially using the same approach as Hart and Townsend[4] but improved by using a clear, transparent resin solution. We also measured current and voltage during electrodeposition, using digitized measurements to record data over fast (millisecond) time scales. Finally, we used acoustic emission equipment to measure the intensity of the sound emitted by the electric discharges.

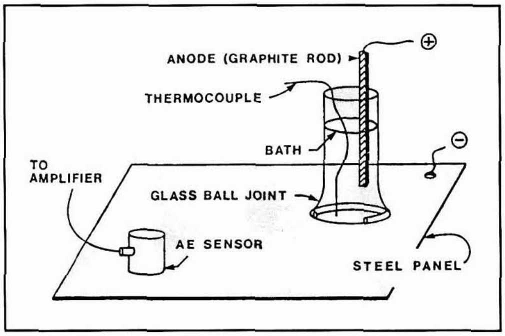

**Figure 2—Cell design for electrodeposition**

## EXPERIMENTAL

### Photographic Studies

Direct visual observation of electrodeposition is complicated by the fact that most commercial electrodeposition baths are pigmented, and even without pigment they are opaque, white resin dispersions. For this part of our study, we used an experimental cationic, highly-functionalized resin that dissolves completely in water to give a clear, transparent solution. The apparatus is shown in *Figure* 1. Power was applied as described in the following text.

### Current-Voltage Measurements

For these experiments, we used conventional, fully-formulated cationic electrodeposition baths, usually PPG UNI-PRIME®, except where otherwise indicated. The apparatus was the cell shown in *Figure* 2. This has several advantages for laboratory studies—only a single side of the metal is coated; only a small amount of metal and bath is used; and the exposed area of metal and the anode-cathode separation are easily held constant. Metal specimens were 4 × 2-in. cut from commercial panels (Advanced Coatings Technologies, Inc.). We used two substrates: nongalvanized unpolished 0.032 in. steel and "1½ side galvanized" 0.030 in. steel, both with the same zinc phosphate conversion coating, Chemfos 168. With the 1½ side galvanized steel, the outer galvanneal side was tested, not the inner hot-dipped galvanized side.

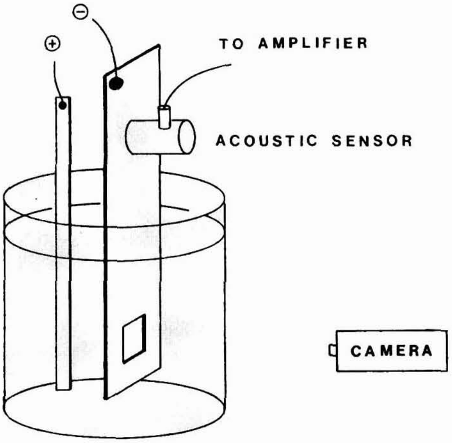

**Figure 1—Apparatus used to observe electrodeposition. The metal substrate (cathode) is masked except for a small area**

Electrical measurements were made using the circuit shown in *Figure* 3. Current and voltage were determined using the conventional arrangement of resistors. The voltage drops across these resistors were sent to conditioners (Data Translation, Inc., model DT6712) that amplified the signal and isolated the electrodeposition process from the measurement. This is done within the DT6712 units by converting the voltage signal into light, then reconverting the light into voltage for measurement. We found that such an isolation barrier is very desirable to avoid various problems due to feedback and improper grounding. The DT6712 units are wide band amplifiers (0-5.6 kHz) chosen for fast response—about 0.1 millisecond.

The analog signal from the DT6712 units was then digitized and stored using a Labmaster® data acquisition board (Scientific Solutions, Inc.) and a personal computer. Data points were usually taken at 100 points/sec. For some tests, faster response was achieved by omitting the DT6712 units and measuring only one signal (current, for example) at a time. The test was then limited by the speed of the Labmaster board, 40 kHz. The signals were calibrated by performing steady-state electrolysis of dilute salt solutions.

Power was applied suddenly by connecting the electrodeposition cell to the power supply, which had been turned on and adjusted to the desired constant-voltage output. This test is more severe, with respect to cratering, than the usual practice of ramping voltage or using a two-stage voltage, but it is more easily reproducible and it increases the intensity of cratering. It would represent a "worst case" production situation. In a typical test, measurements were made over a 10-sec period, and power was applied 1 sec after the start of data acquisition.

### Acoustic Measurements

A commercial acoustic sensor (C175L-7247, AET Corp.) was clamped to the steel panel as shown in *Figure* 2, using a drop of glycerin to insure good acoustic contact. The signal was amplified by 80 dB (10,000 times) using commercial equipment (AECL modular system, AET Corp.). This equipment also includes a threshold adjustment to exclude background noise, and a totalizer to record (and send to the computer) the total cumulative ring-down counts. Briefly, a ring-down count is recorded whenever the voltage output of the acoustic sensor rises above the threshold value, and there may be several ring-down counts for each individual acoustic event.

## RESULTS

### Visual Observations

Direct observation of electric discharges is the most convincing evidence for their occurrence. We performed a series of tests in which the cathode consisted of two metal specimens (nongalvanized steel and galvanneal) mounted side-by-side and electrically coupled so they were at the same potential. As electrodeposition was carried out at increasing voltage, sparks were seen on galvanneal at 240V and above, while on nongalvanized steel sparks appeared at higher voltages, about 300V or greater. The threshold voltage for sparking depended on the sample size and the anode-cathode distance. The sparks appeared as bright flashes, blue in color. This is shown in *Figure* 4, although this photograph is not nearly as convincing as viewing the experiment in real life (or on a color video tape).

One important conclusion from this experiment is that the flashes are, in fact, true sparks, with a lifetime of a fraction of a second. The alternative would be light that is emitted due to resistive heating due to passage of electric current. This would appear as a glow that would take at least a couple seconds to appear and fade.

Sparking on galvanneal follows a pattern. No sparks are seen for the first 1-2 sec after application of current, only gas evolution (presumably hydrogen from electrolysis of water). Then, the resinous coating undergoes a change of appearance simultaneous with a sharp drop in current, indicating that the coating has been neutralized and insolubilized by the high pH near the cathode. It is at this point that sparking begins. Under mild conditions, sparks are only seen at this point, but under more severe conditions, very intense sparking continues indefinitely. Severity can be increased by using higher voltage, closer electrode spacing, or a smaller sample area. Under severe conditions, the overall impression is that the intense sparking follows a ''slip-stick'' pattern, with a repetitive cycle of coating deposition, followed by a spark that blows the coating away, allowing more coating to deposit to result in another spark. Continued sparking in a fixed location is encouraged because current is concentrated at that point, while the rest of the metal is covered with a thicker coating.

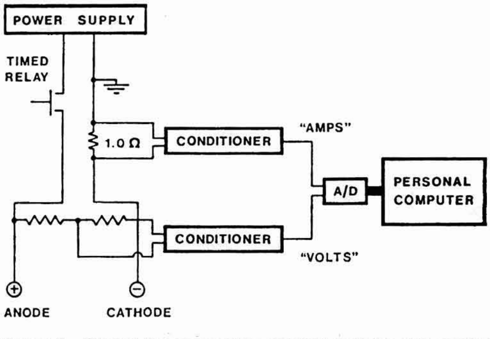

**Figure 3—Circuit for measuring applied voltage and current during electrodeposition. "A/D" is Tecmar analog-to-digital converter**

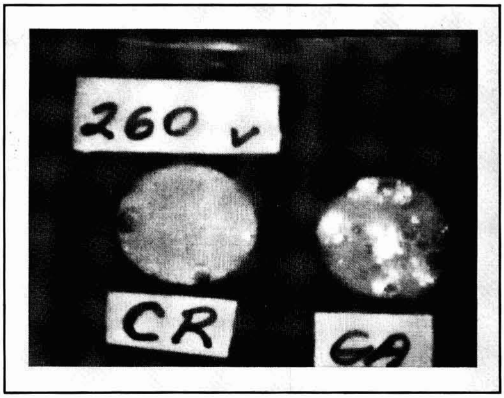

**Figure 4—Electric sparks produced during electrodeposition on galvanneal (right) but not on nongalvanized steel (left). Both panels were coated simultaneously at 260V. Exposed area equals one sq cm on each panel**

We also tried to produce sparks independently of the coating deposition process. We deposited a thin coating in 1-10 sec deposition time, then placed the wet, coated metal in water or electrolyte and applied an electric current. A variety of experimental conditions were used but we could not produce sparks at reasonable voltages (250-300V). It seems that sparks occur only at a critical point early in the deposition process, and if deposition can be carried out beyond that point with no sparking, then subsequent sparking is unlikely. Industrial practice takes advantage of this by using a two-stage arrangement where deposition is begun at a low voltage then continued at a higher voltage.[8]

### Current-Voltage Measurements

The direct observation of electric sparks is convincing and fascinating, but is not quantitative and is not practical with fully formulated, pigmented baths. One approach to quantitative measurement is to determine the surge in electric current that accompanies the sparks. An example of current and voltage behavior on nongalvanized steel is shown in *Figure* 5. The large swings during the first one-half second or so occur before high coating resistance has been established. During this time, the power supply cannot maintain the preset voltage because of the large current draw. Very quickly, however, current is limited by the resistance of the coating and voltage rises to a constant value.

Tests on galvanneal (*Figure* 6) show sharp spikes in the current that are not present with nongalvanized steel. The comparison is clearer in *Figure* 7 where the initial oscillations have been deleted to expand the center portions of the data. Such current spikes are a classic indication of electric discharges.

The current plots in *Figures* 5 and 6 exhibit a smooth rise and fall a couple of seconds after the start. Such momentary increases in current have long been known, as reported most recently by Coon and Vincent[8] in their comparison of zinc-coated and nongalvanized steels. They found that the secondary current increase on galvanneal correlates with the intensity of pinhole defects, while on nongalvanized steel the current increase only appears at high voltages and is not accompanied by pinholes. Other investigators, as cited by Beck,[9] have linked the secondary current maxima to the phenomenon of rupture. These studies were made using strip-chart recorders to record the current-time data. The slower response of a

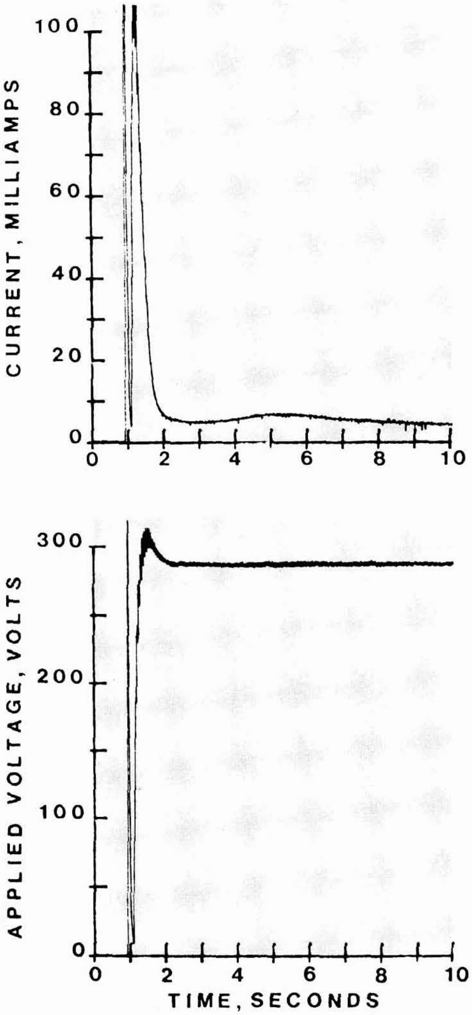

**Figure 5—Typical current, voltage results. Deposition on nongalvanized steel at 290V**

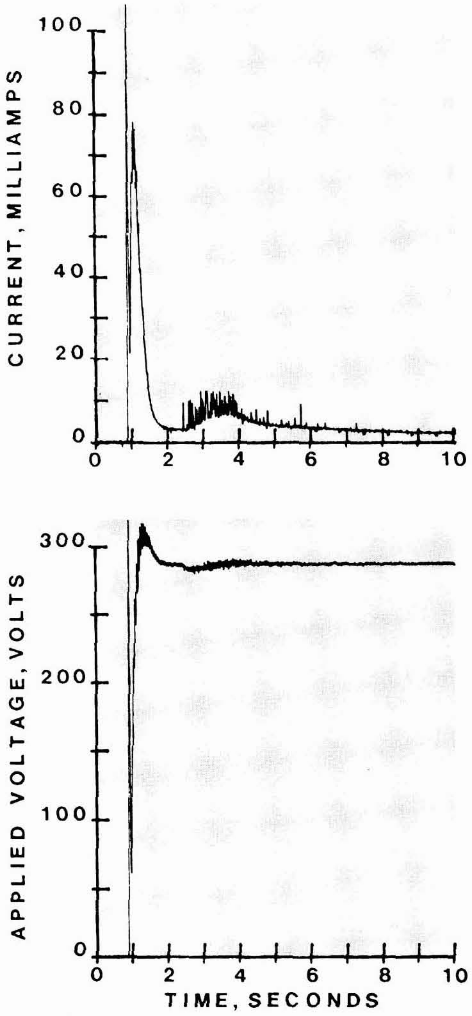

**Figure 6—Current, voltage data for deposition on galvanneal at 290V**

strip-chart recorder causes the signal to be smoothed and filtered, so that the sharp spikes shown in *Figures* 6 and 7 are not observed.

On nongalvanized steel, we used more rapid data acquisition (see Experimental section) in attempts to resolve the broad, continuous current peak into individual spikes. However, the results were still smooth and continuous even when recording 10,000 points per sec.

It would be possible to use these measurements to determine the intensity of sparking by integrating the area of the spikes. An alternative way to quantify sparking is to use an acoustic emission (AE) technique, which has several advantages over current measurement.

## Acoustic Emission

When sparking occurs during electrocoating, as observed visually or by current spikes, it is accompanied by a characteristic "crackling" or "sizzling" noise. This noise can be measured using commercial AE equipment, with typical results as shown in *Figure* 8. The acoustic measurement is the cumulative total of ring-down counts that have been detected, so the acoustic activity is most intense where the slope of the graph is greatest. This roughly coincides with the intensity of current spikes. Similar tests on nongalvanized steel (*Figure* 9) show almost no acoustic signal.

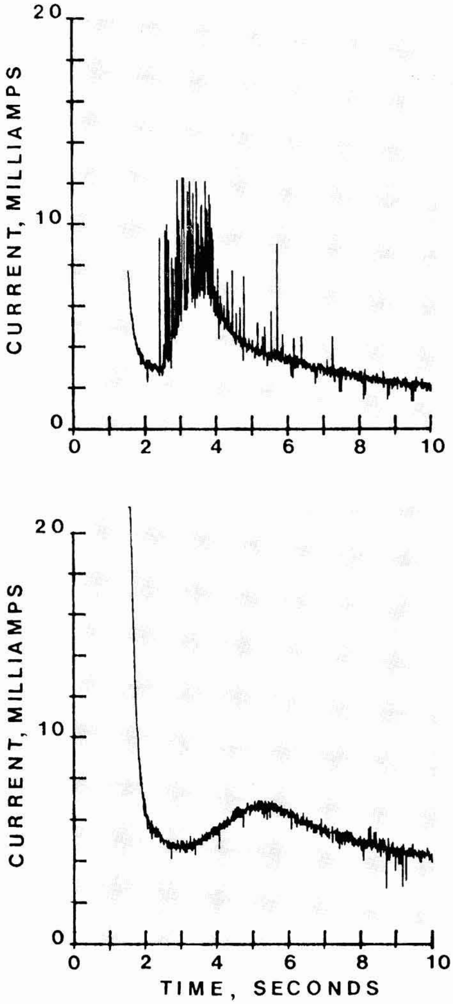

**Figure 7—Current, beginning 1 sec after the start of deposition. Galvanneal, 290V (top); nongalvanized steel, 290V (bottom)**

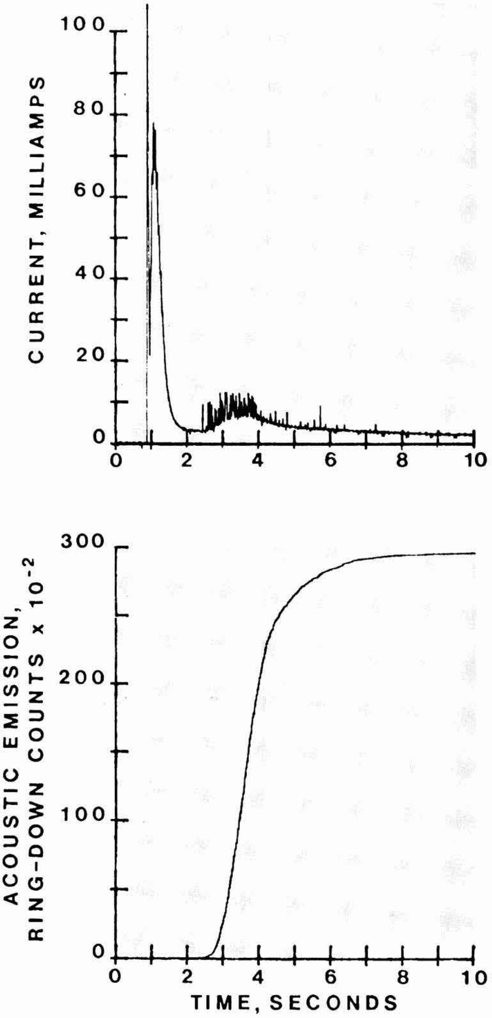

**Figure 8—Current (top) and acoustic emission (bottom) for deposition on galvanneal at 290V**

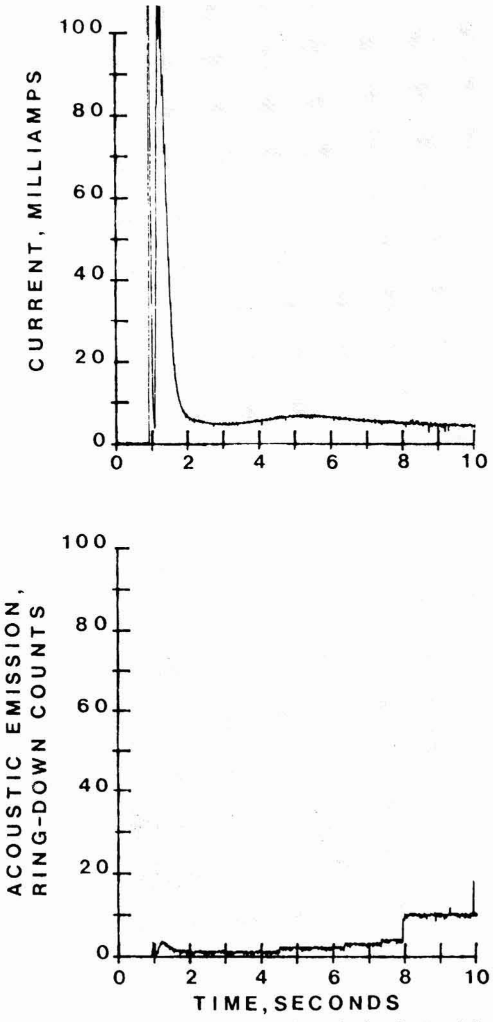

**Figure 9—Current (top) and acoustic emission (bottom) for deposition on nongalvanized steel at 290V**

In order to rate electrodeposition for the greatest AE, the simplest approach is to use the total number of ring-down counts obtained during the first several seconds of deposition. A more meaningful test might be to use the maximum rate of AE, but we decided to use the simplest approach first. *Figure* 10 shows the total AE count after 9 sec of deposition for the two types of steel, at different voltages. As expected, AE is greater at high voltage, and greater on galvanneal.

We have also used AE to test different bath compositions and to determine the effect of bath temperature. In *Figure* 11, AE from the standard UNI-PRIME pigmented bath decreases as temperature is increased. This is consistent with experience on production lines where higher temperatures produce less cratering.

The other two baths in *Figure* 11 are experimental pigment-free coatings. The one that produces the greatest AE activity was rated ''bad'' with respect to cratering, while the other was rated ''moderate,'' and again, the AE results correlate with the severity of cratering. The ''bad'' pigment-free coating is especially interesting because the acoustic signal is more intense at higher temperatures, opposite to the usual behavior. After we obtained the AE results, the ''bad''coating was electrodeposited using standard procedures (4 × 12-in. panels) at different temperatures. These tests confirmed our prediction: There was less cratering at lower temperatures.

## DISCUSSION

Our major goal was to show that electric discharges can occur during electrodeposition of paint, and to confirm that discharges are the cause of cratering on galvanneal, and of rupture in general. Our three sources of evidence—short, bright flashes of light; current spikes; and acoustic emission—are the classic indicators of sparking. In their intensity they correlate with each other and also with the severity of cratering. We found such correlations while varying the type of metal substrate, voltage, bath composition, and bath temperature. On nongalvanized steel, discharges occur with accompanying acoustic signals under conditions that are consistent with the occurrence of rupture. Thus, we believe the occurrence of electric discharges and their effect on film defects have been amply demonstrated.

The exact cause of the electric sparks is not known. In general, dielectric breakdown of liquids or solids occurs in an electric field of about $10^6$ v/cm.[10,11] The field strength within the coating during electrodeposition has been calculated by Pierce[12] and by Beck.[9] They obtained values of about $1-5\times10^5$ v/cm. Thus, under intense conditions, it is not surprising that the electric field is great enough to cause breakdown and sparking. The sequence of events is generally regarded as involving electron emission from the cathode, followed by formation of a gaseous plasma of ions and free electrons, which increases in size and intensity, resulting in a spark.[10,13] The spark could occur across the paint or, alternatively, across a hydrogen gas layer between the metal and the paint.

Electric discharges from a metal immersed in aqueous solutions are uncommon but not unknown. They occur during underwater welding and also under less severe conditions, notably in the formation of anodic oxide barrier films.[13,14] Here, a metal oxide film is formed on a metal immersed in electrolyte and made anodic by application of constant DC current. Voltages of 100-1000V can develop, and sparking has been documented under these conditions. As in our tests, the sparks are accompanied by noise, voltage oscillations (at constant current), and visible flashes of light. They also begin at a breakdown voltage that is quite reproducible, which, as pointed out by Ikonopisov,[14] is unusual for breakdown phenomenon.

Although we have shown that cratering is worse on galvanneal because it is more prone to sparking, we cannot explain why that is so. Various explanations have been suggested[1,2]—roughness, electrical conductivity, homogeneity of the metal, and others—but none have been shown to be the cause. A most interesting result is that the presence or absence of a zinc phosphate conversion coating has no effect.[3,4] We have also produced sparks on a nonmetallic substrate, graphite.

The results on nongalvanized steel are especially interesting. Previous studies[1-5] have shown little or no cratering on nongalvanized steel, even up to 400V in some studies. On the other hand, the occurrence of ''rupture'' is a familiar problem in the electrodeposition of both cationic and anionic coatings on a variety of substrates. Rupture can cause defects of various types, and is accompanied by an easily audible crackling noise. It is usually attributed to gas evolution, and the noise is referred to as ''gassing'' or ''gas pings.'' Our results suggest that rupture is really caused by electric discharges. We can further characterize the electric discharges that occur on nongalvanized steel at high voltage as being more rapid, occurring with higher frequency than those on galvanneal. This is indicated by the current-time plots in *Figure* 7 and by our inability to resolve the current on nongalvanized steel into individual peaks. The second observation can be explained by sparks that occur very rapidly, several at any given time, so that the total current is the sum of several sparks. And, since the area under the curves in *Figure* 7 is about equal, the energy consumed by sparking is about equal for both metals. Thus, when sparking occurs on galvanneal, there are fewer sparks, of greater intensity, while on nongalvanized steel, the sparks are greater in number but weaker in intensity. This may explain why distinct, objectionable defects occur on galvanneal while on nongalvanized steel there are usually no defects or just an overall roughening.

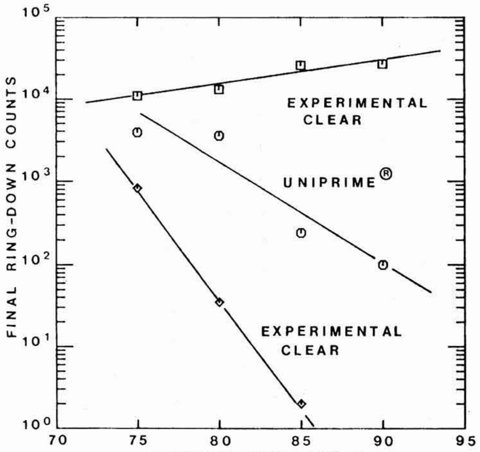

**Figure 11—Effect of bath temperature on acoustic emission for deposition on galvanneal. All tests at 250V**

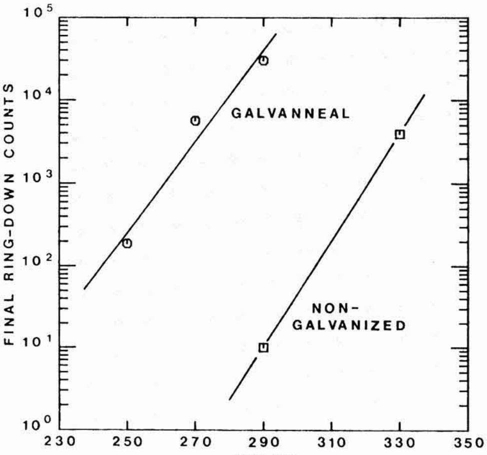

**Figure 10—Effect of voltage on acoustic emission**

Aside from characterizing and understanding the problems of cratering and rupture, our results show two ways to measure the intensity of sparking using current spikes and acoustic emission. Both are useful as research tools, but acoustic measurement is much easier to implement as part of standard development or production procedures. It is also possible that acoustic measurement could find use on a production line to continuously monitor the electrodeposition process. Using threshold and frequency adjustments, a unit could be tuned to respond specifically to the noise caused by sparking, and to ignore other (mechanical) sources of noise. Then, if sparking occurs due to, for example, a change in metal substrate or a change in the power supply, the problem would be detected immediately. Without such a monitor, cratering defects are only detected visually, after the oven bake, or worse, during final inspection.

The key to using AE measurement for such a monitor is that the sensor could be placed on an inert probe inserted into the bath. The sensor would not have to be attached to an individual piece being coated. Measurement of current would be much more difficult on a continuous line where several pieces are coated at the same time, using a single power source.

## SUMMARY

All of our observations support the hypothesis that electric discharges can occur during electrodeposition. On galvanneal steel, the sparks occur at low voltage and cause pinhole defects in the coating. On nongalvanized steel, higher voltage is required to produce sparking, and the sparks are of shorter duration and of lesser intensity compared to those on galvanneal. The phenomenon of "rupture," usually attributed merely to gas evolution, in fact seems to be due to electric discharges.

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# Society Meetings

## BIRMINGHAM............. OCT.

### *"Painting Plastics"*

The meeting's speaker was Herr Reinard Dedrichs, of Bayer. His topic was "PAINTING PLASTICS—NEW PROBLEMS, NEW SOLUTIONS."

Mr. Dedrichs stated that the use of plastics in the automotive industry, as well as other industries, has greatly increased in the past decade, resulting in a need for increased development in the coating technology of plastic products.

According to the speaker, the reasons for coating plastics include: increase in safety (i.e., using flexible coatings on fenders); greater freedom in design; decoration; protection against weathering and aggressive media, mechanical stress, abrasion, and scratch resistance; and impact strength (flexible coatings reduce shattering).

Critical aspects of coating plastics are surface characteristics, heat resistance, electrostatic build-up, adhesion, flexibility, and conductivity. The speaker showed a diagram depicting the importance of flexibility, noting that a properly coated plastic will not shatter. He used a graph to demonstrate the increase in flexibility when using a flexibilizing polyester. Elongation of 90% is possible when pigmented coatings are used, and over 100% elongation is possible when clear coatings are used.

Mr. Dedrichs talked about the typical cleaning and pre-treatment processes, the use of special washes for in mould release thermoplastics, and the special difficulties in coating polypropylene and the various processes used to overcome these problems.

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*Q. Why are there two different types of power washing in the pre-treatment?*

A. This depends on the mould release agent used. Water was used for water-based mould release agents, otherwise, trichloroethylene vapor is required.

*Q. Which weatherometer correlates best for polyurethane coatings?*

A. They do not correlate with Florida exposure. They are useful for comparisons.

D.A.A. WALLINGTON, *Secretary*

## CDIC.................... SEPT.

### *"Bi-Metallic Complexes"*

The officers for 1987-88 are as follows: President—Andrew Nogueira, of Neyra Industries, Inc.; Vice-President—Carolyn L. Tully, of Sun Chemical Corp.; Secretary—N. Jay Huber, Jr., of Paint America Co.; and Treasurer—W.E. Whitlock, of Ashland Chemical Co.

Donald J. Roettker, of B.H. Roettker Co., Inc., presented Mr. Nogueira with the Nuodex gavel.

The evening's technical speaker was Samuel J. Bellettiere, of Nuodex, Inc. Mr. Bellettiere, a member of the Philadelphia Society, presented a talk on "BI-METALLIC COMPLEXES AS OXIDATIVE CATALYSTS IN COATINGS."

The meeting's educational speaker was Society member George R. Pilcher, of Hanna Chemical Coatings Co. Mr. Pilcher, Chairman of the Federation's Professional Development Committee, spoke on the findings of the committee.

N. JAY HUBER, JR., *Secretary*

## CHICAGO................ SEPT.

### *"Odors and Odor Control"*

Educational Committee Chairman John Wamelink, of Reichhold Chemicals, Inc., announced that plans for a management development seminar, scheduled for February or March, are underway. Individuals to staff the committee are needed.

Speaker for the evening was Harold Rafson, of Quad Environmental Technologies Corp. His topic was "ABOUT ODORS AND ODOR CONTROL."

Mr. Rafson reviewed the nature of odors, how they are sensed, and methods for sampling and testing, even at extremely low concentrations. He discussed the generation points and control technology in coating facilities. Included in his talk were the types of chemical scrubbing processes in both paint and polymer production environments.

KEVIN P. MURRAY, *Secretary*

## CHICAGO................. OCT.

### *"Water-Borne Polyurethanes"*

Lynn R. Murr, of Mobay Corp., was the meeting's first speaker. She spoke on "WATER-BORNE POLYURETHANES."

Ms. Murr presented a brief review of polyurethane chemistry that led into a discussion of emulsion type systems. The dispersion scheme and effects of the internal emulsifiers on physical properties were highlighted. In conclusion, the speaker described applications in aqueous adhesives and coatings over a variety of substrates.

The second speaker was Andrew J. Defusco, of Union Carbide Corp. The speaker, a member of the Pittsburgh Society, talked on "LATEX COALESCING SOLVENTS."

The mechanism of latex film formation and the factors that determine coalescence efficiency, along with a correlation of these concepts with coatings performance, were discussed.

KEVIN P. MURRAY, *Secretary*

## CLEVELAND.............. OCT.

### *"Environmental and Legislative Update"*

The Educational Committee's Spring Technical Conference dates have been changed to June 1-2, at John Carroll University.

Rob Forman, of the National Paint and Coatings Association, was the evening's speaker. His talk was titled "ENVIRONMENTAL AND LEGISLATIVE UPDATE."

**HOUSTON SOCIETY OFFICERS for 1987-88 are (l-r): Society Representative—Donald R. Montgomery; Treasurer—Richard W. Storm; President—James A. Harrell; Secretary—Sandra Swift; and Vice-President—James Ignatow**

**1987-88 KANSAS CITY SOCIETY OFFICERS are: Vice-President—Steven D. Johnson; Secretary—Nick Dispensa; President—Roger Haines; Society Representative—Norman A. Hon; and Treasurer—Larry Kytasaari**

The speaker enlightened the audience to the key issues that the NPCA is working on at both the federal and state level.

Mr. Forman spoke of several issues under consideration on the federal level. The Clean Air Act is up for reauthorization and two bills are pending in the Senate and the House. The S-1351 and HR-3054 bills would set national standards for VOC emissions for traffic, military specifications, and architectural coatings. The High Risk Occupational Disease Notification Prevention Act (S-79, HR-162) would require the government to inform the workers of the health risk associated with the long term exposure to chemicals in the work place.

At the state level, Proposition 65, the Safe Drinking Water of Toxic Enforcement Act of 1986, Household Hazardous Waste, VOC Reductions, and Title III of SARA are the issues at hand.

In conclusion, Mr. Forman stated that the initial proposed activity at the state level is more degenerated now than at the federal level. According to the speaker, the trends on the state level usually start with California and the other states follow suit.

Ilona Nemes-Nemeth, *Secretary*

## DALLAS . . . . . . . . . . . . . . . . . SEPT.

### *"Organoclays"*

Van G. Falcone, of Koppers Co., Inc., was elected Society Representative.

Dwaine Siptak, of Southern Clay Products, a subsidiary of E.C.C. America, Inc., was the guest speaker. Mr. Siptak, a member of the Houston Society, spoke on "ORGANOCLAYS—PAST, PRESENT AND FUTURE."

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*Q. Incorporation—is it better in grind or post added?*

A. It can be added either place as long as there is sufficient shear available. You need a high speed disperser or media mill such as a sand mill.

*Q. Is order of addition important on both conventional and activator-free clays?*

A. On conventional organoclays requiring polar activator, sequence is important. Shear is also important. On activator-free clays, order is not important as long as you have sufficient shear.

Steve Stephens, *Secretary*

## GOLDEN GATE . . . . . . . . . . . OCT.

### *"Silicones for Protective Coatings"*

Manufacturing Committee Chairman Louis F. Sanguinetti, of Jasco Chemical Corp., announced that the June 15 program, "In Step with the Times—Are You?" will contain talks on computers and programming, regulations, Proposition 65, and Right-To-Know labeling.

William A. Finzel, of Dow Corning Corp., was the speaker for the evening. A member of the Detroit Society, Mr. Finzel discussed "SILICONES FOR PROTECTIVE COATINGS AND INKS."

The speaker stated that the chemistry and commercialization of silicones have dramatically expanded since the first products were developed in the mid-1940's. Mr. Finzel said that today, silicones are used in almost every industry including medical, cosmetics, automotive, rubber, electrical, heavy industrial, military, aerospace, marine, paper, textile, and protective coatings.

The presentation was divided into four parts: (1) the chemistry of silicon dioxide to chlorosilanes, hydrolysis, and condensation of silane functional polysiloxanes to finished products; (2) high performance resins; (3) reactive silicone intermediates and applications as silicone modified copolymer resins for coil coatings and maintenance paints; and (4) silicone additives for paints and inks.

Mr. Finzel also talked about additive types, products suggested for foam control, leveling, mar resistance, pigment floating, and adhesion promotion.

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*Q. How are silicones for water resistance?*

A. Very poor, water penetrates film quite easily.

*Q. How much more expensive are siliconized polyesters than unsiliconized polyesters?*

A. Approximately 1½-2 times the cost of unmodified polyesters.

Gordon N. Pioch, *Secretary*

## HOUSTON . . . . . . . . . . . . . . . . OCT.

### *"Titanium Dioxide"*

Technical Committee Chairman Jack MacRae, of International Paint Co., solicited ideas for a paper or project for the committee.

The technical presentation was given by Richard I. Ensminger, of NL Chemicals, Inc. His topic was "TITANIUM DIOXIDE—WHY SO MANY GRADES?"

Mr. Ensminger talked about both processes of manufacturing titanium dioxide—sulfate and chloride. He gave a step-by-step procedure of how titanium is manufactured. The treatment stage, which is identical in both processes, is where the pigment comes into contact with silica, alumina, and zinc oxide. The treatments affect dispersability, opacity, and chalk resistance and give each grade its desired properties. The different properties allow the pigment to be used in many applications including paint, plastic, ink, paper, textile, and cosmetics.

**OFFICERS OF THE LOUISVILLE SOCIETY for 1987-88 are: Vice-President—Larry F. Pitchford; Secretary—Raymond L. Mudd; President—Kenneth Hyde; Treasurer—Louis F. Holzknecht; and Past-President—Howard L. Ramsay**

**1987-88 MONTREAL SOCIETY OFFICERS are: Standing: Technical Committee Chairman—John E. Hall; Past-President—Jean-Pierre Côté; Educational Committee Chairman—C.C. Craib; and Manufacturing Committee Chairman—L. Krivanek. Seated: Society Representative—Horace A. Philipp; Treasurer—Luc Pépin; President—E.J. Templeton; Planning Committee Chairman—V. Pederson; and Y. Abraham**

The speaker also discussed titanium extenders, and stated that because of the wide variety of end use applications that the extenders exhibit, it has been necessary to have different grades of titanium.

Mr. Ensminger said that the titanium industry is mature, but it continues to develop new grades, improve existing ones, and manufacture more economically.

Sandra Swift, *Secretary*

## KANSAS CITY ............ OCT.

### *"Zirco Aluminates"*

New England Society member Lawrence B. Cohen, of Cavedon Chemical Co., Inc., gave the evening's presentation. He spoke on zirco aluminates for improved adhesion and promotion of pigment distribution.

Nick F. Dispensa, *Secretary*

## LOS ANGELES............ OCT.

### *"Silicones"*

A moment of silence was observed for Society members Ben Friedland, of Seaside Paint & Lacquer Co., and E.T. "Jack" Horn, of E.T. Horn Co., who died recently.

Harry Shiefer, of Dow Corning Corp., was the meeting's guest speaker. Mr. Shiefer spoke on "Silicones for Protective Coatings and Inks."

The speaker noted that the chemistry and commercialization of silicones have dramatically expanded since the first products were developed in the mid-1940's. He said that silicones, considered hybrids of glass and organic compounds, as a class of materials display much of the inertness of silicone dioxide yet have many characteristics of organic compounds.

Mr. Shiefer stated that silicone resins, reactive intermediates, and additives were developed to satisfy the need for higher temperatures, better weatherability, paint and ink surface properties, and adhesion promotion to a variety of substrates.

Also discussed were additives types and products suggested for foam control, leveling, mar resistance, pigment floating, and adhesion promotion.

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*Q. In regards to paint additives, why doesn't Dow Corning state what silicone they use in the various additives instead of trying to sell solvents? Manufacturers could make their own dilution of the additive.*

A. Many additives are supplied at 100% solids allowing for individual dilution. Others are diluted for customer convenience. All additives are identified by chemical name but the exact structure is not presented.

James F. Calkin, *Secretary*

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

### *"Accelerated Weathering"*

Vice-President Larry F. Pitchford, of Reynolds Metals Co., announced that Past-Presidents' Night has been rescheduled for March.

The evening's guest speaker was Patrick J. Brennan, of the Q-Panel Co. Mr. Brennan, a member of the Cleveland Society, discussed "The Truth About Accelerated Weathering: It's Simpler Than You Think."

Mr. Brennan pointed out that accelerated weathering testing is meant to provide a quick method of discerning relative differences between formulations and for evaluating formula changes made to improve durability of a product. He stated that this type of test is not meant to provide a perfect correlation between natural and accelerated weathering.

Raymond L. Mudd, *Secretary*

## NEW ENGLAND........... OCT.

### *"Polysiloxanes in Coatings"*

Coatings Tech Expo '88, to be held May 11-12, will feature environmental subjects the first day and technical papers the second day.

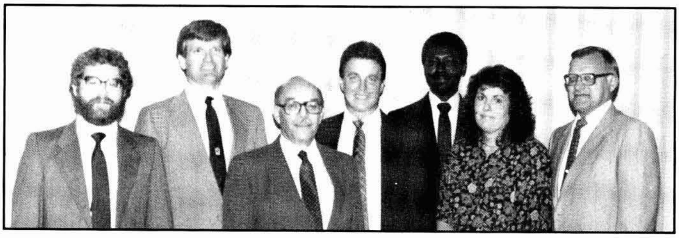
The fourth annual Coatings Awards, for student-written manuscripts, will be presented during the two-day symposium. All papers must be submitted by March 1.

New York Society member Francis E. "Gene" Franklin, of Byk-Chemie USA, spoke on "The Chemistry and Application of Polysiloxanes in Coatings."

Mr. Franklin pointed out that organosilanes are used for flow control, antifloat, slip, defoaming, and to produce hammer tone finishes. He said that the lowest viscosity products are used for flow control progressing through the applications listed as viscosity increases, with highest viscosity types being used for hammer tones.

The speaker stated that silicones' lower surface tension promotes better wetting. According to Mr. Franklin, small differences in surface tension can make big differences in the wetting of the substrate. Since newer high solids coatings do not contain much solvent to aid in wetting, surface tension modifiers are extremely important, he acknowledged.

Fluids, said the speaker, flow from areas of low surface tension to areas of high surface tension. Polysiloxanes orient them-



**ST. LOUIS SOCIETY OFFICERS for 1987-88 are: Technical Committee Chairman—Joseph R. Schinner; President—James N. McDerby, Jr.; Secretary—Howard Jerome; Vice-President—Robert Wagnon; Ken Brown; Terry Gelhot; and Society Representative—John Folkerts**

**SECOND PLACE MMA AWARD—Golden Gate Society President Timothy Donlin (c) presents the MMA Award to Past-President Patricia Shaw (l) and Publicity Committee Chairman Ted Favata. The Society was honored by the Federation at the Annual Meeting in Dallas, TX, for their 1987 Western Coatings Societies' Symposium and Show**

selves at the surface, controlling surface tension and slip. On the other hand, less active types are chosen where better wettability on recoat is a necessity. Changes in the modification chemistry give varying degrees of thermal stability or reactivity where desired, Mr. Franklin commented.

In conclusion, the speaker demonstrated how a ladder study may be done to determine the surface tension of a substrate using liquids of known surface tension.

*Q. What do the crosslinking type polysiloxanes crosslink with?*

A. They react with isocyanate.

JOSEPH T. SCHRODY, *Secretary*

## NEW YORK .............. SEPT.

### *"Salt Spray Resistance"*

Society officers elected for 1987-88 are: President—John W. Burlage, of Pacific Anchor Chemical; Vice-President—Irwin H. Young, of Jessie S. Young Co., Inc.; Secretary—Arthur A. Tracton, of Hempel Coatings, Inc.; and Treasurer—Roger P. Blacker, of Whittaker, Clark, & Daniels, Inc.

Past-President Kenneth J. De Paul, of Whittaker, Clark, & Daniels, Inc., was presented with a Past-Presidents' Pin.

The meeting's speaker was Gail Pollano, of Polyvinyl Chemical Inc. The New England Society member spoke on "FACTORS AFFECTING THE SALT SPRAY RESISTANCE OF AN AQUEOUS COATING ON METAL."

The presentation covered the effects of plasticizers, flash rust inhibitors, corrosion inhibiting pigments, and thickeners. The speaker also focused on levels of materials and synergistic effects. According to Ms. Pollano, the best system includes butyl benzyl phthalate, ammonium dichromate, Hammond's SW111, and Rohm and Haas Company's TT678.

ARTHUR A. TRACTON, *Secretary*

## NEW YORK ............... OCT.

### *"Blocked Isocyanates"*

A moment of silence was observed for Society member William C. Jeff, of John L. Armitage & Co., who died recently.

Mike Granito presented the D.H. Litter gavel to President John W. Burlage, of Pacific Anchor Chemical.

The evening's speaker was Terry Potter, of Mobay Chemical Corp. Dr. Potter's topic was "BLOCKED ISOCYANATES IN COATINGS."

The speaker covered the different types of isocyanates and their chemistry. Dr. Potter stated that the blocked isocyanates are used primarily in baked coatings where heat will unblock them and permit the isocyanates to react.

*Q. Does the fugitive blocking agent affect color?*

A. Only if it stays in the film.

ARTHUR A. TRACTON, *Secretary*

## NORTHWESTERN ......... OCT.

### *"Evaluation of Coalescent Agents"*

The meeting's first talk was given by Dennis H. Guthrie, of Dow Chemical Co. Mr. Guthrie's subject was "EVALUATION OF COALESCENT AGENTS FOR INDUSTRIAL LATEXES."

The speaker explained that a coalescing agent is "a solvent that is left behind after the evaporation of water from a latex paint film. Its function is to soften resin particles, enabling them to fuse together into a continuous film." He also observed the various evaporation rates of numerous solvents on an evaporometer.

Mr. Guthrie found several effects on coalescing agents:

(1) Relative humidity affects the efficiency of a coalescing agent.

(2) The hardness of a paint film can be directly related to the coalescing agent.

(3) The temperature drastically affects film formation and coalescent choice.

In conclusion, the speaker explained that "there is no such thing as a universal coalescent." He also said that many factors, such as VOC, dry time, gloss, hardness, and application conditions affect the choice of an appropriate coalescent.

The second speaker was Don Bartho whose topic was financial planning.

MARK W. UGLEM, *Secretary*

## PIEDMONT ............... OCT.

### *"Titanium Dioxides"*

Thomas W. Mitchell, of Nuodex, Inc., presented President Charles T. Howard, of DeSoto, Inc., with the Nuodex gavel.

The guest speaker was Richard I. Ensminger, of NL Industries, Inc. His topic was "TITANIUM DIOXIDE—WHY SO MANY GRADES?"

Mr. Ensminger introduced his discussion with a quote from the NPCA raw material index. The index states "there are fifty (50) different grades of rutile titanium dioxides ($TiO_2$), sixteen (16) anatase grades and twelve (12) rutile slurries that are available from eight (8) different pigment manufacturers." Many of the grades are designed for the paper, plastic, cosmetic, and food/drug industries.

The speaker fortified his presentation with slides and a flow chart comparison of the sulfate process (circa 1920) vs the chloride process (circa 1950). Mr. Ensminger also discussed the different methods of surface treatments (alumina, silica, and organic treatments) and their effects on various types of coatings.

*Q. What effect does alumina or silica surface treated $TiO_2$ have on catalyzed, high solid thermoset coatings?*

A. If the $TiO_2$ has an alumina surface treatment, the acid catalyst (PTSA) will be absorbed by the alumina particles and detract from the cure response. Therefore, a silica treated $TiO_2$ is recommended because the silica will not absorb the acid catalyst or hinder the cure response.

*Q. Why is there a problem with the availability of $TiO_2$?*

A. The market demand has exceeded the capacity(ies) of $TiO_2$ producers, therefore, inventories are non-existent. This problem was created when the U.S. production decreased in the early 1980's and there was no impetus to build additional capacities for producing $TiO_2$.

FOREST G. FLEMING, II, *Secretary*

## PITTSBURGH ............. OCT.

### *"Catalysts"*

Anna Ninness, of Neville Chemical Co., and Jeffrey C. Sturm, of Koppers Co., Inc., are Co-Chairmen of the Environmental Controls Committee.

Robert G. Middlemiss, of Mooney Chemicals, Inc., was the speaker for the evening. Mr. Middlemiss, a member of the Cleveland Society, presented "CATALYSTS FOR HIGH SOLIDS AND WATER REDUCIBLE COATINGS."

The speaker began his discussion with a definition of driers—materials that significantly enhance the rate of dry in coatings. Typically, according to Mr. Middlemiss, they are metal carboxylates formed by the reaction of metals or most metal derivatives with carboxylic acids of natural or synthetic origin.

Mr. Middlemiss described three common categories of driers: oxidative, polymerizing, and auxiliary.

The speaker said that the five basic steps in the drying process are: induction period, peroxide formation, peroxide decomposition, polymerization, and degradation. He went on to explain that driers shorten the induction period, increase the rate of oxygen absorption, promote peroxide formation and decomposition, and reduce the amount of oxygen required.

Mr. Middlemiss stated that many problems are now being encountered with high solids and water reducible coatings that can be overcome by the proper use of ligands, along with metal driers. Some of the problems with high solids include: drier incompatibility with resins, resin gelation, viscosity build, and drier catalysis of low molecular weight polymers and reactive monomers. Problems with water-borne formulations are: drier incompatibility, hydrolysis, resin discoloration, poor initial dry, high costs, critical recoat times, and loss of dry on aging.

When properly formulated into high solids and water-borne coatings, ligands help to: (1) increase the activity of driers; (2) minimize drier deactivation via absorption of pigments; (3) stabilize driers against hydrolysis; (4) increase film hardness; (5) increase the rate of electron transfer; and (6) change the spin multiplicity or electron distribution.

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*Q. What are some of the negative effects improper drier selection can have on water-reducible coatings?*

A. A common problem has been a plasticization effect on the cured film. Other poor film properties have also been observed.

*Q. In water-reducible systems, is it recommended to chelate "in the paint" or as a premixing operation?*

A. While it can be achieved either way, it is recommended to desensitize the system in a separate operation.

James Lore, *Secretary*

## PITTSBURGH ............. NOV.

### *"In-House Solvent Recovery"*

Fred Slack, of Disti Inc., was the speaker for the evening. Mr. Slack's topic was "IN-HOUSE SOLVENT RECOVERY."

The speaker said that of the 350 industrial SIC codes, 86% are generators of hazardous solvent waste and 63% are generators of industrial oil waste. Federal regulations state that a waste is considered hazardous if it meets one of the following four criteria: ignitable, reactive, corrosive, or toxic.

According to Mr. Slack, generators are companies that produce more than 1000 kg (2200 lbs) or roughly five drums of waste in a 30 day period. Small generators produce 100 kg (220 lbs) or approximately one-half a drum in 30 days.

A generator must comply with manifest regulations, furnish contingency plans to the EPA, and should carry increased liability insurance for the company and personnel responsible for waste management, informed Mr. Slack. The manifest states, in part, that companies certify they have a program in place to reduce the volume of waste generated on site, and selected a method of treatment currently available to minimize the present and future threat to health and the environment.

The speaker then issued four possible methods of reducing the volume of waste generated:

(1) Reduce production levels.

(2) Change processing to minimize waste or switch from listed materials to materials not listed as hazardous.

(3) On-site or off-site recovery which can reduce materials from the hazardous waste state to only hazardous materials.

(4) On-site or off-site incineration.

Mr. Slack went on to say that on-site recovery provides a more economical means of reducing waste if the distilled material can be reused, and does not require a permit if it is done internally.

In conclusion, the speaker said the per capita generation of hazardous waste in the U.S. amounts to about 1200 gallons per year for every person.

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*Q. What is the most popular way of disposing of sludge or semi-solids left after distillation?*

A. Leave sludge in a form where it is still pumpable because it is cheaper to dispose of through incinerators.

*Q. What is the average percent solids of a paint sludge that is pumpable?*

A. Although it varies depending on the constituent raw materials used, generally in the neighborhood of 85%.

James Lore, *Secretary*

## ROCKY MOUNTAIN ........ OCT.

### *"Silicones"*

Harry Schiefer, of Dow Corning Corp., presented the talk for the evening. Mr. Schiefer gave a review of "SILICONES FOR PROTECTIVE COATINGS AND INKS."

Craig Schweiger, *Secretary*

## ST. LOUIS ................ OCT.

### *"EPA Regulations"*

The proposed amendment to the By-Laws was given a second reading and was approved unanimously. The amendment allows all of the Society funds to be consolidated in one interest-bearing account.

Environmental Control Committee Chairman Kenneth J. Brown, Sr., of Carboline Co., introduced James E. Riggins, of U.S. Paint Co., his replacement as Committee Chairman.

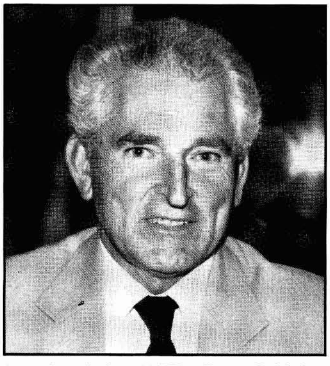
Speaker for the evening was Walt Puryear, of the Missouri Department of Natural Resources. He spoke on "EPA REGULATIONS AS THEY IMPACT ON THE PAINT INDUSTRY."

Mr. Puryear pointed out the types of wastes covered by the local EPA office including: sanitary waste landfills, illegal dumping, and hazardous waste compliance inspection.

The speaker stated that hazardous waste compliance inspection is divided in two parts. Part I covers the meeting with management, checking paperwork, and a thorough plant tour. Part II is the exit interview.

Violations, according to Mr. Puryear, are divided into degrees of hazard. Class I means immediate or potential hazards. Violation of Class I puts the company in jeopardy of being fined and a citation will be issued. Class II are day-to-day shortcomings in record keeping or other violations that pose no threat to workers or the general public. A violation of Class II is answered with a letter of warning and an unannounced inspection will be made at a later date.

The speaker stressed the fact that companies must know the contents of all containers on their property and that all drums must be identified. Materials in process must be labeled and identified. If more



**SILICONES SPEAKER—Harry Schiefer, of Dow Corning Corp., was the guest speaker at the Los Angeles Society October meeting**

than four drums are on the property and they look old, there is a possibility of a Class I violation.

In conclusion, Mr. Puryear stated that Missouri has accepted the Land Banned and Waste Minimization regulations of the Federal Government and they will go into effect August 1988. Manufacturers now will have to identify their plan and prove that it is working.

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*Q. What does the state of Missouri feel is the best way to minimize solvent waste?*

A. Resource recovery is the key to minimizing waste. The process of recycling or "in-house" distillation is the key to minimizing costs and headaches.

*Q. What types of programs are available to educate those responsible for waste management?*

A. Generator workshops are held throughout the state from time to time, however, funding is being somewhat curtailed. You can expect the number of workshops to be reduced.

Howard Jerome, *Secretary*

## WESTERN NEW YORK. . . . SEPT.

### *"Predispersed Polyethylenes and Waxes"*

Edwin Kaczmarek, of Dar-Tech, Inc., presented the Nuodex gavel to President Jean L. Luck, of Pratt & Lambert, Inc.

Michael C. Frantz, of Daniel Products Co., gave the evening's technical presentation. Mr. Frantz, a member of the New York Society, spoke on the "Advantages of Predispersed Polyethylenes and Waxes in High Performance Coatings."

The speaker pointed out that predispersions eliminated incorporation problems and used low energy mixing techniques. He said that "slip additives" are really "surface conditioners" based on their many other uses other than providing "slip."

According to Mr. Frantz, a new generation of dispersions are now used in applications where gloss and clarity are not affected. He commented on the fact that new wet grinding processes are providing polyethylene dispersions to a fine particle size never before obtainable.

In conclusion, the speaker said that wax dispersions have become available in solvents and/or blends of solvents for applications where they otherwise would not have been satisfactory.

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*Q. What about the effectiveness of predispersed waxes in air-dry coatings?*

A. They are more efficient in bake or force-dry coatings. In air-dry coatings only if the film is thin allowing wax particles to come to the surface.

Marko K. Markoff, *Secretary*

## Constituent Society Meetings and Secretaries

BALTIMORE (Third Thursday—Snyder's Willow Grove, Linthicum, MD). Donald Hilliard, Unocal, 1500 Carbon Ave., Baltimore, MD 21226. Virginia Section (Fourth Wednesday—Ramada Inn-East, Williamsburg, VA).

BIRMINGHAM (First Thursday—Strathallan Hotel, Birmingham, England). D.A.A. Wallington, Macpherson Drynamels Ltd., Westgate, Aldridge, West Midlands WS9 8YH England.

CDIC (Second Monday—Sept., Jan., Apr., June in Columbus; Oct., Dec., Mar., May in Cincinnati; and Nov., Feb. in Dayton). N. Jay Huber, Jr., Paint America Co., 1501 Webster St., Dayton, OH 45404.

CHICAGO (First Monday—meetings alternate between Como Inn in Chicago, IL and Sharko's West in Villa Park, IL). Kevin P. Murray, DeSoto, Inc., 1700 S. Mt. Prospect Rd., Des Plaines, IL 60018.

CLEVELAND (Third Tuesday—meeting sites vary). Ilona Nemes-Nemeth, Sherwin-Williams Co., Cleveland Technical Center, 601 Canal Rd., Cleveland, OH 44113.

DALLAS (Thursday following second Wednesday—Harvey Hotel, North Dallas, TX). Steve Stephens, Ribelin Sales, Inc., P.O. Box 461673, 3857 Miller Park Dr., Garland, TX 75046.

DETROIT (Second Tuesday—Ukrainian Cultural Center, Warren, MI). Liana Callas Roberts, A.T. Callas Co., 1985 W. Big Beaver, Suite 308, Troy, MI 48043.

GOLDEN GATE (Monday before third Wednesday—Alternate between Francesco's in Oakland, CA and Leaning Tower Restaurant in S. San Francisco). Gordon Pioch, Triangle Coatings, Inc., 1930 Fairway Dr., San Leandro, CA 94577.

HOUSTON (Second Wednesday—Look's Sir-Loin Inn, Houston, TX). Sandra Swift, Cron Chemical Corp., P.O. Box 14042, Houston, TX 77221.

KANSAS CITY (Second Thursday—Cascone's Restaurant, Kansas City, MO). Nick Dispensa, Davis Paint Co., P.O. Box 7589, N. Kansas City, MO 64116.

LOS ANGELES (Second Wednesday—Steven's Steak House, Commerce, CA). James F. Calkin, E.T. Horn Co., 16141 Herron Ave., La Mirada, CA 90638.

LOUISVILLE (Third Wednesday—Executive West Motor Hotel, Louisville, KY). Raymond L. Mudd, Porter Paint Co., Coatings Div., P.O. Box 1439, 400 S. 13th St., Louisville, KY 40201-0439.

MEXICO (Fourth Thursday—meeting sites vary). Arturo Ita, Pinturas Aurolin, S.A. De C.V., Poniente 150 No. 750, Nueva Industrial Vallejo, 02300 Mexico, D.F.

MONTREAL (First Wednesday—Bill Wong's Restaurant, Montreal). Robert Benoit, NL Chemicals Canada Inc., 4 Place Ville-Marie, Ste. 500, Montreal, Que., Canada H3B 4M5.

NEW ENGLAND (Third Thursday—LeChateau Restaurant, Waltham, MA). Joseph T. Schrody, Unocal Chemicals Div., 90 Cumberland Rd., Leominster, MA 01453.

NEW YORK (Second Tuesday—Landmark II, East Rutherford, NJ). Arthur A. Tracton, Hempel Coatings, Inc., Foot of Curie Ave., Wallington, NJ 07057.

NORTHWESTERN (Tuesday after first Monday—Jax Cafe, Minneapolis, MN). Mark W. Uglem, Hirschfield's Paint Mfg., Inc., 4450 Lyndale Ave., N., Minneapolis, MN 55412. Winnipeg Section (Third Tuesday—Marigold Restaurant, Winnipeg). Neil Webb, Phillips Paint Products Ltd., 95 Paquin Rd., Winnipeg, MB, Canada R2J 3V9.

PACIFIC NORTHWEST (Portland Section—Tuesday following second Wednesday; Seattle Section—the day after Portland; British Columbia Section—the day after Seattle). Emil Iraola, Olympic Home Care Products Co., 1141 N.W. 50th, Seattle, WA 98107.

PHILADELPHIA (Second Thursday—Williamson's, GSB Bldg., Philadelphia, PA). Orville E. Brown, M.A. Bruder & Sons Inc., 52nd & Grays Ave., Philadelphia, PA 19143.

PIEDMONT (Third Wednesday—Americana Inn, Greensboro, NC). Forest G. Fleming, Reliance Universal, Inc., P.O. Box 2124, High Point, NC 27261.

PITTSBURGH (Second Monday—Montemurro's, Sharpsburg, PA). James Lore, Watson Standard Co., P.O. Box 11250, Pittsburgh, PA 15238.

ROCKY MOUNTAIN (Monday following first Wednesday—Bernard's Arvada, CO). Craig Schweiger, Walsh & Associates, 10190 Bannock St., Denver, CO 80221.

ST. LOUIS (Third Tuesday—Salad Bowl, St. Louis, MO). Howard Jerome, Mozel Equipment Co., 4003 Park Ave., St. Louis, MO 63110.

SOUTHERN (Gulf Coast Section—Third Thursday; Central Florida Section—Third Thursday after first Monday; Atlanta Section—Third Thursday; Memphis Section—bi-monthly on Second Tuesday; Miami Section—Tuesday prior to Central Florida Section). Kenneth W. Espeut, Jim Walter Research, 10301 9th St. N., St. Petersburg, FL 33702.

TORONTO (Second Monday—Cambridge Motor Hotel, Toronto). Roy A. Donnelly, St. Lawrence Chemical Co. Ltd., 321 Humberline Dr., Rexdale, Ont., Canada M9W 5T6.

WESTERN NEW YORK (Third Tuesday—meeting sites vary). Marko K. Markoff, 182 Farmingdale Rd., Cheektowaga, NY 14225.

# Elections

## BALTIMORE

*Active*

Allan, Charles H.—SCM Pigments/SCM Corp., Baltimore, MD.
Ayres, Charles F.—Valspar Corp., Baltimore.
Blakely, Archie K.—Valspar Corp., Baltimore.
Cook, David D.—Valspar Corp., Baltimore.
Hansen, Donna L.—Genstar, Texas, MD.
Kraus, Michael C.—Valspar Corp., Baltimore.
Kurnas, John S.—Burns & Russell Co., Baltimore.
Lally, Thomas A.—Arcal Chemicals Inc., Baltimore.
Liu, Tony Y.—Valspar Corp., Baltimore.
McCormick, James A.—LCI, Inc., Baltimore.
Morgan, Roger E.—Valspar Corp., Baltimore.
Mostafa, Yehia Ali—Valspar Corp., Baltimore.
Provins, M. Robert—Valspar Corp., Baltimore.
Pund, C. Herbert III—Sampson Coatings, Inc., Richmond, VA.
Schilare, Joseph C.—Valspar Corp., Baltimore.
Williams, Leon J.—SCM Pigments/SCM Corp., Baltimore.

*Associate*

Basque, David E.—Dow Chemical, Moorestown, NJ.
Hall, Vincent W.—E.M. Sullivan Associates, Inc., Havertown, PA.
Jortland, Robert A.—R.J. Chemical Sales Inc., Cockeysville, MD.
Krimmel, Eric P.—Tioxide America, Inc., Columbia, MD.
Merges, John C.—Saturn Chemicals Inc., Philadelphia, PA.
Reitano, Philip A.—Charles A. Wagner Co., Inc., Philadelphia.
Sherman, Dana—A.B. Kohl Sales Co., Towson, MD.
Stiff, Wendy L.—Color Corp. of America, Sicklerville, NJ.
Vacca, Suzanne M.—C.J.Osborne Chemicals, Inc., Pennsauken, NJ.

## BIRMINGHAM

*Active*

Deaville, James—Capricorn Chemicals, Cheadle Hulme, Cheshire.
Griffiths, Neil—Newtown Ind. Paints, Erdington, Birmingham.
Kerr, John D.—Holden Surface Coatings Ltd., Birmingham.
Mitchell, S.J.—Manders Industrial Div., Ruabon Wrexham, Clywd.

## C-D-I-C

*Active*

Motter, Lisa—DAP Inc., Dayton, OH.
Nedesky, Richard D.—Borden Inc., Columbus, OH.
Patel, Ron D.—A.O. Smith, Protective Coatings, Florence, KY.
Pearson, Paul D.—Borden Inc., Columbus.
Rapkin, Myron C.—Boehringer-Mannheim, Indianapolis, IN.
Widdecombe, Lawrence W.—Plastic Coatings Corp., St. Albans, WV.

*Associate*

Boldt, Paul W.—Schabel Products, West Chester, OH.
Broxterman, Michael P.—Michelman Inc., Cincinnati, OH.
Kistler, Frederick J.—EM Industries, Cincinnati.
Polaski, Edward T.—Sun Chemical Corp., Cincinnati.
Samuelson, Peter J.—Lawter International Inc., Cincinnati.

## CHICAGO

*Active*

Attard, Peter M.—U.S.G. Corporation, Libertyville, IL.
Baker, James L.—Benjamin Moore & Co., Melrose Park, IL.
Campbell, Gordon G.—Moline Paint Mfg. Co., Moline, IL.
Clancy, Kevin M.—U.S.G. Corporation, Libertyville.
Dahm, Donald B.—Niles Chemical Paint, Niles, MI.
Derer, John L.—DeSoto, Inc., Des Plaines, IL.
Desai, Snehal S.—Domino Amjet Inc., Gurnees, IL.
England, Arthur D.—Midland Div., Dexter Corp., Waukegan, IL.
Forman, Steven S.—Polychrome Chemicals Co., Chicago, IL.
Fults, Terry—U.S.G. Corporation, Libertyville.
Gentile, Gregory N.—Sherwin-Williams Co., Chicago.
Holzrichter, Norm—Illinois Bronze, Lake Zurich, IL.
Larson, Richard—U.S.G. Corporation, Libertyville.
Lencioni, Leonard M.—Matthews Paint Co., Wheeling, IL.
Negri, Robert H.—U.S.G. Corporation, Libertyville.
Neidich, Richard S.—Benjamin Moore & Co., Melrose Park.
Patel, Sankabhia D.—Polychrome Chemicals Co., Chicago.
Poganski, William J.—Moline Paint Mfg. Co., Moline.
Robinson, Russel D.—O'Brien Corp., South Bend. IN.
Schmidt, Richard—Spraylat Corporation, Chicago.
Stahlberg, Scott—Rust-Oleum Corp., Evanston, IL.

*Associate*

Beels, Gregory J.—Hitchcock Publishing, Wheaton, IL.
Blanchard, Joseph R.—Akzo Chemie America, Chicago, IL.
Mishler, Pamela S.—Leader Industries, Portage, IN.
Wasielewski, Wayne S.—Sun Chemicals, Addison, IL.
Wilhelm, George H.—Polychrome Chemicals Co., Chicago.

## CLEVELAND

*Active*

Christy, Thomas G.—Jamestown Paint & Varnish Co., Jamestown, PA.
Cox, Michael W.—Man-Gill Chemical Co., Bedford, OH.
Erikson, Leonard E.—Man-Gill Chemical Co., Bedford.
Erwin, Emmett M.—General Electric Co., Cleveland, OH.
Faber, David T.—Man-Gill Chemical Co., Bedford.
Glover, Roy A.—Jamestown Paint & Varnish Co., Jamestown.
Grays, Kwan L.—Man-Gill Chemical Co., Bedford.
Hasan, Syed Y.—Sherwin-Williams Co., Cleveland.
Krempasky, Louis J.—Cook Paint & Varnish Co., Cleveland.
Lack, Jeffrey A.—Man-Gill Chemical Co., Bedford.
Mandat, Michael J.—Whittaker Corp., Cleveland.
McAllister, Raymond P.—Jamestown Paint & Varnish Co., Jamestown.
McCarthy, Joseph F. Jr.—Plasti-Kote Co., Inc., Medina, OH.
Mendat, Ryne—Man-Gill Chemical Co., Bedford.
Mikol, Richard A.—Tremco Corp., Cleveland.
Monske, Robert L.—Jamestown Paint & Varnish Co., Jamestown.
Parsons, Larry I.—Man-Gill Chemical Co., Bedford.
Selecky, Douglas C.—Man-Gill Chemical Co., Bedford.
Shaffer, Stephen M.—Jamestown Paint & Varnish Co., Jamestown.
Slifko, Phillip M.—CRGI, Cleveland.

Tuckerman, Thomas D.—Stewart Bros. Paint Co., Alliance, OH.
Winston, Adrienne K.—Cook Paint & Varnish Co., Cleveland.

*Associate*

Admire, Gloria L.—FBC Chemical, Akron, OH.
Dressel, Thomas—D.A. Campbell & Co., Inc., Cleveland.
Frketic, Karen E.—FBC Chemical, Mars, PA.
Griffiths, Ruth V.—Union Carbide Corp., Brecksville, OH.
Jordan, Dennis P.—Lomas Minerals and Chemicals, Williamsville, NY.
Leiby, Dean M.—Degussa Corp., Hudson, OH.
Varga, Carl M.—Man-Gill Chemical Co., Bedford, OH.

*Retired*

Hill, H. Earl—Erie, PA.

## DALLAS

*Active*

Beard, Frederick T.—DeSoto, Inc., Garland, TX.
Cira, Thomas D.—Western Specialty Coatings Co., Grand Prairie, TX.
Davidson, Brad H.—Mohawk Laboratories, Irving, TX.
Heydrick, Jeff—DeSoto, Inc., Garland.
Huber, Fred John—Caddo Paint Co., Inc., Shreveport, LA.
Hudgins, Bill—Tri-Con Technology Inc., Ennis, TX.
Hughes, James Z.—Western Specialty Coatings Co., Grand Prairie.
Kesatie, Douglas—Kerr-McGee Chemical Corp., Oklahoma City, OK.
Larey, C. E.—Secure Inc., Waxahachie, TX.
Leonard, Joseph R.—DeSoto Inc., Garland.
McCroskey, Tom W.—Kelly-Moore Paint Co., Inc., Hurst, TX.
Miles, William M.—DeSoto, Inc., Garland.
Rapple, Rod S.—Texstar Inc., Arlington, TX.
Savell, Fred B.—Secure Inc., Waxahachie.
Tomlinson, Gene—DeSoto, Inc., Garland.
Walrup, David M.—Del Paint Mfg. Corp., Oklahoma City.
Weaver, Kenneth M.—DeSoto, Inc., Garland.

*Associate*

Bazard, Greg—Delta Distributors, Dallas, TX.
Bress, John—M.D. Chemical Enterprises Inc., Waxahachie, TX.
Curry, Chris L.—Hercules Incorporated, Alpharetta, GA.
Mulligan, Ronald E.—Cron Chemical Co., Dallas.
Pugh, Bobby L.—Cron Chemical Co., Dallas.
Pylant, George D.—Hoechst Celanese Corp., Whitney, TX.
Saba, Phillip S.—Cron Chemical Co., Dallas.
Sanders, John T.—Ribelin Sales, Inc., Garland, TX.
Wright, Bill N.—Cron Chemical Co., Dallas.

## KANSAS CITY

*Active*

Bailey, William B.—Farmland Industries, Inc., North Kansas City, MO.
Claibourn, William A.—Davis Paint Co., North Kansas City.
Davidson, Rance A.—Cook Paint & Varnish Co., Kansas City, MO.
Marolf, Steven C.—Hallmark Cards Inc., Leavenworth, KS.
Murphy, Lawrence J.—Tnemec Co., North Kansas City.
Parker, Larry D.—Prosoco, Inc., Kansas City.
Schmedding, Nick J.—Tnemec Co., Inc., North Kansas City.
Sours, Joseph D.—Cook Paint & Varnish Co., Gladstone, MO.

*Associate*

Ankofski, Greg T.—Buckman Laboratories, Mission, KS.

## LOS ANGELES

*Active*

Davis, Paul Gregory—Multi-Chemical Inc., South El Monte, CA.
Diaz, Mark A.—Spraylat Corp., Los Angeles, CA.
Russell, James L.—Walt Disney Productions, Burbank, CA.
Strugar, Daniel—Behr Process Corp., Santa Ana, CA.
Trinh, Yen T.—BASF Corp., Anaheim, CA.

*Associate*

Cline, Bob—Allied Environmental, Downey, CA.
Gerlach, Irving J.—BASF Corp., El Monte, CA.

## LOUISVILLE

*Active*

Brattain, Mike E.—Devoe Marine Coatings, Louisville, KY.
Coffey, Wayne N.—United Catalyst, Inc., Louisville.
Hubbuch, Bruce E.—Porter Paint Co., Louisville.
Rembold, William H. Jr.—Devoe Marine Coatings, Louisville.
Van de Streek, Gary—Reliance Universal, Inc., Louisville.

## NEW ENGLAND

*Active*

Benson, Janice M.—Kyanize/NuBrite, Everett, MA.
Manoochehri, Ali—Permuthane Coatings, Winthrop, MA.
Volkin, Gerald—Kyanize/NuBrite, Everett.

*Associate*

Clark, Gordon A.—Diano-Milton Roy Co., S. Attleboro, MA.

Snape, Wayne L.—Rohm and Haas Co., Stafford Springs, CT.

## NEW YORK

*Active*

Berberian, Edward M.—D.H. Litter Co., Inc., Summit, NJ.
Dante, Mark F.—Exxon Chemical Co., Linden, NJ.
Engel, Walter D.—Cook & Dunn Paint Corp., Carlstadt, NJ.
Friedman, Jack E.—Jema-American, Inc., Dunellen, NJ.
Hirsch, Marc S.—Benjamin Moore & Co., Newark, NJ.
Kelley, Lloyd—Ultra Adhesives Inc., Paterson, NJ.
Leeds, Alfred B.—Agate Lacquer Mfg. Co., Long Island City, NY.
McGrath, James—Hempel Marine Coatings, Wallington, NJ.
Morales, Ellen S.—U.S. Aluminum, Inc., Flemington, NJ.
Shah, Jitendra—R&A Specialty Chemical Corp., Inc., Brooklyn, NY.

*Associate*

Castorina, Thomas J.—Lenape Chemicals, Bound Brook, NJ.
Hiraishi, Shunichi—DIC Americas, Inc., Fort Lee, NJ.
Nagi, Sati—Fabricolor Inc., Elizabeth, NJ.
Rudeau, Thomas G.—Lenape Chemicals, Bound Brook.
Verhagen, Len—Jesse S. Young Co., Inc., Elizabeth.

*Retired*

Samit, Saul—Highland Park, NJ.

## NORTHWESTERN

*Active*

Levitt, Mark D.—Multi-Clean Inc., St. Paul, MN.
Rajan, Sundar J.—3M Company, St. Paul.
Thompson, Del R.—3M Company, St. Paul.

*Associate*

Hagge, Terry R.—Worum Chemical Co., St. Paul, MN.
Husom, June—3M Company, St. Paul.

## ST. LOUIS

*Active*

Ladage, John J. Jr.—Carboline Co., St. Louis, MO.
Schnuvman, Michael S.—Sinnett-Elpaco Coatings Corp., St. Louis.
Zanardi, A.E.—C.L. Smith Co., St. Louis.

*Associate*

Bonnell, Ronald—Johnson Wax, St. Louis, MO.

# Future Society Meetings

## Baltimore

(Jan. 21)—"Vinyl Acrylics in Rheology Modified Coatings"—Richard Caldwell, Reichhold Chemicals.

## Birmingham

(Feb. 4)—"The Future of the Paint Industry: A Personal View"—Quintin Knight, ICI Paints.

(Mar. 3)—"Fundamentals of Water-Based Technology"—G. Brown, Harlow Chemical Co.

(Apr. 7)—"Improving Dispersion of Pigments"—Allen Cowley, ICI Chemicals and Polymers Ltd.

(May 5)—59th Annual General Meeting.

(May 12)—"British Standard BS 5750 Quality Assurance and the Paint Industry"—J. Cauthorpe, Sonneborn & Rieck Ltd.

## C-D-I-C

(Mar. 14)—"Improving Opacity and Flow Properties with Organic Pigments"—Gary Jordan, Hoechst Corp.

(Apr. 11)—"Evaluating Coatings for Long Term Protection"—Bernard Appleman, Steel Structures Painting Council.

## Chicago

(Feb. 1)—"Solubility and Performance of High Solids with 1,1,1 Trichloroethane"—James A. Mertens, Dow Chemical Corp. and "Mercaptans: Added Dimensions for Epoxy Coatings"—Stuart Hartman, Henkel Corp. Como Inn.

(Mar. 7)—"Media Selection"—Ivan Quackenbush, Quackenbush Co. and "Driers and Related Additives"—Sam Bellettiere, Nuodex, Inc., Sharko's.

(Apr. 4)—"Improved Flow and Opacity with Organic Pigments"—Gary Jordan, Hoechst Corp. and "Dispersion of Organic Pigments"—Ted Vernardakis, Sun Chemical Corp. Sharko's.

(May)—Awards Night.

## Cleveland

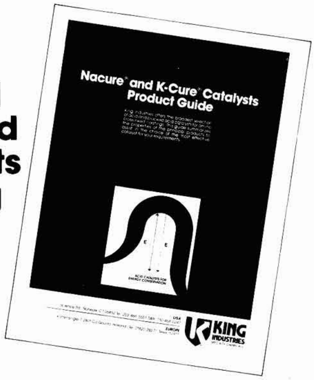
(Jan. 19)—Joint Meeting with Cleveland PCA. "VOC and the Ozone Issue"—James C. Berry, U.S. Environmental Protection Agency. Harley Hotel.

(Feb. 16)—"Activities of the Center for Adhesives, Sealants, and Coatings (CASC)"—Charles Rogers, Case Western Reserve University. Independence Brown Derby.

(Mar. 15)—Speaker to be announced.

(Apr. 19)—Awards Night. "Plasma Surface Treatment for Enhanced Adhesion of Coatings for Plastics"—Peter Rose, Plasma Science Inc. Independence Brown Derby.

(May 17)—"Effect of Coatings on Acoustic Qualities of Musical Instru-



Ments"—Speaker to be announced. Harley Hotel.

## Golden Gate

(Jan. 18)—"CPVC of Latex Paints and Formula Optimization"—William D. Meadows, Cyprus Industrial Minerals. Francesco's Restaurant, Oakland.

(Feb. 8)—Joint Meeting with Golden Gate PCA. Holiday Inn, So. San Francisco.

(Mar. 14)—"Production Management, Formula Analysis and Compliance Using the Personal Computer"—Christy Ausman, Pacific Micro. Francesco's Restaurant.

(Apr. 18)—"Modern Trends in Organic Pigment Technology"—Hugh M. Smith, Sun Chemical Corp. Holiday Inn.

(May 16)—"Under Utilized Kaolin"—Dan Dixon, Engelhard Minerals & Chemicals Corp. Francesco's Restaurant.

(June 13)—Manufacturing Committee Program. Holiday Inn.

## Houston

(Mar. 16-18)—Southwest Paint Convention—Speaker to be announced. Hyatt Regency Hotel, Houston, TX.

(Apr. 13)—"Advantages of Pre-Dispersed Polyethers and Waxes in High Performance Coatings"—Elio Cohen, Daniel Products Co.

(May 11)—Speaker to be announced.

## Los Angeles

(Mar. 9)—Past-Presidents' Night. "Production Management, Formula Analysis and Compliance Using the Personal Computer"—Christy Ausman, Pacific Micro.

(Apr. 13)—Bosses' Night. "Modern Trends in Organic Pigment Technology"—Hugh M. Smith, Sun Chemical Corp.

(May 11)—Awards Night. "Under Utilized Kaolin"—Dan Dixon, Engelhard Minerals & Chemicals Corp.

(June 8)—Annual Meeting and Election of Officers.

## Louisville

(Jan. 20)—Federation Officers and Past-Presidents' Night.

## Montreal

(Feb. 3)—"Stains for Wood Siding"—F. Dale Williamson, Olympic Home Care Products Co.

(Mar. 2)—"Breakthrough in Maintenance Paint for Steel"—Michael Bishop, ICI Mond Div.

(Apr. 6)—Technical Committee Presentation—John E. Hall, Tioxide of Canada Ltd.

(May 4)—Manufacturing Committee Presentation—Ladislov Krivanek, International Paints Ltd.

## New York

(Feb. 11)—Seminar and Joint Meeting with Metropolitan New York PCA. "'88 Legislative Update."

(Mar. 8)—"High Solids Urethane Coatings"—Bernard Talb, NL Chemicals.

(Apr. 12)—Speaker to be announced.

(May 10)—Past-Presidents' and PaVaC Awards Night.

## Pacific Northwest—Portland, Seattle, & Vancouver Sections

(Jan. 19-21)—"CPVC of Latex Paints and Formula Optimization"—William D. Meadows, Cyprus Industrial Minerals, Inc.

(Mar. 15-17)—"Production Management, Formula Analysis and Compliance Using the Personal Computer"—Christy Ausman, Pacific Micro.

(Apr. 19-21)—"Modern Trends in Organic Pigment Technology"—Hugh M. Smith, Sun Chemical Corp.

(May 17-19)—"Under Utilized Kaolin"—Dan Dixon, Engelhard Minerals & Chemicals Corp.

## Philadelphia

(Feb. 11)—"Modern Trends in Organic Pigment Technology"—Hugh M. Smith, Sun Chemical Corp.

(Mar. 10)—"Coatings for Plastic Substrates"—Richard Johnson, Cargill, Inc.

(Apr. 8)—Awards Night.

(May 12)—Speaker to be announced.

## Pittsburgh

(Feb. 8)—Federation Officers' Night.

(Apr. 11)—Symposium on Hazardous Waste Laws—Speaker to be announced.

## Rocky Mountain

(Mar. 7)—"Production Management, Formula Analysis and Compliance Using the Personal Computer"—Christy Ausman, Pacific Micro.

(Apr. 11)—"Modern Trends in Organic Pigment Technology"—Hugh M. Smith, Sun Chemical Corp.

(May 9)—"Under Utilized Kaolin"—Dan Dixon, Engelhard Minerals & Chemicals Corp.

# People

E.C.C. America, Inc., Atlanta, GA, has announced the promotion of **Paul I. Prescott** to Marketing Manager—Extended Pigments. Mr. Prescott has been with the company since 1985, and most recently served as Manager—New Business Development. He is a member of the Southern Society.

**Lany B. Aldrich** has been appointed Technical Representative for the Los Angeles and San Francisco areas for SCM Chemicals, Baltimore, MD. Mrs. Aldrich will be responsible for the direct sales and support of all the company's products.

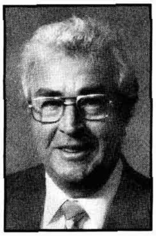
Bee Chemical Company, Lansing, IL, recently appointed **Joseph J. Rizzo** National Sales Manager for the Universal Color Dispersions (UCD) Division. Based in Lansing, Mr. Rizzo will be responsible for coordinating selling activities of the independent sales agencies representing UCD in the United States and Canada.

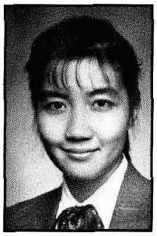
The Board of Directors of WhiteMetal Inc., Houston, TX, has announced the appointment of **Ronald A. Munier** to President and Chief Operating Officer. Mr. Munier will also serve in the same capacities with the company's affiliate HoldTight, Inc.

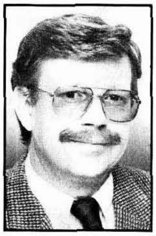
In addition, **G.C. "Mike" Castillo** has been named Manager—Service. He will be responsible for field services and manufacturing functions for both WhiteMetal and HoldTight.

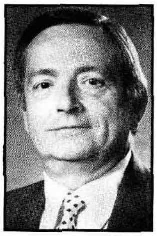
**Samuel B. Luse** has been named Plant Manager at Troy Chemical Corporation, Newark, NJ. In his new position, he will be responsible for all phases of the Newark plant operation, including plant facilities, warehousing, and maintenance. Prior to joining Troy, Mr. Luse spent 15 years with the Lubrizol Corporation in Ohio.

In addition, **Alexander M. Gerardo** has been appointed Director of Human Resources. He will be responsible for employee recruiting, training, benefits, compensation, employee relations, and communications.


**P.I. Prescott**


**L.B. Aldrich**


**M. Wild**


**R. Olszewski**

**Martin Wild** has joined the staff of D/L Laboratories, New York, NY, as Technical Director. He will be responsible for overall supervision of the research and testing programs conducted by the firm, including studies being carried out for various commercial clients, as well as U.S. government research.

The Coatings, Colors and Electronic Materials Group of the Ferro Corporation, Cleveland, OH, has appointed **James F. Fisher** to the position of Group General Manager. In his new position, Mr. Fisher will assume responsibility for the direction and management of the group's five divisions (Frit, Powder Coatings, Color, Electronic Materials, and Transelco).

In addition, **Richard C. Oudersluys** has been named General Manager of the Color Division of Ferro Corporation. Prior to his new position, Mr. Oudersluys served as Executive Vice-President of Ferro (Holland) B.V., in Rotterdam, Holland.

In a move to focus greater attention on the individual needs of its users, the Coatings & Additives Group of Hercules Incorporated, Wilmington, DE, has created two new industry positions to service the paint and coatings, and plastics and rubber fields. Appointed to the posts are **John P. DeVido**—Industry Manager for Paint and Coatings, and **Peter J. Wilson**—Industry Manager for Plastics and Rubber Applications. Mr. DeVido, formerly the group's Technical Services Manager, brings to this assignment 30 years of experience, and Mr. Wilson has been serving the rubber and plastics industries for Hercules since 1959.

The Chemical Coatings Division of The Sherwin-Williams Company, Chicago, IL, has announced that **Robert Olszewski** has been appointed Business Unit Manager of the division's coil operations. Using an extensive background in the coil coatings industry, Mr. Olszewski will also direct marketing activities for the division's electrocoating and aluminum extrusion businesses.

**Harvey E. Bair** of AT&T Bell Laboratories has been named the recipient of the 1987 Mettler Award in Thermal Analysis. The award, which is sponsored by Mettler Instrument Corporation, Hightstown, NJ, recognizes and encourages individual achievement in the field of thermal analysis.

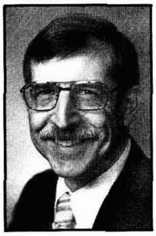
**Henry W. Fishkin,** President of Ferro Corporation's Coatings Division, Cleveland, OH, has announced his retirement after nearly 40 years of service. He joined the company in 1948 as a Development Engineer in the porcelain enamel laboratory, and has since held various sales, marketing, and managerial positions.

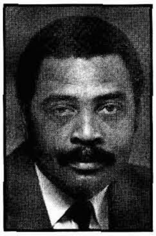
Also, Ferro announced the restructuring of two of its coatings businesses into separate divisions—the Frit Division and the Powder Coatings Division. The Frit Division will operate under the direction of **Lester M. Dunning**—General Manager, and the Powder Coatings Division will be headed by **Charles W. Johnson**—General Manager.

In addition, **Morris E. Van Vooren** has joined the Color Division of Ferro as Sales Engineer, Forehearth Colors.

Rohm and Haas Company, Philadelphia, PA, has announced the appointment of **George F. Detrick** to the position of Market Manager—General Industrial Finishing. Before being named to this new position, Mr. Detrick served as Market Manager in charge of aqueous general industrial finishing, as well as building products coatings for Rohm and Haas.

Succeeding Mr. Detrick as Market Manager, Building Products, is **Herbert A. Pigrom.** Mr. Pigrom will be responsible for marketing the company's line of acrylic polymers used to manufacture coatings for products such as hardboard and aluminum siding.


G.F. Detrick


H.A. Pigrom

A series of managerial and sales appointments in the Chemicals Division of Unocal Corporation, Schaumburg, IL, has taken place. Named to managerial posts were: **Mark R. Alexander**—Plant Manager, Birmingport, AL; **Jim Turner**—Customer Service Manager, Chicago, IL; **Craig L. Mikkelson**—Account Manager, Distribution Sales, Chicago; and **Bryan S. Hervey**—Account Manager, Memphis, TN. Named to sales positions were: **Michael D. Wendling**—Telemarketing Sales Representative, Houston, TX; and **Patricia S. Ross**—Sales Representative, Wichita, KS. Mr. Hervey is a member of the Southern Society.

**Jeffrey J. Norris** has been named Manager of Research and Development, Pigment Dispersions for the Color Division of Harshaw/Filtrol Partnership, Cleveland, OH. His new responsibilities include new product research and development for the company's line of universal pigment dispersions.

**Jeffrey S. Chiu** has been named Industry Manager—Paint and Coating, of Kraft Chemical Company, Melrose Park, IL. Mr. Chiu brings many years of experience in the chemical raw material industry to his new position.

Goodyear's Polyester Division, Akron, OH, has appointed **Ed Sisson** to the position of Polyester Recycle Coordinator. Among his many responsibilities, Mr. Sisson will work with polyester research on new end uses of recycled resin as well as reexamine the uses developed in the firm's earlier findings.

The Powder Coatings Group of Morton Chemical Division, Chicago, IL, has promoted **Robert A. Korecky** to National Sales Manager. Based in Reading, PA, he will be responsible for product growth and sales in both the development and commercial sales area. Reporting to Mr. Korecky will be **Paul J. Morgano** who was promoted to Assistant National Sales Manager. He will be based in New Jersey and will be responsible for all internal sales activity and support, including product marketing.

In addition, **Berl M. Garner** has been promoted to Marketing Manager for the firm's Water Based Polymers Group, in Chicago. Mr. Garner has been with the company for 23 years, most recently as Marketing Manager, Chemical Specialties.

Reichhold Chemicals, Inc., White Plains, NY, has announced the promotion of **D. Eric Pogue** to Senior Vice-President. Mr. Pogue joined Reichhold in 1982 as Director of Human Resources and recently served as Vice-President—Human Resources.

**Steven J. Kody** has been promoted to Senior Account Manager in the eastern sales region of Union Carbide Corporation's UCAR Emulsion Systems group, based in Somerset, NJ. Mr. Kody is a member of the Pittsburgh Society.

J.M. Huber Corporation, Clay Division, Macon, GA, has announced the promotion of **Joseph G. Colwell, Jr.** to Production Manager/Chief Engineer of the Wrens, GA, and Edisto, SC, offices. He will be responsible for the engineering and maintenance functions, and will direct the mining and processing operations for both locations.

In addition, the following five promotions were announced: **Gebru Belay**—Senior Product Engineer; **Charles Chalker**—Production Superintendent; **Don Cochran**—Senior Process Engineer; **Robert Inglett**—Production Engineer; and **Lynette Leonard**—Production Cost Analyst.

The Midland DDvision, of The Dexter Corporation, Waukegan, IL, has announced the following promotions: **Jacqueline Thyne**—Development Chemist, Packaging Laboratory; **Edward T. Pincombe**—Senior Laboratory Assistant; **Scott Wenzel**—Senior Technician, Packaging Laboratory, International Support Group; **Michael Nedelka**—Laboratory Assistant, Packaging Laboratory, International Support Group; **Sean C. Stupegia**—Technical Service Representative, Packaging Products; **Francine Shuster**—Product Manager, Military Program; and **Rocco Tischio**—Director of Laboratories, Specialty Products Group of Industrial Products.

Ms. Shuster is a member of the Chicago Society and serves as a member of the Editorial Review Board of the JOURNAL OF COATINGS TECHNOLOGY. Mr. Tischio is a member of the New England Society.

**Jay W. Adams** has been named Technical Service Manager for Tego Chemie Service USA, a Division of Goldschmidt Chemical Corporation of Hopewell, VA. Prior to joining Tego, Mr. Adams was Laboratory Manager for Dampney Company, Inc., Everett, MA.

Whittaker Corporation, Los Angeles, CA, has announced that **Don Lopez** has been appointed Vice-President—Market Development and Technical Director of the firm's Ram Chemicals Division. Prior to his appointment with Whittaker, Mr. Lopez was Technical Products Manager for Interplastic Corporation.

The appointments of **Tom Karalis**—Director of Research and Development, Clearing Laboratory, Chicago, IL, and **Khalid Rasheed**—Group Manager, Surfactant Laboratories, Houston, TX, have been announced by the Organics Division of Witco Corporation, New York, NY.

**John Severns** has joined the staff of Applied Color Systems, Inc., Princeton, NJ, as Technical Sales Representative for the company's Ohio Valley territory. He brings to this position extensive experience in the field of color measurement instrumentation.

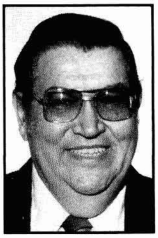
In addition, **Michael D. Duni** has been named Southwest Technical Sales Manager covering western Louisiana, Oklahoma, Texas, New Mexico, Arizona, Nevada, and Hawaii. He will be based in Dallas, TX.

# Obituary

**Joseph A. Vasta,** Senior Research Fellow in the Fabricated Products Department of E. I. du Pont de Nemours & Co., Inc., Wilmington, DE, died on November 5.

Active in the Federation for many years, Mr. Vasta served as Chairman of its Educational Committee. Through his efforts, the Committee recently produced a videotape promoting careers in the coatings industry. Additional contributions included serving as Chairman of the Mattiello Lecture and Roon Awards Committees, as a Trustee of the Coatings Industry Education Fund, and as a member of the Professional Development and Publications Committees. He served on the JCT Editorial Review Board since 1982. Mr. Vasta was a member of the Philadelphia Society.

Mr. Vasta received a B.S. Degree in Chemistry from Georgia Institute of Technology in 1950 and M.S. Degree in Chemistry from Drexel University in 1954.



He began his career at the Georgia Institute of Technology Research Center, where he was involved in the study of superconductivity of rare earth metals, among other projects. In 1952, he joined the DuPont Marshall R & D Laboratory and was responsible for both research and development assignments. Areas of study included adhesives, ambient room temperature curing, waterborne, and powder coatings.

In 1972, Mr. Vasta was named a Research Fellow of the Fabricated Products Department. He is credited with the technology incorporated in many widely used coatings; for example, Imron™ urethane coating was one of his inventions. In addition, he was an early pioneer for the introduction of safer solvents and low VOC coatings. In his 35 years at the company, he was responsible for more than 75 U.S. patents and numerous commercial coating products.

Mr. Vasta served as Chairman of the Gordon Research Conferences and was involved in the Polymer Materials, Science and Engineering group of the American Chemical Society and that organization's Roy Tess Award.

He is survived by wife, Rita J., and daughters, Rita, Julia, Victoria, and Linda. The family requests that contributions be made in his memory to the Coatings Industry Education Fund, 1315 Walnut St., Philadelphia, PA. Notes of condolence can be sent in care of Mr. Vasta's daughter, Rita Vasta, DuPont Co., Inc., Experimental Station, Polymer Products Dept., Building 353, Wilmington, DE 19898.

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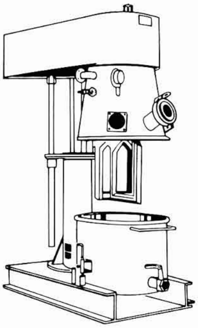

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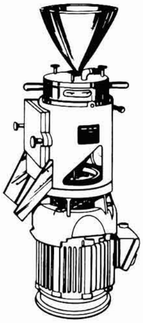

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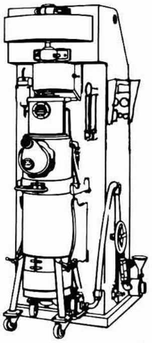

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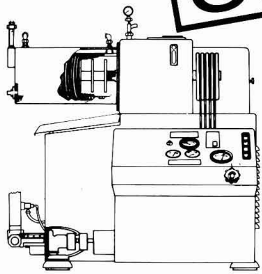

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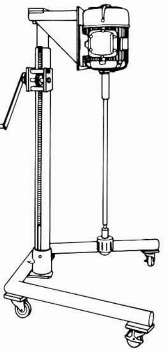

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# University of Missouri-Rolla Spring Courses To Focus on Coatings and Polymer Science

The Chemistry Department of the University of Missouri-Rolla, Rolla, MO, has scheduled five short courses as part of its spring Paint & Coatings Program.

The first offering, *Maintenance Coatings for Contractors and Paint Inspectors*—"Know Your Paints to Avoid Complaints," will be held from February 22 to 24. This intensive three-day program is designed to bring attendees up to date on new materials, equipment, and methods of preparing surfaces for applying maintenance coatings. Areas covered will include specification reading and writing, paint "anatomy," and current regulations. The course is targeted towards paint contractors, maintenance engineers, paint specifiers, architects, painting foremen, and paint sales people. Instructor John A. Gordon will present lectures and demonstrations in an informal way, inviting questions and discussions.

*56th Introductory Short Course*—"The Basic Composition of Coatings" is scheduled from February 29 to March 4. Intended to introduce the newcomer to the technical aspects of paint manufacture, testing, and use, the course is also designed for those involved in raw material manufacture, sales, and technical service. Topics of discussion include the history of paint, materials used in manufacture, simple formulating techniques that can be put to immediate use, an introduction to the equipment used to make and test modern protective coatings, and modern chemical instrumentation as applied to coatings. Particular attention will be given to the needs of newcomers to the coatings industry in laboratories, production units, or marketing groups. No prior experience in the coatings field is needed to participate in this introductory course. A tour of a local paint company will conclude the course.

*16th Introductory Short Course*—"Paint Formulation"—will be held March 14 to 18. It is intended for persons interested in the basic fundamental concepts of this important science. Topics include: basic raw materials and their influences on the performance characteristics of the finished coating, manufacturing and testing of coatings in the laboratory to meet the state requirements of the job to be done with a minimum of inventory complication, limitations of plant production equipment and the variables that can be introduced when a coating is moved from the laboratory to the plant, systems for reducing variables in screening series, and modern chemical instrumentation as applied to coatings. In an intensive lecture and laboratory situation, attendees will practice principles taught and have an opportunity to test some of their own ideas. Guest lecturers from industry will also provide a variety of ideas. For laboratory work, students will have a choice between paint formulating or whole paint analysis. Prerequisites include experience in a coatings laboratory or raw materials and manufacturing company, completion of the UMR introductory short course "Basic Composition of Coatings," or some basic training in chemistry.

"Conformal Coatings" will be presented from April 18 to 20. This course is intended for persons involved in the use, formulation, selection, manufacture, or sales of conformal coatings used in electronics. Highlights include discussions on selection of criteria for proper circuit protection, quality control needs, compatability of board and components with the coating, performance limitations of each resin type, and curing or drying for the coatings. The course begins with specifications of the board and continues through to production. The four major resin types will be discussed in detail with their advantages and limitations. The course is critical for all people involved in board design and protection. Prerequisites are an introductory course in chemistry and/or physics, a background in circuit board assembly manufacturing, or experience in coatings.

"Physical Testing of Paint and Coatings —From Classic Methods to Modern Instrumental Techniques," scheduled for May 16-20, is designed to improve quality control protocol for paints and coatings. This intensive course will demonstrate how to better measure the quality of paint from the standpoint of the coating manufacture. All tests are based on ASTM methods and other currently acceptable practices. Lectures will concentrate on the purposes, theory, and techniques of quality assurance. Laboratory workshops will include tests on equipment discussed in lectures and how to use the equipment and techniques. Guest lecturers will provide insights on monitoring the manufacturing process, finished product testing, setting up specifications, government regulations, etc. Participants should have experience in a quality assurance laboratory, completion of the UMR "Basic Composition of Coatings" course, or the equivalent of one year of college chemistry.

For more information, contact the Coatings and Polymer Science Program, Department of Chemistry, University of Missouri-Rolla, Rolla, MO 65401-0249.

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# 62nd Colloid and Surface Science Symposium To Be Offered by ACS, June 19-22, 1988

The 62nd Colloid and Surface Science Symposium, sponsored by the American Chemical Society Division of Colloid and Surface Chemistry, will be held on June 19-22, 1988, at the Pennsylvania State University, University Park, PA.

The scheduled symposia are as follows: "Films Adsorbed on Solid Surfaces"; "Application of Surface Science Techniques to Catalysis"; "Micellization and Microemulsions"; "Colloids in Materials, Environment and Bio Technologies"; "Fundamental Research in Colloid Science"; and, "Fundamental Research in Surface Science." In addition, there will be a poster session of general papers (papers that are not covered by any of the symposia topics), and an exhibition of instruments and books.

For more information on the Symposium, contact R. Nagarajan, 161 Fenske Laboratory, University Park, PA 16802.

## NCCA Announces Opening Of Design Showcase '88 Competition

The National Coil Coaters Association (NCCA) invites entries for Design Showcase '88, the 20th annual international competition which offers recognition for outstanding and innovative examples of products and processes involving metal coil.

Entry eligibility covers a broad scope including not only products made of coated coil, but also processing methods and materials currently in commercial production. Innovative products and processes developed to utilize the advantages of pre-coated metal, and applications, materials, and treatments involved in the manufacturing of coated coil may be submitted by any company throughout the world using metal pre-coated by an NCCA member firm, by all paint companies, coil coating equipment suppliers, and process equipment suppliers.

Entries which are designed to improve products, reduce costs, replace competitive materials, utilize a new process, or advance fabrication and finishing techniques are being accepted until February 22.

Design Showcase winners will be announced at an award ceremony during NCCA's Annual Spring Meeting, April 10-13. First prize is $1,000, with an additional $1,000 presented to the person finding and submitting the winning entry. Recognition will be awarded in numerous categories relating to coil coatings by an independent jury comprised of senior editors from the trade press and members of the coil coating industry.

For complete rules and entry forms, contact: NCCA, 1900 Arch St., Philadelphia, PA 19103.

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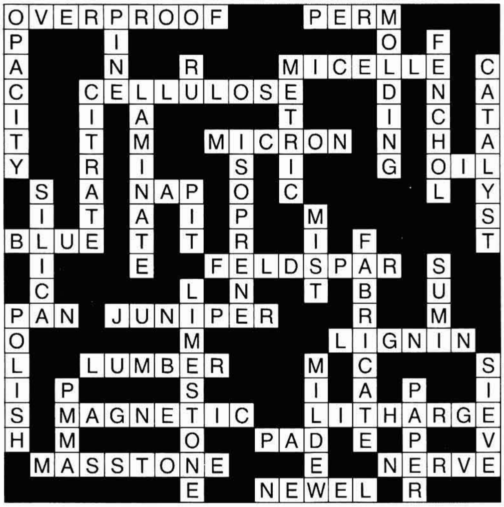
## Du Pont's Process Safety Management Seminar Dates Scheduled for 1988

The Du Pont Company has announced the 1988 schedule for its three-day "Process Safety Management" seminar. The program is directed toward process, production, and maintenance engineers, and toward safety engineers and managers responsible for process reviews. Its objective is to help them develop the necessary skills and confidence for conducting process reviews and in identifying potential problems.

Dates and locations are: February 16-18—Wilmington, DE; May 10-12—Houston, TX; August 6-18—Wilmington; November 8-10—Atlanta, GA.

For additional information, contact Du Pont Safety Services, Barley Mill Plaza, P19-1104, Wilmington, DE 19898.



*Solution to December CrossLinks*

## SSPC Announces Symposium On Removing Lead Paints

As part of a conference co-sponsored by the Federal Highway Administration, the Steel Structures Painting Council (SSPC) will conduct a symposium to address the subject of removing lead-based paints from industrial structures. The SSPC symposium, along with a workshop on bridge paint removal sponsored by the FHWA, will be held February 29-March 3, at the Sheraton National Hotel in Arlington, VA. The symposium will be open to representatives of all companies and industries who have an interest in lead paint removal.

The symposium will consist of papers on subjects such as containment methods; environmental regulations on air quality, water quality, land use and waste disposal; health and safety; new equipment and technology; proposed standards; and the nature and extent of such issues for different applications.

Participants are expected to include facility owners and representatives; general and painting contractors; specifiers; architectural and engineering firms; paint manufacturers; equipment suppliers; and representatives from federal, state, and local regulatory agencies.

In addition to technical presentations, arrangements are being made for informal discussion periods, and for manufacturers and suppliers to exhibit and discuss their products and services.

For more information, write: Lead Paint Removal Conference, Steel Structures Painting Council, 4400 Fifth Ave., Pittsburgh, PA 15213.

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## Lehigh Univ. Sponsors Spring Short Course

Lehigh University, Bethlehem, PA, will present its 19th annual short course, "Advances in Emulsion Polymerization and Latex Technology," during the week of June 6-10, 1988. The short course is designed for engineers, chemists, and other scientists and managers who are actively involved in emulsion work and for those who wish to develop expertise in this area.

The course is an in-depth study of the synthesis and properties of high polymer latexes. The subject matter includes a balance of theory and application as well as a balance between chemical and physical problems. Lectures will be given by leading academic and industrial workers.

The course fee is $700 for the entire week or $190 per day for any part.

For more information, contact Dr. Mohamed S. El-Aasser, Dept. of Chemical Engineering, Sinclair Lab #7, Lehigh University, Bethlehem, PA 18015.

# Literature

## Isodecyl Benzoate

A line of benzoate esters have been introduced in recently released literature. The isodecyl benzoate functions as a low odor latex paint coalescent. For more data on the use of Velate™ 262 isodecyl benzoate, write Velsicol Chemical Corp., 5600 N. River Rd., Rosemont, IL 60018.

## Liquid Detackifier

An all-organic chemical for paint detackification of industrial spray booths has been introduced in literature. When used with other spray booth chemicals, the detackifier can produce a dense sludge than can be removed by filter screens or various mechanical methods. For more information, write Nalco Chemical Co., One Nalco Center, Naperville, IL 60566-1024.

## Dispersant Guide

An updated, six-page brochure on dispersing agents is available. The brochure reviews the use of dispersing agents to prevent settling of solids, and to aid in the formation of pastes or creams in liquid suspensions. For a copy of "How to Handle Your Mixing Problems," write Organic Chemicals Div., Marketing Communications Dept., 55 Hayden Ave., Lexington, MA 02173.

## Adhesion Tester

An adhesion tester for coatings and adhesives has been introduced in literature. This model complements and extends a line of pneumatic adhesion tensile testing instruments designed to evaluate the pull-off strength of coatings according to the new ASTM standard D4541. More data on the Patti-3 is available from SEMicro Corp., 15817 Crabbs Branch Way, Rockville, MD 20855.

## Resins Catalog

A new 28-page resins catalog offers detailed technical information concerning product composition, viscosity, drying characteristics, and flash point in easy-to-read charts and text. For more information and a copy of the brochure, write NL Chemicals, Inc., P.O. Box 700, Hightstown, NJ 08520.

## Automotive Software

Automotive software for the appearance analysis of automotive textiles exterior finishes, and soft trim is highlighted in literature. The software simplifies sampling number determination and tolerance adjustments by eliminating hand calculations. Also, the software allows selection of additional data to report and features auto printing of results. For more information or a demonstration of the J1545 Software, write HunterLab, Hunter Associates Laboratory, Inc., 11491 Sunset Hill Rd., Reston, VA 22090.

## Flatting Agent

Information is available on a synthetic silica flatting agent that helps paint formulators meet government VOC regulations while maintaining acceptable viscosity levels. The agent is designed for use in a wide variety of coatings and can be used in both oil and water systems. For more information on ZEOMATT™ 155, contact J.M. Huber Corp., Chemicals Div., P.O. Box 310, Havre de Grace, MD 21078.

## Safety Coating

Information is available on a general purpose, heavy duty, nonslip safety coating which can help reduce the number of slips and falls on a variety of surfaces in and around commercial and residential buildings, and industrial plants. Write Barry Clark, Martex Safety Products, I-A Paine Ave., Irvington, NJ 07111 for further details on FERROX and other safety products.

## Computer Color Technology

A four-page newsletter describes new systems and software for computer color matching, paint and coatings formula design, color matching in retail stores, and color measurement instrumentation. The newsletter is designed for management and technical personnel in the paint, plastics, textiles, ink and printing, and other industries which rely on precise reproduction and control of color in industrial processes. For more information or a copy of "Prismatics," contact Applied Color Systems, Inc., P.O. Box 5800, Princeton, NJ 08543.

## Urethane Dispersion

Information is available on a high-solids water-borne urethane dispersion for high performance coatings applications that require rapid hardness development plus chemical and abrasion resistance. For samples and additional technical information on NeoRez®, contact Greg Reardon, Manager Market Development, Polyvinyl Chemicals, 730 Main St., Wilmington, MA 01887.

## Particle Size Analyzer

Literature on a fully automated sedimentation particle size analyzer which provides particle size analysis in the range of 300 micrometers to 0.1 micrometer is available. For more information on the SediGraph 5100, write Micromeritics Instrument Corp., One Micromeritics Dr., Norcross, GA 30093-1877.

## Viscometer Software

Information is available on a software program that gathers, analyzes, and graphically displays rheological data, and also collects data in timed, manual, vari-speed or spring relaxation mode. For more detailed information on the "DV Gather" Software Program, write Brookfield Engineering Laboratories, Inc., Dept. NR 56, 240 Cushing St., Stoughton, MA 02072.

## Latent Hardener

A high peformance hardener which exhibits high reactivity at temperatures above 100°C is the subject of a recently issued data sheet. To receive a copy of the data sheet on Hardener HT 9506, contact CIBA-GEIGY Corp., Three Skyline Dr., Hawthorne, NY 10532.

## Powder Coating System

A powder coating system which combines state-of-the-art technology, specially-engineered materials, innovative gun design, and a new electrostatic charging method is described in a full-color brochure. Write Nordson Corp., North American Div., 555 Jackson St., Amherst, OH 44001 for more information on the Nordson® 100 Plus™.

## Hardener

Technical information is available on a hardener which achieves sufficient cure over a wide range of baking schedules, from 30 minutes at 177°C to 60 seconds at 300°C. Applications include can linings, collapsible tubes, protective pipe coatings, and other applications where high corrosion resistance is required. For further information on Hardener HZ 949U, and a copy of a data sheet detailing cured properties of clear coatings and baked finishes, write CIBA-GEIGY Corp., Three Skyline Dr., Hawthorne, NJ 10532.

## High Density Storage

A brochure that provides detailed information on a wide range of VSR and horizontal high density mobile storage for industrial applications has been issued. The many lines of storage systems described in the four-color brochure range from small hand-controlled laterals and standard mobile units, to mechanical assist, a series of electric powered units, and vertical storage and retrieval systems. For a copy of brochure #SC-8707, contact Mark Haubenschild, Spacesaver Corp., 1450 Janesville Ave., Fort Atkinson, WI 53538.

## Resins

Information on a series of high solids polyester resins for low VOC bake finishes is now available. The new series is designed to be crosslinked in industrial baking enamels and is suitable for use in VOC compliant finishes for metal furniture, cabinetry, tools, light fixtures, and small implements. For more information on Aroplaz 6800 series of polyester baking resins, write NL Chemicals, Inc., P.O. Box 700, Hightstown, NJ 08520.

## Batch Mixing Systems

Solids batch mixing systems with portable containerized process modules is the subject of a two-page fact sheet. The mixing capabilities are tailored with scientific precision to each individual application offering multiple processing ability and optimized performance. For a copy of Bulletin 700-C on the Lightnin CMB®, contact Betty Felix, Mixing Equipment Co., 135 Mt. Read Blvd., Rochester, NY 14603.

## Cracking Process

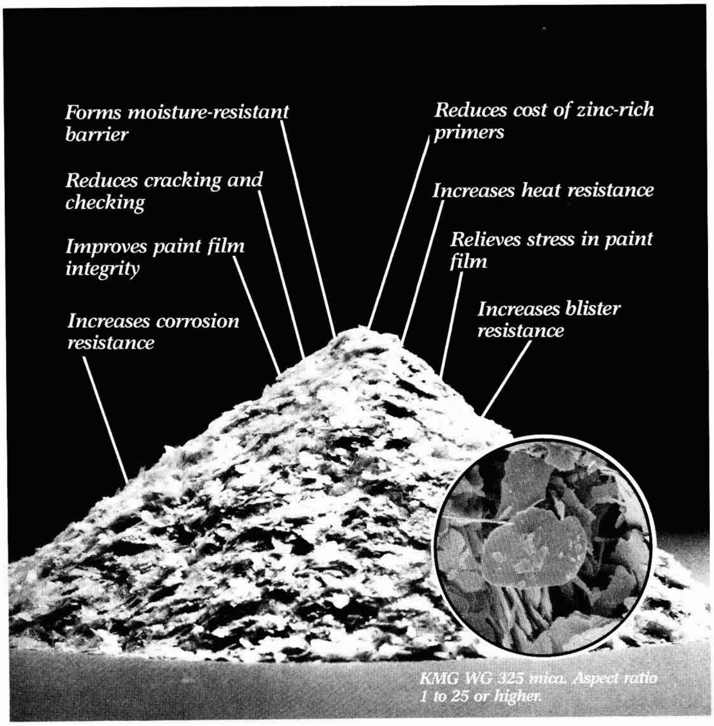
Information is available on a new cracking process which is designed to deliver a higher precentage of usable product. The process employs a series of precision rollers which "crack" instead of grind particles. This method reportedly results in more uniform particle size with a high volume of usable product. For more information on the Crack-U-Lizer®, contact Modern Process Equipment, Inc., 3150 S. Kolin, Chicago, IL 60623.

## Cellulose Ether

A cellulose ether designed as an alternative viscosifier for non-methylene chloride paint stripper formulations is the focus of literature. The cellulose ether reportedly exhibits good solubility in a wide range of organic solvents as well as water. For more information about Methocel® 311, contact Inquiry Services/Methocel, The Dow Chemical Co., Box 1206, Midland, MI 48641-1206.

## Cryogenic Cleaning

A new cleaning system that uses dry ice particles to safely remove dirt, rust, paint, and other contaminants is the subject of new literature. Effective on all types of smearable, energy-absorbing, or fixed contaminants, the cryogenic system will thoroughly clean plant walls and floors. For more information on Liquiflow® Cryogenic Cleaning System, request form #6834 from Liquid Carbonic, Advertising Dept., 135 LaSalle St., Chicago, IL 60603.



## Awareness Program

A safety program that develops awareness of the Toxic Substances Control Act (TSCA) and an understanding of its compliance procedures, especially those to be initiated by companies, has been introduced. The material is primarily designed for technical and professional personnel and others whose functions relate to assuring compliance. Please direct inquiries on Du Pont's TSCA Program to, Du Pont Co., Safety Services, Barley Mill Plaza, P19-1210, Wilmington, DE 19898.

## Solvent Recovery Equipment

A recently released eight-page, four-color brochure describing a series of automated large volume solvent recovery equipment can now be obtained upon request. The units provide safe and efficient processing of hazardous waste solvent into 99+% pure solvent for reuse. Capacities range from 250-1600 gallons per eight-hour shift with batch or continuous-feed operation. For a copy of the BCF Series brochure, contact Finish Co., Inc., 921 Greengarden Rd., Erie, PA 16501-1591.

## Acrylic Emulsion

Information on a new modified-acrylic emulsion, developed for wet adhesion in interior semigloss and exterior trim paints, is now available. The new emulsion develops rapid wet adhesion, even to such difficult surfaces as gloss alkyds. Further information on UCAR® Acrylic 522, including formulations, can be obtained from Union Carbide Corp., UCAR Emulsion Systems, Dept. L4488, 39 Old Ridgebury Rd., Danbury, CT 06817-0001.

## Mixing Paddle

Literature highlights a mixing paddle that will mix both dry and wet materials in batch sizes ranging from 5-55 gallons. The unique blade design lifts heavy solids, produces turbulent flow to disperse particles, and moves material horizontally by creating a vortex. Write Indco, Inc., P.O. Box 589, New Albany, IN 47150 for further details on the Lift-Mixer.

## Drum Liners

Information is available on an electrically conductive liner for 55 gallon drums and five gallon pails. These conductive liners are designed to protect against all three major static problems: direct discharge, static fields, and triboelectric charging. For more information, write CDF Corp., Static Protection Systems Div., 100 Enterprise Dr., Marshfield, MA 02050.

## Infrared Booster Ovens

Information has been issued on a new infrared booster oven line which is designed to raise the speed and quality of most process line curing and drying operations for automobile manufacture. For more information on the Heraeus system, contact Jim Ford, Heraeus Amersil Inc., 650 Jernees Mill Rd., Sayreville, NJ 08872.

## Grinding Mill

A recently released four-page brochure describes a small-media dry grinding mill. The brochure features engineering specifications and accessories available for several production models of the mill, with grinding chamber capacities ranging from 10-500 liters (2.8-132 gallons). For a copy of the Turbamill™ brochure, contact Union Process, Inc., 1925 Akron-Peninsula Rd., Akron, OH 44313.

## Defoamer

Information on a new defoamer which provides rapid bubble breaking in roller and brush applied, solvent thinner, and clear urethane wood finishes is now available. The defoamer sufficiently improves flow-out and leveling to insure filling of bubble-related pinholes. For further information on Dapro Defoamer NA 1621, write Daniel Products Co., 400 Claremont Ave., Jersey City, NJ 07304.

## Luminance Meters

Technical information is available on two luminance meters. The meters reportedly offer a wide measuring range and high resolution for more accurate measurements of small light sources and surface areas. Contact Minolta Corp., Industrial Meter Div., 101 Williams Dr., Ramsey, NJ 07446 for more information on the LS-100 and LS-110 luminance meters.

## Polyurethane Resin

Information on a new ultraviolet (UV) light-curable polyurethane resin that allows formulators to produce fast-curing coatings with excellent gloss and hardness is now available. The resin cures in less than 30 seconds under a UV light source, improving coating productivity by eliminating lengthy drying periods. For detailed information on Polylite® polyurethane resin 13-851, contact Jeffrey Danneman, Project Manager—Radiation-Curable Coatings, Chemical Coatings Div., Reichhold Chemicals, Inc., P.O. Box 1433, Pensacola, FL 32596.

## Coatings Formula Design

Information is now available on a program package for paint and coatings formula design. Formula ingredients can be entered into the program in a variety of different ways, including: percent total solids by volume or weight; percent total pigment by volume or weight; and PVC or P/B or percent vehicle solids by volume or weight. For further information on the LABCAL program package, write Applied Color Systems, Inc., Box 5800, Princeton, NJ 08543.

## Glycol Ethers

Booklets which describe a propylene glycol monomethyl ether, and a propylene glycol menomethyl ether acetate have been published. The propylene glycol monomethyl ether is a colorless product with medium volatility, a pleasant odor, and complete solubility in water and many organic solvents. The propylene glycol monomethyl ether acetate is a slow evaporating, partially water-soluble solvent that combines an ester and ether linkage in the same molecule. Copies of the booklets, "Methyl Propasol® Solvent" and "Methyl Propasol Acetate," designated F-60593 and F-60592, respectively, are available from Union Carbide Corp., Solvents and Coatings Materials Div., Dept. L4488, 39 Old Ridgebury Rd., Danbury, CT 06817-0001.

## Aramid Pulp

Recently released information highlights an aramid pulp that combines high-temperature stability, good chemical resistance, increased tensile, tear strength with easy processibility, and is environmentally safe. For further information on "Kevlar" aramid pulp, write to the Du Pont Co., Room G-50942, Wilmington, DE 19898.

## CLASSIFIED ADVERTISING

# Book Review

## WATER SOLUBLE POLYMERS: BEAUTY WITH PERFORMANCE

Edited by J. E. Glass

Published by the
American Chemical Society
Washington, DC, 1986
xii + 449 pages, $89.95

Reviewed by
Robert F. Brady, Jr.
Naval Research Laboratory
Washington, DC 20375

This book is a collection of 23 papers presented during a Symposium on Water Soluble Polymers held by the American Chemical Society in the fall of 1984. The book aims primarily at applications in coatings (eight chapters) and petroleum drilling and recovery (seven chapters), but also includes chapters on the characterization of water-soluble polymers by size-exclusion chromatography, carbon-13 nuclear magnetic resonance, and intrinsic viscosity measurements.

This book is especially valuable because it contains much useful information on the rheological properties imparted to water-borne coatings by polymeric thickeners. Separate chapters treat the influence of cellulose ethers, styrene-modified associative thickeners (SMAT), and hydrophobic ethoxylated urethane (HEUR) thickeners on the performance of water-borne coatings. Another chapter discusses the advantages and disadvantages of associative thickeners from both formulating and manufacturing viewpoints, and gives a hint of the very extensive laboratory work required before the advantages of associative thickeners can be realized. Information on the effect of cosolvents and surfactants on the behavior of associative thickeners is included in another chapter.

The book also includes a chapter which treats the effect of variations in dynamic surface tension on the curing of water-borne coatings, and another on the grafting reactions which occur on (hydroxyethyl) cellulose when it is used as a protective colloid in the commercial manufacture of vinyl acetate and acrylic polymers.

This book is highly recommended, particularly to those who need modern information on the chemical properties and practical uses of thickeners for water-borne coatings. The information on coatings applications is particularly timely because of the pressure on the industry to reduce the amount of volatile organic compounds in coatings. Each chapter contains many references to the literature. The text is complemented by many clear figures, and contains useful author and subject indexes.

## SPECIALTY POLYMERS

Edited by
R. W. Dyson

Published in the U.S. by
Chapman & Hall
New York, NY
186 pages, $59.95

Reviewed by
Thomas J. Miranda
Whirlpool Corp.
Benton Harbor, MI

This book is intended for those who have a familiarity with commodity plastics and who could benefit from the overview presented in the area of specialty polymers. The introductory chapter is a review of polymer structure and general properties which is then followed by a chapter on polymerization and poly blends. From this, the various contributors take the reader through Fire Retardant and High Temperature Resistant Polymers, Hydrophilic Polymers, Conducting, Ionic and concludes with Polyurethanes.

There is a list of tradenames and abbreviations at the beginning of the text which is useful. This is an easily readable book which provides the reader with a quick look at these interesting polymers.

## HIGH SOLIDS ALKYD RESINS

by
Krister Holmberg

Published by
Marcel Dekker
New York, NY
240 pages

Reviewed by
Taki J. Anagnostou
Eastern Michigan University
Ypsilanti, MI

This book can almost be considered a primer on alkyd resins. It is easy to read, informative, and integrates alkyd technology into the more technical aspects of polymer chemistry such as molecular weight, side reactions, branching, kinetics, etc. The chapters include an introduction of basic alkyd structures, factors controlling solids content, basic alkyd preparation, solvent theory, amino resins and reactive diluents. Each chapter is accompanied by an excellent set of references, including many European journals, although a few may be more of historical interest than of technical relevance.

I enjoyed reading this book, but was somewhat disturbed by the many things the author could have said but did not. As a result, some of the basic premises could prove misleading to the less experienced alkyd chemist. The so-called "Tricks of the Trade" are noticeably absent so one is left with an academic overview of the art of "alkyd chemistry." In addition, the author does not take into account the trends in the technology being driven by the various United States ecological laws being developed and enforced.

The real value of this work is the author's attempt to illustrate that alkyd film formation is dependent upon many other factors beyond the alkyd molecular structure. Formulating chemists will find this aspect stimulating and informative.

# Coming Events

## FEDERATION MEETINGS

*For information on FSCT meetings, contact FSCT, 1315 Walnut St., Philadelphia, PA 19107 (215-545-1506).*

### 1988

(Mar.)—Federation Seminars on Statistical Process Control. Level I: Mar. 4-5, Mexico City, Mexico; Mar. 14-15, Philadelphia Airport Marriott, Philadelphia, PA; Mar. 21-22, Chicago O'Hare Marriott, Chicago, IL; and Mar. 28-29, Cleveland Airport Marriott, Cleveland, OH. Level II: Mar. 16-18, Philadelphia Airport Marriott; Mar. 23-25, Chicago O'Hare Marriott.

(May 17-20)—Federation "Spring Week." Seminar on the 17th and 18th; FSCT Society Officers Meeting on the 19th; FSCT Board of Directors Meeting on the 20th. Orlando Marriott Hotel, Orlando, FL.

(Oct. 19-21)—66th Annual Meeting and 53rd Paint Industries' Show. McCormick Place, Chicago, IL.

### 1989

(Nov. 8-10)—67th Annual Meeting and 54th Paint Industries' Show. Rivergate, New Orleans, LA.

### 1990

(Oct. 19-21)—68th Annual Meeting and 55th Paint Industries' Show. Convention Center, Washington, D.C.

## SPECIAL SOCIETY MEETINGS

### 1988

(Feb. 3-5)—Southern Society. 15th Annual Water-Borne and Higher-Solids Coatings Symposium. Hyatt Regency, New Orleans, LA. (Dr. Gordon L. Nelson, Chairman, Dept. of Polymer Science, University of Southern Mississippi, Southern Station Box 10076, Hattiesburg, MS 39406-0076).

(Mar. 16-18)—Southwestern Paint Convention of Dallas and Houston Societies. Hyatt Regency Hotel. Houston, TX. (J. Harrell, Buckman Labs., 5127 Wightman Ct., Houston, TX 77069).

(Apr. 13-15)—Southern Society. Annual Meeting. Omni Hotel, Charleston, SC. (Scott McKenzie, Southern Coatings Co., P.O. Box 160, Sumter, SC 29150).

(Apr. 19)—Detroit Society. 13th Annual FOCUS Conference. "International Trends in Automotive Coatings." Management Education Center, Troy, MI.

(Apr. 28-30)—Pacific Northwest Society. Annual Symposium. Hotel Vancouver, Vancouver, B.C., Canada. (Yvon Poitras, General Paint Corp., 950 Raymur Ave., Vancouver, B.C., Canada V6A 3L5).

(May 11-12)—New England Society. 1988 Tech Expo. Sheraton Boxborough Hotel, Boxborough, MA. (G. Pollano, Polyvinyl Chemicals, 730 Main St., Wilmington, MA 01887).

(June 1-2)—Cleveland Society. 31st Annual Conference on Advances in Coatings Technology. John Carroll University, Cleveland, OH.

(June 10-12)—Joint meeting of St. Louis and Kansas City Societies. Holiday Inn, Lake of the Ozarks, MO. (Tom Hilton, F.R. Hall, Inc., 1920 Swift Ave., Suite 202, N. Kansas City, MO 64116).

### 1989

(Mar. 13-15)—Western Coatings Societies Symposium and Show. Disneyland Hotel, Anaheim, CA. (Andy Ellis, NL Industries, Inc., 200 N. Berry St., Brea, CA 92621).

(Apr. 5-7)—Southern Society. Annual Meeting. Hyatt Regency Westshore, Tampa, FL.

## OTHER ORGANIZATIONS

### 1988

(Jan. 20-21)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Atlanta, GA. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Jan. 21-22)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Toledo, OH. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Jan. 24-27)—ASTM Committee D-1. Holiday Inn, Clearwater Beach, FL. (Dave Bradley, ASTM, 1916 Race St., Philadelphia, PA 19103).

(Jan. 25-29)—9th AESF/EPA Environmental Conference. Co-sponsored by The American Electroplaters and Surface Finishers Society and the U.S. Environmental Protection Agency. Sheraton World, Orlando, FL. (AESF, 12644 Research Pkwy., Orlando, FL 32826-3298).

(Jan. 27-28)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Seattle, WA. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Feb. 4-5)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Chicago, IL. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Feb. 12-14)—Southern Decorating Products Show sponsored by the National Decorating Products Association. Georgia World Congress Center, Atlanta, GA. (Lillian Smysor, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Feb. 16-18)—"Process Safety Management" Seminar sponsored by Du Pont Co., Wilmington, DE. (Du Pont Safety Services, Barley Mill Plaza, P19-1104, Wilmington, DE 19898).

(Feb. 22-24)—"Maintenance Coatings for Contractors and Paint Inspectors." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(Feb. 25-26)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Stouffer Resorts Hotel, Orlando, FL. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Feb. 25-26)—"Introduction to Coating Inspection." Course sponsored by the National Association of Corrosion Engineers. New Orleans, LA. (NACE Education and Training Dept., P.O. Box 218340, Houston, TX 77218).

(Feb. 29-Mar. 1)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Dallas, TX. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Feb. 29-Mar. 2)—Finishing Technologies '88 sponsored by Coatings Magazine. Constellation Hotel, Toronto, Ont., Canada. (CM, 86 Wilson St., Oakville, Ont., Canada L6K 3G5).

(Feb. 29-Mar. 3)—"Removing Lead Paints from Industrial Structures" Seminar and Workshop co-sponsored by Federal Highway Administration, and Steel Structures Painting Council. Sheraton National Hotel, Arlington, VA. (Kitti Condiff, SSPC, 4400 Fifth Ave., Pittsburgh, PA 15213).

(Feb. 29-Mar. 4)—"56th Introductory Short Course—The Basic Composition of Coatings." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(Mar. 1-3)—Electrocoat/88 Conference sponsored by Products Finishing Magazine. The Drawbridge Inn, Cincinnati, OH. (Julianne Hall, Electrocoat/88, c/o Products Finishing, 6600 Clough Pike, Cincinnati, OH 45244-4090).

(Mar. 5-6)—Canadian Decorating Products Show sponsored by the National Decorating Products Association. Constellation Hotel, Toronto, Ont., Canada. (Lillian Smysor, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Mar. 9-10)—"Professional Paint Foreman." Course sponsored by the National Association of Corrosion Engineers. Houston, TX. (NACE Education and Training Dept., P.O. Box 218340, Houston, TX 77218).

(Mar. 10-11)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Los Angeles, CA. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Mar. 14-17)—"Spray Applications for Furniture Finishing" Seminar followed by workshop, sponsored by Society of Manufacturing Engineers. High, N.C. (Jody Pickens, SME, Professional Education Dept., One SME Dr., P.O. Box 930, Dearborn, MI 48121).

(Mar. 14-18)—"16th Introductory—Paint Formulation." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(Mar. 16-17)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Dallas, TX. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Mar. 17-18)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Bloomington, MN. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Mar. 21-25)—Corrosion/'88 sponsored by the National Association of Corrosion Engineers. Cervantes Convention & Exhibition Center, St. Louis, MO. (Allison Mayer, NACE Exhibits Dept., P.O. Box 218340, Houston, TX 77218).

(Mar. 26-27)—Western Decorating Products Show sponsored by the National Decorating Products Association. Brooks Hall, San Francisco, CA. (Lillian Smysor, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Mar. 30-31)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Denver, CO. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Apr. 4-5)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Grand Rapids, MI. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Apr. 9-10)—Eastern Decorating Products Show sponsored by the National Decorating Products Association. World Trade Center, Boston, MA. (Lillian Smysor, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

(Apr. 9-13)—National Coil Coaters Association Annual Meeting. Marriott's Rancho Las Palmas, Palm Springs, CA. (NCCA, 1900 Arch St., Philadelphia, PA 19103).

(Apr. 11-12)—28th Annual Symposium sponsored by the Washington Paint Technical Group. Marriott Twin Bridges Hotel, Washington, D.C. (Mildred A. Post, Publicity Chairwoman, Washington Paint Technical Group, P.O. Box 12025, Washington, D.C. 20005).

(Apr. 11-12)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Neenah, WI. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(Apr. 13-14)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Cleveland, OH. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Apr. 13-15)—"Radiation Curing." Course sponsored by The Center for Professional Advancement. San Mateo, CA. (The Center for Professional Advancement, 46 W. Ferris St., East Brunswick, NJ 08816).

(Apr. 18-20)—"Conformal Coatings." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(Apr. 20-21)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Minneapolis, MN. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(Apr. 20-27)—Surface Treatment '88 at Hannover Fair Industry '88. Hannover Fairgrounds, Hannover, W. Germany. (Joachim Schafer, Hannover Fairs USA Inc., 103 Carnegie Center, P.O. Box 7066, Princeton, NJ 08540).

(Apr. 24-28)—RadTech '88. New Orleans Fairmont Hotel, New Orleans, LA. (John Waxman, Director of Conferences and Exhibits, RadTech International, 60 Revere Dr., Suite 500, Northbrook, IL 60062).

(May 2-4)—International Seminar sponsored by the Ford Motor Co. Dearborn, MI. (A. Golovoy, Ford Motor Co., Box 2053/SRL 3198, Dearborn, MI 48121).

(May 4-5)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Boston, MA. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(May 8-10)—Inter-Society Color Council Annual Meeting. Sheraton Inner Harbor Hotel, Baltimore, MD. (Paula J. Alessi, 10 Bay Park, Webster, NY 14580).

(May 9-11)—Federation of Scandinavian Paint and Varnish Technologists. 12th Congress, Helsinki, Finland. (Arja Saloranta, Tikkurila Oy, PB 53, SF 01301 Vanda, Finland).

(May 9-13)—"Dispersion of Pigments and Resins in Fluid Media." Course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(May 10-12)—"Process Safety Management" Seminar sponsored by Du Pont Co., Wilmington, DE. (Du Pont Safety Services, Barley Mill Plaza, P19-1104, Wilmington, DE 19898).

(May 11-13)—"Radiation Curing." Course sponsored by The Center for Professional Advancement. Chicago, IL. (The Center for Professional Advancement, 46 W. Ferris St., East Brunswick, NJ 08816).

# CALL FOR PAPERS

## "INTERNATIONAL TRENDS WITH AUTOMOTIVE COATINGS"

13TH ANNUAL FOCUS CONFERENCE
FUTURE OF COATINGS UNDER STUDY
Detroit Society for Coatings Technology
April 19, 1988
Management Education Center
Troy, Michigan

Conference will FOCUS on new coatings technologies being developed in Europe and Asia. Solicited papers should cover one of the following areas:

- New Resins
- New Pigments
- Equipment Advances
- Plastics Finishing
- New Precoated Steel and Corrosion Protection
- Increasing Customer Appeal

Those wishing to participate are urged to submit a letter of intent including a tentative title of paper as soon as possible, and an abstract of about 200 words by January 29, 1988.

Abstracts on any subjects related to Automotive Coatings would be welcome. Please forward all communications to: The Detroit Society for Coatings Technology, 26727 Newport, Warren, MI 48089. Telephone (313) 252-8998.

(May 16-17)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Cherry Hill, NJ. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(May 16-20)—"Physical Testing of Paints and Coatings." Course sponsored by the University of Missouri-Rolla, Rolla, MO. (Coatings and Polymer Science Program, Dept. of Chemistry, UMR, Rolla, MO 65401-0249).

(May 18-20)—"Measurement of Appearance" Workshop sponsored by HunterLab. Sheraton Hotel, Tysons Corner, VA. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(May 19-20)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Boston, MA. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(May 23-25)—"Radiation Curing." Course sponsored by The Center for Professional Advancement. East Brunswick, NJ. (The Center for Professional Advancement, 46 W. Ferris St., East Brunswick, NJ 08816).

(May 23-27)—"Adhesion Principles and Practice for Coatings and Polymer Scientists." Course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(May 24-25)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Charlotte, NC. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(May 25-27)—10th International Conference on "Advances in the Stabilization and Controlled Degradation of Polymers." Sponsored by the State University of New York. Luzern, Switzerland. (Angelos V. Patsis, Director, Materials Research Laboratory, CSB 209, State University of New York, New Paltz, NY 12561).

(May 30-June 1)—Second International Conference on "Crosslinked Polymers." Sponsored by the State University of New York. Luzern, Switzerland. (Angelos V. Patsis, Director, Materials Research Laboratory, CSB 209, State University of New York, New Paltz, NY 12561).

(June 1-2)—Regional "Color and Appearance" Seminar sponsored by HunterLab. Cherry Hill, NJ. (Hunter Associates Laboratory, Inc., 11491 Sunset Hills Rd., Reston, VA 22090).

(June 5-11)—American Chemical Society. 195th National Meeting and Third Chemical Congress of North America. Toronto, Ont., Canada. (B.R. Hodson, ACS, 1155—16th St. NW, Washington, D.C. 20036).

(June 6-10)—19th Annual Short Course "Advances in Emulsion Polymerization and Latex Technology." Sponsored by Lehigh University, Bethlehem, PA. (Mohamed S. El-Aasser, Dept. of Chemical Engineering, Sinclair Lab #7, Lehigh University, Bethlehem, PA 18015).

(June 9-10)—"The Fundamentals of Color" Seminar sponsored by Macbeth, a division of Kollmorgen Corp. Cincinnati, OH. (Jeanne Dolan or Karen Degnan, Macbeth, Little Britain Rd., P.O. Box 230, Newburgh, NY 12550-0382).

(June 13-17)—"Applied Rheology for Industrial Chemists." Course sponsored by Kent State University, Kent, OH. (Carl J. Knauss, Chemistry Dept., Kent State Univ., Kent, OH 44242).

(June 15-16)—Surfex '88. Oil and Colour Chemists' Association. Harrogate International Conference Center, Yorkshire, England. (R.H. Hamblin, OCCA, Priory House, 967 Harrow Rd., Wembley, Middlesex HA0 2SF England).

(June 19-22)—62nd Colloid and Surface Science Symposium. Pennsylvania State University, State College, PA. (R. Nagarajan, 161 Fenske Laboratory, University Park, PA 16802).

(July 11-15)—14th International Conference on "Organic Coatings Science & Technology." Sponsored by the State University of New York. Athens, Greece. (Angelos V. Patsis, Director, Materials Research Laboratory, CSB 209, State University of New York, New Paltz, NY 12561).

(Aug. 16-18)—"Process Safety Management" Seminar sponsored by Du Pont Co., Wilmington, DE. (Du Pont Safety Services, Barley Mill Plaza, P19-1104, Wilmington, DE 19898).

(Sept. 18-24)—XIXth Congress of FATIPEC. Aachen, Germany. (C. Bourgery, FATIPEC Secretary General, 76 Blvd. Pereire, 75017 Paris, France).

(Sept. 25-30)—"Polymers in Information Storage Technology" Symposium sponsored by the American Chemical Society. Los Angeles, CA. (K.L. Mittal, IBM-Corporate Technical Inst., 500 Columbus Ave., Thornwood, NY 10594).

(Oct. 2-4)—Canadian Paint and Coatings Association. 76th Annual Convention. Ottawa, Ontario. (CPCA, 515 St. Catherine St. W., Montreal, Que. H3B 1B4 Canada).

(Oct. 4-7)—12th World Congress on Metal Finishing, INTERFINISH 88. Palais des Congres, Paris, France. (SEPIC INTERFINISH, 17 rue d'Uzes, 75002 Paris, France).

(Oct. 5-7)—Fall Meeting of the National Coil Coaters Association. Westin Hotel, O'Hare Airport, Chicago, IL. (NCCA, 1900 Arch St., Philadelphia, PA 19103).

(Oct. 10-13)—15th International Naval Stores Meeting. Intercontinental Ritz and Meridien Hotels, Lisbon, Portugal. (Manco L. Snapp, Jr., Arizona Chemical Co., Panama City, FL).

(Nov. 4-6)—41st Annual Show and Convention of National Decorating Products Association. McCormick Place, Chicago, IL. (Lillian Smysor, NDPA, 1050 N. Lindbergh Blvd., St. Louis, MO 63132-2994).

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# 'Humbug' from Hillman

I am sure that many of our readers fondly remember Gerry Allyn, who spent many years helping to guide Rohm and Haas to the attention of the coatings industry. Well, John Warner, in his search for the practical in technical articles, found the following in the *Official* DIGEST of May, 1955. We publish an abstract of the tastier parts.

### Preparation of Solanum Tuberosum By the Resina Method

### by Gerould Allyn

The origin of the rosin potato is shrouded in the darkness of early Southern days. One authority states that the custom was originated by workers in the pine forests around the rosin stills. At noon they craved a little something hot to eat, particularly in the winter time. They learned that if they would melt enough rosin in a can to cover a potato, it would soon cook through and remain hot due to the insulating qualitities of the peel saturated with rosin.

*Author's Experimental Cooks*—In order to check the generalized observations made under somewhat less than scientific conditions, the author made a few cooks using a five quart varnish kettle and about six pounds of rosin. This experiment was conducted out-of-doors and it will be found to promote friendly relations in the home if this practice is continued unless extremely good ventilation is available over the kitchen stove! In the particular case, a small portable gasoline stove was used for heating. A barbecue or other outdoor fire would be excellent.

So that a varnish maker (or any other interested gourmet—Ed.) will get good results, we give below a potato cooking log.

**Rosin Potato Cooking Log**

| | Minutes |
|---|---|
| Start | 0 |
| 400°F. | 22 |
| Potatoes added | 23 |
| Potatoes, floated, hold at 400° | 39 |
| Potatoes out | 63 |

Heat rosin to 400°F., add dry potatoes, regain 400° and hold for a total cooking time of approximately 40 minutes. Remove potatoes, wrap in paper, cut open and butter and salt to taste.

Some precautions are in order. The "varnish cooker" should wear glasses (safety goggles or sun glasses) to protect his eyes since splashes would be dangerous. A pair of tongs should be used to put the potatoes in the hot rosin and to remove them. A pair of gloves is very helpful. It is wise not to fill the kettle with rosin because vigorous agitation occurs as soon as the potatoes are placed in the hot rosin. This is due to steam escaping from the potatoes.

At no time during the experiment was foam a problem. The molten rosin was quiet until the potatoes were added and then vigorous foaming ensued. In fact, the rate of bubbling is a pretty good indication as to the temperature of the bath.

The temperature does not seem to be too critical in this cook, but about 300 to 400° seems to be somewhat near optimum. This is below the fuming point of rosin. About 40 minutes are required for complete cooking of a normal sized baking potato. Very large potatoes would take longer.

*Note*—"Humbug" is indebted to John Warner for his intensive research and for his patience while we spent months trying to get approval from our cooking consultant—at which we failed.

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Our cooking consultant's comments on what follows is not printable.

Frank Borrelle had to go to the May 1986 issue of "Surface Coatings Australia" to find this scoop as published in *The Washington Post* by Michael Weiskopf.

In place of grandma's favorite recipe, the Pentagon has drafted 18 pages of specifications for the traditional fruitcake—Mil-F-1499F. For companies that produce fruitcakes for far flung U.S. soldiers, the specifications include instructions to soak raisins "as necessary to prevent clumping," to dice candied pineapple in quarter-inch chunks and to use nuts of "the latest crop" and shortening with the "stability of not less than 100 hours."

It calls for candied orange peel "thoroughly deragged and processed with sugar and corn syrup of not less than 72% soluble solids."

Flavoring "shall be pure or artificial vanilla in such quantities that its presence shall be organoleptically detected.

For the taste test, the cooled cake, bisected horizontally or vertically with a sharp knife, "shall not crumble or show any compression streaks, gummy centres, sloggy areas and display an even grain structure throughout."

The finished product is to "conform to the inside contour of the can or can liner," with no "point on the top lid greater than ¾ inch from the top of the can."

Translators are still at work!

---

That was 1987 that streaked by—diabolically laughing all the way.

*—Herb Hillman*
*Humbug's Nest*
*P.O. Box 135*
*Whitingham, VT 05361*

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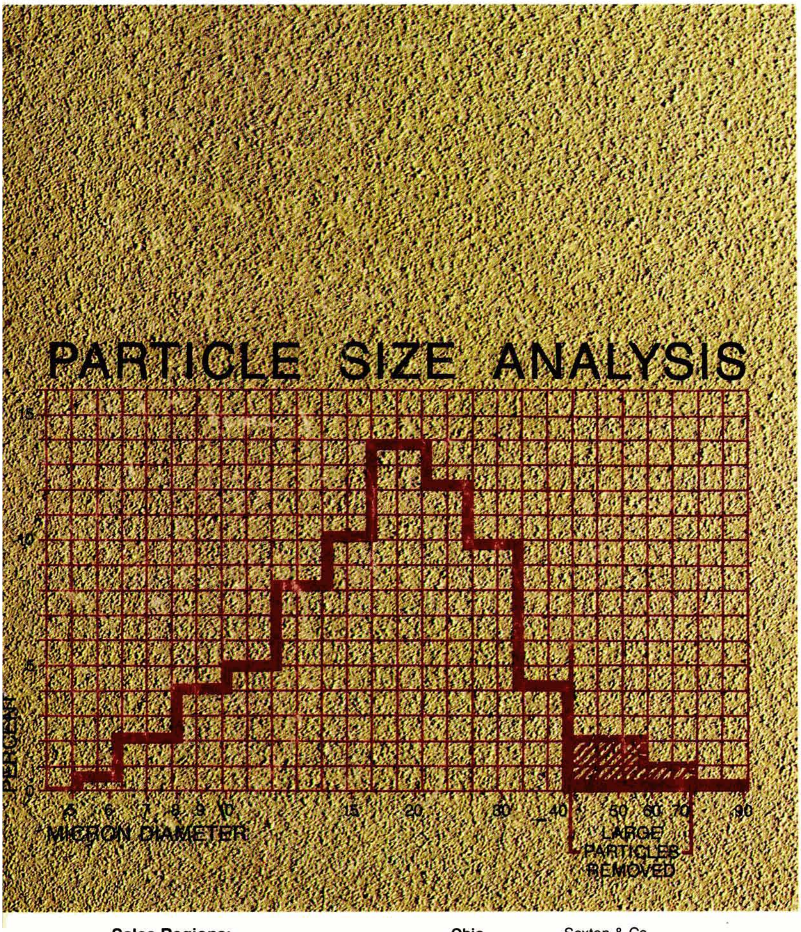

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