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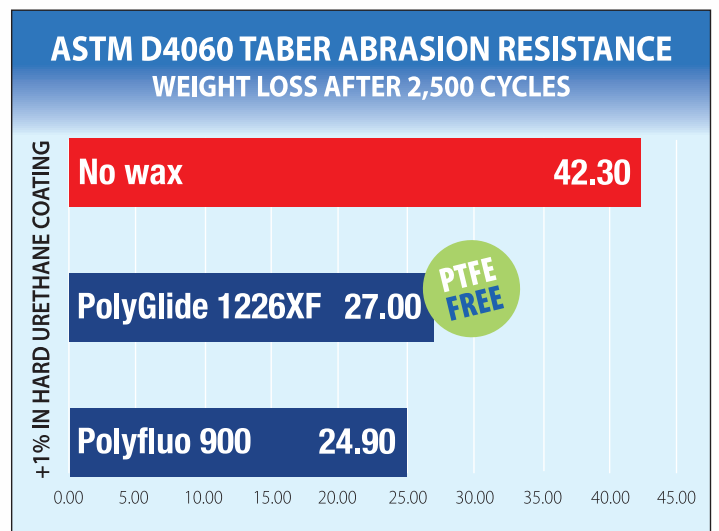
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COVER STORY

Raw Materials 2022

By George R. Pilcher, The ChemQuest Group
and The ChemQuest Technology Institute

As the paint and coatings industry navigates away from the effects of the COVID-19 pandemic, raw materials shortages, substitutions, price increases, allocations, force majeure, and other woes make for a barrage of daily bad news. Despite all that, there may be some good news ahead in 2022.



FEATURES

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Coatings Xperience

The Two Pillars of Surface Preparation

By Cynthia A. Gosselin, The ChemQuest Group

There are two primary “pillars” of the surface preparation process: cleanliness and pretreatment. Learn how adhering to these procedures will help ensure the best result in the painting and coating process.

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Current Trends in Interior Architectural Coatings

By Leo J. Procopio, Paintology Coatings Research LLC

Industry experts weigh in on what is new and now, how the pandemic affected the interior coatings market, and which trends are influencing product development and consumer aesthetic choices.

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Diving Deeper into VOCs

By Jessica Lum, Madeline Schultz, and Erik Sapper, Department of Chemistry and Biochemistry,
California Polytechnic State University

In this article, the authors examine the prediction of formulation component GC-MS response factor using quantitative structure-activity relationships coupled with artificial neural networks.

47

ACA and the WCC: An Update on Global Regulatory Developments

By Heidi McAuliffe, ACA Vice President of Government Affairs

In the global arena, ACA monitors and tracks the issues of air quality, environmental requirements, chemicals management, occupational safety and health, and sustainability, conducting its advocacy under the umbrella of the World Coatings Council (WCC) and its members. This article examines the international issues facing the industry.

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Architectural coatings consist of a wide array of paints and coatings for both interior and exterior surfaces. In an in-depth Q&A, industry experts discuss how the pandemic affected the interior coatings market and which trends are influencing product development and consumer aesthetic choices. Learn more on page 30.

COATINGSTECH

CoatingsTech provides a forum for publication of industry and association news, highlighting new materials and technology in practice, regulatory and legislative updates, as well as essential business information related to the coatings and allied industries. As the principal membership and industry publication of the American Coatings Association, *CoatingsTech* serves the global membership of ACA and others in the coatings industry, and showcases industry news, science and technology updates, and market insights.



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ACA Webinar Series Continues

ACA will present several webinars for corporate members in April and May. Additional webinars will be scheduled throughout the year. The latest updates, webinar descriptions, and registration are available online at www.paint.org/aca-events/webinars.

New ACA Sustainability Standard for Architectural Coatings April 14, 1:00–2:00 p.m. (ET)

This free webinar will introduce ACA's new Sustainability Standard for Architectural Coatings. The standard, developed in coordination with NSF International, uses a lifecycle approach to evaluate the environmental impacts of architectural coatings on the environment and provide transparency to the public on these impacts. The webinar will review the standard's framework, including its consensus-based performance metrics, as well as certification and how the standard can work in tandem with LEED to help industry products achieve maximum credits.

The webinar will be led by ACA's Katherine Berry, director, Sustainability & Environment, and NSF International's Justin Brown, senior technical reviewer, Sustainability.

State Affairs Network Update for Illinois, Kentucky, Minnesota, and Ohio

April 19, 2:00–3:30 p.m. (ET)

This free webinar will provide an update on legislative activity in Illinois, Kentucky, Minnesota, and Ohio as monitored for industry impact by ACA's State Affairs Network lobbyists. ACA staff will also provide an update on regulatory efforts related to architectural and industrial maintenance (AIM) coatings in those states.

The webinar will be led by Heidi McAuliffe, ACA vice president, Government Affairs

Getting Out of the Lab—Advantages of Evaluating Coatings in a Real-world Manufacturing Environment

April 21, 1:00–2:00 p.m. (ET)

This free webinar will present the disconnect that often occurs between coating application performance measured at lab scale and translating this data into a real-world manufacturing environment. Part size and geometry, heat mass, substrate condition, humidity, temperature, application equipment, overspray, and other variables are traditionally not evaluated at lab scale with small test coupons. Each of these variables present in the manufacturing environment can affect coating performance. Failure to understand, isolate, and control these manufacturing variables at the formulation design stage can result in quality issues which are difficult to troubleshoot later. This webinar will cover the theoretical framework of these variables, as well as methods to test for these variables early in the formulation design process.

The webinar will be led by Douglas Corrigan, vice president, ChemQuest Technology Institute.



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What You Should Know about TSCA in 2022 May 11, 1:00–2:00 p.m. (ET)

This free webinar will address how U.S. Environmental Protection Agency policies and procedures for implementing the Lautenberg Amendments to the Toxic Substances Control Act (TSCA) continue to evolve. The webinar will highlight expected changes in the areas of greatest consequence to industry and will cover the following:

- Anticipated changes in how EPA conducts New Chemical Reviews
- Implications associated with EPA's plan to repropose updates to TSCA's fee structure
- Impacts on industry from pending litigation on transparency in New Chemical Reviews
- Impending changes to the rules governing TSCA confidential business information (CBI) protection
- Status of EPA's expedited rules that ban most uses of certain PBT chemicals including PIP 3:1

The webinar will be led by Martha E. Marrapese, partner at Wiley Rein LLP.

Making 'Zero VOC' Claims: A Legal Perspective May 23, 1:00–2:00 p.m. (ET)

This free webinar will review the history of the U.S. Federal Trade Commission's (FTC) regulation of products that make "zero VOC" claims, including agency enforcement actions against different industries. The webinar will also review the latest FTC guidance on making "zero VOC" claims, and some of the challenges of implementing it. Participants will gain a better understanding of the available guidance, legal requirements, and risks associated with making such claims.

The webinar will be led by Philip A. Moffat and Irene A. Hantman of Verdant Law.

ACA Webinar Archive

ACA also maintains an archive of past webinars. These are also complimentary for corporate members who are logged in on the website. To listen, visit the ACA member center at www.paint.org/aca-member-center/corporate-member-center/.



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ACA Presents Annual Safety Awards

To promote occupational safety and health as a priority for industry, ACA encourages and recognizes its members with outstanding safety records through its Annual Safety Awards Program.

The purpose of the program goes beyond recognizing superior safety performance at plant locations; it also enables the collection of valuable data. This industry safety information is useful to member companies in assessing the effectiveness of their safety programs as compared with others in the industry. ACA operates the program to benchmark the industry's commitment to workplace safety.

To report the data in comparable groupings, ACA requires that submissions use the Standard Industrial Classification (SIC) or North American Industry Classification System (NAICS) code.

Submissions for the 2020 Safety Awards were accepted in 2021 and evaluated based on 2020 facility safety data. In March, ACA presented safety awards to companies in the following three categories:

SAFETY AWARDS OF EXCELLENCE

This award is presented to companies in various size categories that achieved zero death and total lost-workday cases for the subject five-year period.

AD Fire Protection Systems Inc.

St. Louis, MO

Arkema Coating Resins

Cary, NC

Arkema Coating Resins

Hahnville, LA

Arkema Coating Resins

North Kansas City, MI

Axalta Coating Systems Canada Company

Hilliard, OH

Axalta Coating Systems Canada Company

Sacramento, CA

Euclid Chemical Company

Phoenix, AZ

Henkel U.S. Operations Corporation

Calhoun, GA

Henkel U.S. Operations Corporation

Lincolnton, NC

Kop-Coat

St. Louis, MO

Masco Corporation

McDonough, GA

Rudd Company, Inc.

Seattle, WA

The Sherwin-Williams Company

Elkhart, IN

The Sherwin-Williams Company

Lebanon, PA

The Sherwin-Williams Company

Marengo, IL

The Sherwin-Williams Company

Medina, OH

The Sherwin-Williams Company

Memphis, TN

The Sherwin-Williams Company

Richmond, KY

Tremco, Inc.

Harbor Springs, MI

Tremco, Inc.

Spearfish, SD

SAFETY AWARDS OF HONOR

This award is presented to companies that had the lowest rate of death and total lost workday cases for the latest reporting year.

AD Fire Protection Systems Inc.

Louisa, VA

AD Fire Protection Systems Inc.

Green Bay, WI

Applied Polymerics Inc.

Conyers, GA

Arkema Coating Resins

Grand Rapids, MI

Arkema Coating Resins

Torrance, CA

Axalta Coating Systems Canada Company

Fort Madison, IA

Axalta Coating Systems Canada Company

Front Royal, VA

Axalta Coating Systems Canada Company

High Point, NC

Axalta Coating Systems Canada Company

Houston, TX

Axalta Coating Systems Canada Company

Madison, AL

Axalta Coating Systems Canada Company

Jacksonville, TX

Axalta Coating Systems Canada Company

Orrville, OH

Axalta Coating Systems Canada Company

Riverside, CA

Axalta Coating Systems LLC

Orrville, OH

Henkel U.S. Operations Corporation

Compton, CA

Henkel U.S. Operations Corporation

Franklin Park, IL

Henkel U.S. Operations Corporation

Memphis, TN

Henkel U.S. Operations Corporation

Muncie, IN

Henkel U.S. Operations Corporation

Nashville, TN

Henkel U.S. Operations Corporation

Richmond, VA

Masco Corporation

McDonough, GA

Masco Corporation

Chicago Heights, IL

Masco Corporation

Santa Ana, CA

Masco Corporation

Roanoke, TX

Masco Corporation

Algona, WA

Masco Corporation

Imperial, MO

Masco Corporation

Santa Ana, CA

PPG Industries, Inc.

Allison Park, PA

The Sherwin-Williams Company

Andover, KS

The Sherwin-Williams Company

Arlington, TX

The Sherwin-Williams Company

Bedford Heights, OH

The Sherwin-Williams Company

Birmingham, AL

The Sherwin-Williams Company

Bowling Green, KY

The Sherwin-Williams Company

Charlotte, NC

The Sherwin-Williams Company

Cleveland, OH

The Sherwin-Williams Company

Columbus, OH

The Sherwin-Williams Company

Covington, GA

The Sherwin-Williams Company

Flora, IL

The Sherwin-Williams Company

Greensboro, NC

The Sherwin-Williams Company

Lawrenceville, GA

The Sherwin-Williams Company

Los Angeles, CA

The Sherwin-Williams Company

Matteson, IL

The Sherwin-Williams Company

Moline, IL

The Sherwin-Williams Company

Pittsburgh, PA

The Sherwin-Williams Company

Rochester, PA

The Sherwin-Williams Company

Rockford, IL

The Sherwin-Williams Company

Winter Haven, FL

The Euclid Chemical Company

Phoenix, AZ

The Euclid Chemical Company

Pasadena, TX

The Euclid Chemical Company

Odessa, FL

Tremco, Inc.

Medina, OH

Tremco, Inc.

Hudson, NH

SAFETY AWARDS OF COMMENDATION

This award is presented to companies that had the lowest rate of death and away-from-work cases during the latest reporting year.

Axalta Coating Systems Canada Company

Mt. Clemens, MI

Masco Corporation

Denver, CO

Masco Corporation

Kutztown, PA

Masco Corporation

Orlando, FL

Masco Corporation

Sauk Village, IL

Prosoco

Lawrence, KS

The Sherwin-Williams Company

Garland, TX

The Sherwin-Williams Company

Morrow, GA

The Sherwin-Williams Company

Ontario, CA

The Euclid Chemical Company

Kirkland, IL

Tnemec Company, Inc.

North Kansas City, MO

Tremco, Inc.

Columbus, GA



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Brenntag Specialties and BASF Expand Collaboration



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Brenntag Specialties will become the exclusive distributor for BASF’s Baxxodur® amine-based curing agents for the United States and Canada. The agreement, which is effective May 1, expands the collaboration between BASF and Brenntag Specialties. Since July 2019, Brenntag has been the exclusive distributor for Baxxodur products in the western and eastern United States.

“This collaboration provides our customers the convenience of developing their entire formula and sourcing raw materials from one easy-to-work-with distribution leader,” said Ted Davlantes, Brenntag president of material science, Americas. “Customers are fully supported with a dedicated team of industry experts and a comprehensive product portfolio.”

“Broadening our existing relationship with Brenntag for the Baxxodur and the polyetheramines portfolio in the United States and Canada aligns with our product line growth strategy,” said Kevin Anderson, BASF vice president, business management, amines, acetylenics, and carbonyl derivatives, North America. “We are excited to further our collaboration, especially considering Brenntag’s technical expertise and extensive market knowledge for these products.”

BASF’s Baxxodur portfolio, including polyetheramines and isophorone diamine, is used by customers as curing agents and chain extenders in epoxy and polyurea applications for the wind, electrical, composites, adhesives, and flooring industries. According to the company, the usage of Baxxodur allows customers to achieve a wide range of benefits in their formulation, including curing time, hardness, flexibility, peel strength, chemical, and temperature resistance.

DOWD AND GUILD, TERRA FIRMA, AND NORTHSPEC CHEMICALS CREATE NEW PARTNERSHIP

Dowd and Guild Inc., Terra Firma, and Northspec announced the next step in what the companies call a “bespoke” specialty chemicals

distributor that will serve the United States and Canada.

Dowd and Guild, based in California, and Canadian company Northspec have joined Maryland-based Terra Firma through a partnership recapitalization. The principals of all three firms remain invested through the recapitalization, which the companies say allows for zero management exits and no consolidation

IMPORTANT PRODUCER PAINT INDEX UPDATE: The formula for the proprietary ACA paint materials index (1991=100) has been modified. Several raw material inputs previously included in it are no longer published (titanium dioxide, iron oxide, other organic and inorganic pigments, and paint fillers). The new formula uses PPI information still published by the Bureau of Labor Statistics for resins, pigments, solvents, and containers within a revised weighted average.

BUREAU OF LABOR STATISTICS PRODUCER PAINT INDEX

	PREPARED PAINT ^{1,2} Commodity Code: 0621 (1982=100)	PAINT MATERIAL ³ (1991=100)	NET INPUTS TO COATINGS INDUSTRY ¹ (March 2013=100)
2021			
FEBRUARY	312.8	193.4	103.3
MARCH	313.8	205.1	108.1
APRIL	318.6	206.7	110.6
MAY	320.8	218.0	114.9
JUNE	323.8	222.7	117.6
JULY	333.0	227.0	119.4
AUGUST	337.4	234.0	121.2
SEPTEMBER	343.0	230.6	120.9
OCTOBER	346.9	234.7	122.1
NOVEMBER	349.7 (P)	239.0 (P)	123.6 (P)
DECEMBER	353.3 (P)	234.6 (P)	122.8 (P)
2022			
JANUARY	376.4 (P)	236.6 (P)	122.8 (P)
FEBRUARY	378.7 (P)	240.9 (P)	124.1 (P)

SOURCE: 1. U.S. Dept. of Labor, Bureau of Labor Statistics; 2. Not seasonally adjusted; 3. ACA Management Info Committee; (P)—preliminary, (R)—revised

of offices. According to the companies, the combination of the three enhances the companies' abilities to focus on customers' formulary and logistical needs.

"By bringing together our complementary cultures, expertise, strategies, and specialty chemical focus, we are creating a premier North American specialty chemical distribution company that collectively has over 140 years of industry experience and longevity," said Tim Fetters, Dow and Guild CEO.

Northspec CEO Noel Shahnazarian added, "The creation of this new partnership signifies our collective commitment to growth while preserving the market-focused specialty business model that has made each company in this partnership successful."

In addition, private investment firm Goldner Hawn has been brought on as a financial partner.

"With Goldner Hawn, we have found the perfect partner who shares a long-term horizon and fully supports our commitment to true organic growth," said David Behan, CEO of Terra Firma. "This new chapter builds on the meaningful dedication all three businesses have given to our industry and at the same time secures our place in the future. We endeavor to never lose sight of the past and those who made our success possible."

ERGON ASPHALT & EMULSIONS BUYS SUMTER COATINGS

Ergon Asphalt & Emulsions Inc. has purchased Sumter Coatings Inc., which will be a part of the company's ErgonArmor division. Since its founding in 1996, Sumter Coatings has served the structural steel fabricators, industrial finishes and maintenance, repair, and operations markets.

Headquartered in Sumter, SC, the company produces enamel, urethane, alkyd and epoxy primers and coatings under the brands Metal Master, Topkote, and others, as well as customer labels. Sumter Coatings also provides formulating and contract manufacturing services.

"In addition to introducing Sumter Coatings products to our industrial and private label customers, we plan to develop new solvented products to expand ErgonArmor's product range for industrial construction, maintenance, and repair applications," said David Brackins, senior vice president and general manager of ErgonArmor.

According to the company, Sumter Coatings can process lower flashpoint chemicals in its South Carolina facility, which will expand current capabilities at ErgonArmor's production facilities in Kansas City, KS, and Memphis, TN.



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OQ CHEMICALS EXPANDS PRODUCTION FACILITY FOR TCD ALCOHOL DM

OQ Chemicals has expanded its capacity for TCD alcohol DM (tricyclodecanedimethanol) at its plant in Oberhausen, Germany.

"With the expanded plant, we are significantly increasing product availability and supply reliability for our customers," said Patricia Morkramer, global marketing director, amines and higher aldehydes/specialty derivatives at OQ Chemicals. "Our additional capacity will cover the expected growth of the global market for TCD alcohol DM for years to come."

In exterior coatings, TCD alcohol DM functions as a copolymer that enables hardness, scratch resistance, and good adhesion to steel, aluminum, and glass with low water absorption, according to the company. OQ Chemicals says that for adhesives and coatings in electronic applications and materials for 3D printing, it leads to high resistance to temperatures, aging and weathering, as well as mechanical stability and low-water-vapor permeability. In optical materials, TCD alcohol DM ensures UV transmission, resistance to yellowing and high Abbé numbers.

NORTH DAKOTA STATE UNIVERSITY SCHEDULES COATINGS SHORT COURSES FOR 2022

The Department of Coatings and Polymeric Materials at North Dakota State University has announced the dates for its 2022 short courses. The Coatings Science short course will be held June 5–10 and the Corrosion Protection by Coatings short course will be held June 13–15. Both courses will be in-person on the Fargo campus.

The Coatings Science short course provides a comprehensive overview of the basic principles of coatings science including resin chemistry, solvents, pigments, additives, evaluation of performance, rheology, durability, and corrosion protection. The Corrosion Protection by Coatings course is designed to be a practical guide to the corrosion process, characterization of corrosion, corrosion protection by coatings and testing of coatings.

For more information, visit www.ndsu.edu/cpm/shortcourse or contact Dean Webster at dean.webster@ndsu.edu.

CALL FOR PAPERS: WOOD COATINGS & SUBSTRATES 2022

The Department of Chemistry and Biochemistry of the University of North Carolina at Greensboro, in collaboration with The Wood Coatings Research Group, Inc., has issued a call for papers for the 10th Biennial Wood Coatings and Substrates Conference.

The conference is planned as a hybrid event with the onsite venue to be September 22 and 23 on the campus of the University of North Carolina at Greensboro, NC.

Abstracts are being accepted for topics pertaining to chemistry, application, and technology related to wood and wood coatings, environmental regulations, and wood-based substrates. Focus areas include but are not limited to:

- Wood substrates
- Digital printing
- Water-based technology
- UV-curable technology
- Green chemistry
- Crosslinking methodologies
- Film formation

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Abstracts for consideration are due by June 1. To submit or for more information, contact Ronald Obie of the Wood Coatings Research Group at r.obie@woodcoatingsresearchgroup.com or visit www.woodcoatingsresearchgroup.com/wood-coatings-substrates-conference-2022.html.

HMG PAINTS TEAMS WITH TRADE SECRETS AS DISTRIBUTOR

Trade Secrets of Scotland will be stocking HMG's "Made in Britain" accredited decorative range this spring. Trade Secrets customers will be able to purchase HMG fence and shed paint immediately with more products being introduced throughout the year, including PVC Pro.

"We are really looking forward to launching with Trade Secrets this spring, in time for the outdoor season," said Gracienne Ikin, HMG brand development and communications manager. "After many meetings pulling together the perfect portfolio for the launch, we can't wait get started on our partnership together."

Trade Secrets, which is based in Aberdeen, says it approached HMG Paints after seeing the popularity of HMG's fence and shed paint across the painting and decorating industry. According to the company, the fact that HMG produces all their paint in Britain was an important factor in the decision to approach the independent paint manufacturer.

Founded in 2018, Trade Secrets is a "decorator's merchant" for customers and consumers to purchase tested products. The company says it provides technical application advice and creates a community for sharing best practices.

BASF BUILDS PLANT FOR ALKYLETHANOLAMINES IN BELGIUM

BASF is building a new production plant for alkylethanolamines at the Verbund site in Antwerp, Belgium. According to the company, the plant, which is projected to start up in 2024, will increase the global annual

production capacity of the company's alkylethanolamines portfolio by nearly 30% to 140,000 metric tons per year.

Alkylethanolamines are mainly used as precursors for flocculants applied in water treatment and in the coatings industry, where they act as binders between pigments and resins. Other applications include gas treatment, fabric softeners, additives for metalworking fluids, and polyurethanes.

BASF has approximately 300 different amines in its portfolio. Along with alkyl-, alkanol- and alkoxyalkylamines, the company offers heterocyclic, aromatic, and specialty amines. It also boasts an expanding portfolio of chiral amines of high optical and chemical purity.

"We see a continuing, growing demand for alkylethanolamines in a broad range of industries such as water treatment, detergents and gas treatment over the next years," said Dr. Frank Stein of the BASF Intermediates division. "The investment in Antwerp will have a positive effect on the available capacity for alkylalkanolamines."

In addition to the Antwerp site, BASF has production facilities for its alkylethanolamines portfolio in Ludwigshafen, Germany; Nanjing, China; and Geismar, LA.

IMCD TO ACQUIRE QUELARIS INTERNACIONAL S.A.

IMCD N.V., a distributor of specialty chemicals and ingredients, announced that it has signed an agreement to acquire 100% of the business and the subsidiaries of Quelarís Internacional S.A., a Latin America (LATAM) regional raw material distributor with offices in Colombia, Costa Rica, and Peru.

"Following IMCD's acquisition of Andes Chemical Corp. nine months ago, the Quelarís acquisition further enhances IMCD's presence and offering in North LATAM," said Marcus Jordan, IMCD Americas president. "The addition of Quelarís further reinforces our approach of creating growth opportunities for our supply and customer partners."

Generating a revenue of approximately USD \$52 million in 2021, Quelarís was established in 1993, operates in 14 LATAM countries and adds 46 employees to IMCD. It has a strong presence in the polyurethane, coatings, adhesives, rubber, and other industrial markets throughout the region.

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THE SHERWIN-WILLIAMS COMPANY ACQUIRES AQUASURTECH

The Sherwin-Williams Company has completed the acquisition of AquaSurTech, a Canada-based company specializing in the development, manufacturing, and sale of environmentally friendly coatings for the vinyl/PVC building products industry, which is one of the fastest growing subsegments of the industry.

AquaSurTech has a manufacturing footprint in the greater Toronto area and color blending facilities in both the United States and Canada.

“This transaction helps accelerate our growth into one of the most important segments of the building products industry,” said Karl Jorgenrud, president and general manager, general industrial division, at Sherwin-Williams.

“AquaSurTech’s unique technology and strong product platform will help us advance our growth strategy and better serve the strong demand of Sherwin-Williams customers.”

In other Sherwin-Williams news, the company has signed an agreement with the state of North Carolina, Iredell County, and the city of Statesville to significantly expand its architectural paint and coatings manufacturing capacity and establish a larger distribution facility in Statesville. Sherwin-Williams says it plans to invest a minimum of \$300 million in the project and add more than

180 full-time jobs at the site over the next three years, which would essentially double the existing workforce.

The project will include a 36,000-square-foot extension of its existing 200,000-square-foot manufacturing facility, the addition of four new rail spurs, as well as the construction of a new 800,000-square-foot distribution and fleet transportation center, which has an additional 200,000 square feet available for future expansion.

UNIVAR SOLUTIONS TAPPED AS DISTRIBUTOR OF COIM USA PRODUCTS

Univar Solutions Inc., a chemical and ingredient distributor, announced that COIM USA, Inc. has selected Univar as the exclusive distributor of Diexter-G™, Isoexter™, and Hydroexter™ in the United States and Canada. According to the company, COIM’s polyester polyols and specialty resins are designed to enhance the properties of coatings, adhesives and sealants (CAS) and will complement Univar Solutions’ existing CAS product lines.

“We’re excited to enhance our already robust high-performance polyester and polyurethane technologies product line through our new collaboration with COIM,” said Chris Fitzgerald, Univar global vice president, CASE, rubber and plastic additives. “This allows Univar Solutions to be even more valuable to our customers and help solve their

toughest challenges, develop more innovative and sustainable products, and reduce time to market.”

According to the companies, Diexter-G, Isoexter, and Hydroexter are well-suited for use in a wide range of applications, from industrial and polyurethane coatings, adhesives, and sealants to resin synthesis and color dispersions. Polyesters are used in CAS applications for mechanical properties, flexibility, and impact resistance, adhesion, solvent, oil, fuel, oxidation resistance, abrasion and chip resistance, weatherability, and UV resistance. ❖

BASF BOARD OF EXECUTIVE DIRECTORS SHIFTS RESPONSIBILITIES

The BASF Board of Executive Directors announced changes to the responsibilities in two Board Ressorts. These will take effect on March 1 and are structured as follows:

Saori Dubourg, Ressort IV, will assume responsibility for the Monomers, Performance Materials, Petrochemicals, and Intermediates divisions. She will continue to be responsible for the region Europe.

Michael Heinz, Ressort V, based in Florham Park, NJ, will assume responsibility for the Agricultural Solutions, Care Chemicals, and Nutrition and Health divisions. He will continue to be responsible for the North America and South America regions.

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Waterborne Symposium Returns to New Orleans for 49th Year

As New Orleans prepared for its first official Mardi Gras since the COVID-19 pandemic struck the United States in early 2020, nearly 230 coatings industry formulators, scientists, chemists, and technical managers came together February 20–25 in Louisiana’s Crescent City for the 49th Annual International Waterborne, High-Solids, and Powder Coatings Symposium—better known as the Waterborne Symposium.

Hosted by the University of Southern Mississippi (USM) School of Polymer Science and Engineering, the Waterborne Symposium offered attendees five days of short courses, technical presentations, a poster session, and in-person networking opportunities.

Three days of optional short courses kicked off the week, leading up to the opening of the symposium on Wednesday, when USM’s Dr. Robson Storey presented the plenary lecture, “Alternative Polyurethane Polymers Cured via Azide-alkyne Cycloaddition.”

Storey is professor emeritus at the USM School of Polymer Science and Engineering, where he has held a faculty appointment since 1983. He has served as chairman or co-chairman of the Waterborne Symposium since 1985.

Following Storey’s presentation, attendees gathered for coffee and networking in the Technology Showcase exhibit hall, where nearly 20 leading suppliers to the industry, including *CoatingsTech*, offered a firsthand look at related products, equipment, services, and expertise.



Matthew J. Gadman, left, accepts the Siltech Best Paper Innovation Award from Dr. Robson Storey of USM.

After the morning break, Dean Webster, professor and chair of Coatings and Polymeric Materials Department at North Dakota State University, presented the Sidney Lauren Memorial Lecture, “Alternative Crosslinking Polyurethanes (ACPU): Novel Synthesis of Epoxy Functional Polyurethanes.”

The Sidney Lauren Memorial Lecture is a staple of the symposium that memorializes Sidney Lauren, a scientific leader in the coatings industry who served as executive director of the Coatings Research Group and was active in the Coatings Industry Education Foundation, which supported educational programs and curriculums devoted to the sciences of coatings technology.

Following the opening lectures, the technical presentations split into two tracks—waterborne and high solids/general—for the remainder of the event. Organizers report that among the 39 presentations, 28 papers were presented.

At the conclusion of the conference, three presenters were recognized for their papers’ exceptional contributions to the technical program. Top honors for the Siltech Best Paper Innovation Award went to Matthew J. Gadman of King Industries for his presentation, “Unique Catalyst for Low Temperature Cure Epoxy Powder Coatings.”

Earning the PCI Award for Technical Excellence was Otto Soidinsalo of Borregaard for his paper “Microfibrillated Cellulose—The Effect of a Novel and Renewable Multifunctional Additive on Common Waterborne Coating Issues.”



PHOTO COURTESY OF WATERBORNE SYMPOSIUM

... the Waterborne Symposium offered attendees five days of short courses, technical presentations, a poster session, and in-person networking opportunities.

The students recognized in 2022 student poster session are, from left to right, Jonathan Gray, Valeria Collo, Maria Martinez, Catherine Sarantas, Samantha Daymon, and Logan Dugas.

CONTINUED ON PAGE 12

Waterborne Symposium

CONTINUED FROM PAGE 11

Benjamin M. Alameda of USM was recognized for best student paper for “Hydrolyzable Poly(β -Thioether Ester Ketal) Thermosets via Acyclic Ketal Monomers.”

Other students from USM and Louisiana State University also participated in the event, sharing their research with attendees during the poster session that featured 22 student posters. Among the poster presentations, four graduate and two undergraduate student posters were honored in the 2022 Evonik Student Poster Competition:

- “Diketoenamine-based Vitrimers via Thiol-ene Photopolymerization” by Logan Dugas
- “A Comparative Study of Hydrogen Bond Organization Between Three Generations of Dendrimers Based on bis-MPA” by Samantha Daymon
- “Necessary and Sufficient Conditions for Frontal Polymerization in Thin Layers for Coatings” by Maria Martinez
- “Bulky Amines for Covalently Adaptable Polyurethanes” by Catherine Sarantas
- “Structure-property Relationships of Bioinspired Glycohydrogels for Transcuticular Drug Delivery Applications” by Valeria Collo
- “Synthesis and Evaluation of the Oxygen Barrier Properties of Polyisobutylene grafted Edge Oxidized Graphene Oxide Nanocomposite Films” by Jonathan Gray

As a crucial component of the USM academic program, the Waterborne Symposium plays a central role in supplying the industry with qualified candidates to fill technical positions.



Waterborne attendees meet with graduate and undergraduate students during the student poster session at the Waterborne Symposium in February. Twenty-two student posters were on display.

Proceeds help the university recruit and retain students who show promise as future coatings industry innovators, supporting graduate student stipends and undergraduate student scholarships, acquisition and maintenance of equipment, and more.

The 50th Waterborne Symposium will be held February 12–17, 2023. USM says the abstract submissions will open this summer, and abstract submissions are due October 15, 2022. For more information about categories of interest and how to submit, visit the Waterborne Symposium website at www.waterbornesymposium.com/submit-for-2023. ❄

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The 50th Waterborne Symposium will be held February 12–17, 2023.



Celeste Mastin

H.B. FULLER CO.

H.B. Fuller Company has appointed Celeste Mastin as executive vice president and chief operating officer. She will assume the executive leadership role most recently held by **Ted Clark**, who is moving into a strategic advisory role. Mastin joins H.B.

Fuller with more than 30 years' experience in manufacturing and distribution with a successful track record of guiding companies' growth through innovation, service improvement, global expansion, and acquisition. Most recently, she served as CEO of PetroChoice Lubrication Solutions. Mastin has also held CEO roles at Distribution International, Inc. and MMI Products, Inc. (a division of Oldcastle), as well as executive leadership roles at Ferro Corporation and Bostik Adhesives, now owned by Arkema. She also currently serves on the board of directors of Granite Construction, Inc.



Jeffrey Glajch

ORION ENGINEERED CARBONS

Mike Orion Engineered Carbons has appointed Jeffrey Glajch as chief financial officer. He will succeed Bob Hrivnak, who currently serves in the dual role of interim CFO and chief accounting officer and will continue as chief accounting

officer. Glajch has more than 30 years of experience leading corporate finance and accounting control functions for both public and private companies. He joins Orion from Graham Corporation, where he has served as CFO for the past 13 years and led all aspects of finance, business development, investor relations, risk management, legal, information technology, and human resources. Prior to Graham Corporation, he held senior financial roles at several companies.



Tim Dining

ADMIX, INC.

Tim Dining has joined Admix as the new as chief operating officer. Dining has more than 30 years of experience leading manufacturing operations environments. He has held many executive and operational leadership roles, and was most recently

vice president of Jewell Instruments, LLC, where he oversaw sales and marketing, engineering, operations, supply chain management, and the company's ISO 9001 initiatives. Dining has also served on several boards throughout his career and is currently on the board of advisors for the New Hampshire Small Business Development Center and on the board of directors for the New Hampshire Manufacturing Extension Partnership.

In the Industry, On the Move

MATT MCGRAW Barentz has appointed Matt McGraw as the new operations manager for its CASE and Plastics vertical business. Prior to joining Barentz, McGraw spent approximately eight years with Moen, where he held leadership positions within operations, business intelligence, national accounts, and sales. Barentz says McGraw, a decorated U.S. Army veteran, brings with him an operations and sales background that will be crucial to the company's growth.

JABU BANDA Chromaflo Technologies has named Jabu Banda commercial director, sub-Saharan Africa. He will lead sustainable market share growth in the sub-Saharan region through market development and conversion of primary sales targets, including the proliferation of existing product lines and introduction of new product lines. Banda has 20 years of experience with executive management level and product commercialization with Gilbarco Veeder-Root, global suppliers of fueling and convenience store equipment and technology. Banda has extensive experience in closing deals in sub-Saharan Africa and has successfully led sales teams and channel managers during his years of travel in the region.

In Memoriam

PETER "PETE" CORTELYOU, chairman and former CEO and president of Tnemec Company Inc., passed away on February 11. He was 75. Cortelyou joined the Tnemec team in 1975 as controller and office manager. In 1986, he was elected president and CEO, where he oversaw Tnemec's biggest periods of growth. He resigned from his position in 1994, but he rejoined the company in 2003 and was shortly thereafter elected as CEO. He served in that role before retiring and transitioning to chairman of the Tnemec Board in 2016. Cortelyou was a lifelong resident of Kansas City, MO. He is survived by his wife and three daughters.

PHILLIP "PHIL" G. PHILLIPS, owner and executive vice president of CHEMARK, passed away February 9. He was 84. Phillips earned a Ph.D. in business from Warren National University and worked his entire career in the chemical business with an emphasis in powder coatings before beginning his own consulting business. During his career, he served on management committees and boards of directors for several corporations. He was the co-founder of the Association of Finishing Processors for the Society of Manufacturers Engineers-Powder Coating Division and the National Paint and Coatings Association. In 2013, he was inducted into the Powder Coating Institute Hall of Fame. He is survived by his wife of 41 years, Patricia, and his three children.



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ACA Letter to Senate EPW Commends Federal Recycling Proposals

ACA sent a letter in February to the U.S. Senate Committee on Environment and Public Works (EPW) leadership, expressing strong support for a robust national recycling infrastructure, and to commend the committee for holding a hearing February 2 on “Legislative Proposals to Improve Domestic Recycling and Composting Programs.”

That hearing garnered bipartisan support for two bills: the Recycling and Composting Accountability Act and the Recycling Infrastructure and Accessibility Act, which collectively aim to strengthen the “circular economy.”

The Recycling and Composting Accountability Act seeks to boost the U.S. Environmental Protection Agency’s (EPA) recycling and composting data and would require the EPA administrator to carry out certain activities to improve recycling and composting programs in the United States. The Recycling Infrastructure and Accessibility Acts seeks to tackle barriers to recycling, which abound for many communities, including in rural and low-income areas.

Market challenges for recycling are real. As former export markets such as China decline foreign waste products, domestic solutions for recycling are necessary.

“It is clear that our nation’s recycling infrastructure needs significant investment in order to develop the systems necessary to improve recycling programs and appropriate waste management options for a myriad of products,” the ACA letter said. “We are hopeful that these two bills will lead to support for recycling projects that will complement efforts of the Infrastructure Investment and Jobs Act.”

ACA PAINTCARE PROGRAM

ACA highlighted for the committee the innovative and tested approach to manage post-consumer, leftover paint championed by the U.S. paint industry—PaintCare, an architectural paint stewardship program.

Noting that leftover architectural paint—interior or exterior coatings used on homes, businesses, and other structures—is often the most common material collected by government-run household hazardous waste (HHW) programs, this leftover paint is also a valuable resource that can be diverted from HHW programs for reuse, recycling, energy recovery, or manufacturing products. To achieve this requires a convenient and efficient collection system.

Many government HHW programs have collected unwanted paint for years, but the cost is burdensome and diverts resources that could be used for managing other waste materials. For some local governments, it is simply beyond available capacity.

ACA’s PaintCare program takes responsibility for ensuring an environmentally sound and cost-effective paint stewardship program, reducing the generation of post-consumer architectural paint; promoting its reuse; and providing for its collection, transport, and processing.

PaintCare has been a tremendous success: It currently operates in 11 states, including California, Colorado, Connecticut, District of Columbia, Maine, Minnesota, Oregon, Rhode Island, Vermont, Washington, and New York.

In these states, PaintCare has collected more than 54 million gallons of leftover paint and diverted more than 75% of it from landfills by reusing it, recycling it, or in the case of solvent-based paint, recovering the energy value from it.

While PaintCare is a remarkably successful program focused on the waste stream of leftover household paint, the paint and coatings industry and many other industries confront systemic obstacles when attempting to handle other waste streams in a similar manner. As such, ACA applauds Congressional efforts to advance legislative measures to augment the nation’s recycling infrastructure.

Contact ACA’s Heidi McAuliffe (hmcauliffe@paint.org) for more information.

EPA Part II Asbestos Evaluation Could Impact Formulated Products

The U.S. Environmental Protection Agency has published its draft scoping document for Part II of its asbestos evaluation under the Toxic Substances Control Act (TSCA). The Part II evaluation was mandated by the Ninth Circuit Court of Appeals via a 2019 opinion in *Safer Chemicals, Healthy Families v. EPA*, 943 F.3d 397 (9th Cir. 2019), requiring that EPA consider legacy uses and associated disposal (i.e., ongoing and future disposal from legacy uses).

The draft can be read at www.epa.gov/system/files/documents/2021-12/asbestos_part2_draftscope_epa-hq-oppt-2021-0254.pdf.

EPA's evaluation could affect paints, coatings, sealants and adhesives, due to inclusion of minerals used in raw materials. EPA's proposed scope includes asbestos as defined in Title II (Sec. 202) of TSCA with other minerals generally mined with asbestos, such as vermiculite and talc, due to geological mixing and proximity to asbestos. Under this scope, EPA would include:

- Asbestiform varieties of six fiber types: chrysotile (serpentine), crocidolite (riebeckite), amosite (cummingtonite-grunerite), anthophyllite, tremolite and actinolite
- Libby Amphibole Asbestos (LAA), its constituents tremolite, winchite and richterite, with vermiculite mined with LAA
- Talc containing asbestos

EPA identifies relevant CAS numbers as: 1332-21-4 (asbestos; this is the only asbestos on the TSCA Inventory), 12001-29-5 (chrysotile), 12001-28-4 (crocidolite), 12172-73-5 (amosite), 17068-78-9 (anthophyllite), 14567-73-8 (tremolite), 12172-67-7 (actinolite), 1318-09-8 (LAA), 12425-92-2 (winchite), and 17068-76-7 (richterite). See pages 9 and 10 of the draft scope for EPA's description of asbestos-related substances within scope of evaluation.

EPA will consider legacy use and associated disposal of vermiculite. Its evaluation of talc would include ongoing use and disposal. For EPA risk evaluation, conditions of use include a variety of industrial and consumer formulated products including coatings, textured paints, vehicle undercoats, adhesives and sealants, extruded sealant tape, etc. EPA's selection of a use for evaluation is not an indication of risk. See page 26 of the draft scoping document for EPA's table of Conditions of Use.

EPA explains inclusion of vermiculite at page 31 of the draft scope as follows:

"Vermiculite, a silicate, mica-like mineral, was widely used in building materials that will be a focus of much of Part 2 of the risk evaluation. It is well established that LAA—which consists mostly of winchite, richterite, and tremolite fibers with trace amounts of other amphiboles—is known to be present in vermiculite that was extracted from an open pit mine near Libby, Montana. Although the mine closed in 1990, it provided over 70 percent of all vermiculite sold in the United States from 1919 to 1990 (U.S. EPA, 2014). It has been demonstrated that asbestos has been detected in other vermiculite but not to the same degree or the same type of contamination. Thus, in the Part 2 risk evaluation, it will be important to consider asbestos fibers in vermiculite."

Manufacturers have expressed concerns that the proposed scope may be overly broad and touching on products where health risk is already known and mitigated. Moreover, broadening the scope to include asbestos as a trace contaminant may misdirect agency resources resulting in inaccuracies in evaluation of potentially significant exposure pathways.

At the time of this writing, EPA is set to propose a related asbestos reporting rule sometime in March and issue the final rule in November 2022. In its regulatory agenda, EPA explains that the rule would

"require the maintenance of records and submission to EPA: reports by manufacturers, importers and processors of asbestos and mixtures and articles containing asbestos (including as an impurity). The information sought includes data on the quantities of asbestos used in making products, employee exposure data, and waste disposal data. Reported information would be used by EPA and other Federal agencies in considering the regulation of asbestos."

More information from EPA regarding the draft scoping document for Part II of the asbestos evaluation is available at www.epa.gov/assessing-and-managing-chemicals-under-tsca/risk-evaluation-asbestos-part-2-supplemental-evaluation.

Notification related to the asbestos reporting rule is also available online at www.reginfo.gov/public/do/eAgendaViewRule?pubId=202110&RIN=2070-AK99.

Contact ACA's Riaz Zaman (rzaman@paint.org) for more information.



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The Two Pillars of Surface Preparation

By Cynthia A. Gosselin, The ChemQuest Group

Journalist Colin Mason once wrote, “A pristine superyacht in the marina, with shining paint work, sparkling stainless steel elements, gleaming brightwork and flawless teak decks is not the result of luck. Paintwork in particular involves a complex process that is tough to get right and requires a perfectly well-ordered and clean environment.”¹

His discussion centered upon keeping the yacht workplace consistently tidy, clean, and free of dust, dirt, and residue to eliminate expensive repainting and other corrections during the building of these expensive boats.

There are two primary “pillars” of the surface preparation process; adhering to these procedures will help ensure the best result in the painting and coating process.

THE FIRST PILLAR: CLEANLINESS

The first essential element for the application of a defect-free durable coating is that of a clean substrate. A large percentage of in-service coating failures are the result of the inadequate removal of surface contaminants such as mill oils, greases, fingerprints, oxides, mill scale, metallic fines, weldment residue, molding release compounds, and other soils. These “dirty” surfaces inhibit adequate pretreatment and ultimately lead to ugly paint delamination.

Even do-it-yourself (DIY) painters are cautioned about the need for a clean painting surface, be it a wall, floor, or metal yard furniture. Instructions on every paint can stress that before painting, the

surface must be free of dirt, oil, mold, mildew, and any other pertinent contaminant that has the propensity to lead to a poor aesthetic, or even worse, paint voids, or delamination.

In the industrial world, the ideal cleaning agent is one that removes contaminants from the metal surface. The process must be robust enough to inhibit any detrimental reaction products from forming and at the same time prevent redeposition of soils onto the surface.

Typical chemical cleaning methods range from alkaline cleaning, solvent cleaning, vapor degreasing, ultrasonic cleaning, and pickling.

Mechanical cleaning can involve brushing, grit blasting, wire brushing, chipping, and sanding. In addition to removing soils, cleaners can be tailored to activate the substrate surface to uniformly accept either a pretreatment, adhesive, or paint film.

It is important to pair the proper cleaner with the proper type of contaminant. Generally, soils are either organic or inorganic. Mill oils, rolling solutions, lubricants, and rust-preventative oils are typical examples of organic soils. Alkaline cleaner chemistries are most effective in removing organic soils. These cleaners can lift soils off the substrate surface and disperse them into the bath. The soils are then removed by overflowing the bath, mechanically skimming residue from the bath surface or by filtration.

Conversely, mill scale, heavy oxides, and metallic fines are considered inorganic soils. Acid cleaners are used to remove them. Pickling is a typical acid cleaning process.

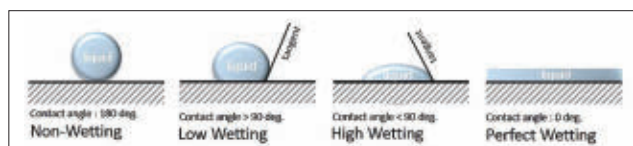
Most cleaning sections are followed by water rinses to remove any loosened residue or remaining cleaning solution. In the laboratory, panels are said to be

It is important to pair
the proper cleaner with
the proper type of
contaminant.

“water-break free” when the surface is adequately cleaned. This is a quick visual approach to monitoring cleanliness of the surface. More sophisticated approaches involve measuring the contact angle and even stating the optimum measurement on a technical data sheet.²

A contact angle is a quantitative way to measure the degree of wetting of a solid by a liquid. Surfaces can be identified as perfectly wetting with a strong solid-liquid interaction strength ($\Theta = 0^\circ$) to a completely non-wetting interaction ($\Theta = 180^\circ$). Typically, a contact angle between 0° and 90° will exhibit good wettability (Figure 1).³ The better the wetting, the more uniform the pretreatment, adhesive, or paint deposition onto a surface.

FIGURE 1—Schematic of contact angles exhibiting various levels of wettability as defined by the balance at the point of three phase contact of solid, liquid, and gas.



THE SECOND PILLAR: PRETREATMENT

Once the metal surface is adequately cleaned, the second essential element governing durability and corrosion resistance of a painted substrate is the deposition of a pretreatment onto the clean, activated surface. This technology has evolved significantly since the first phosphate bath was commercialized in 1906. In fact, today, a microcrystalline phosphate pretreatment can even serve as a functional interim coating in conjunction with mill oil to facilitate formability. This is a common approach for forming automotive panels.

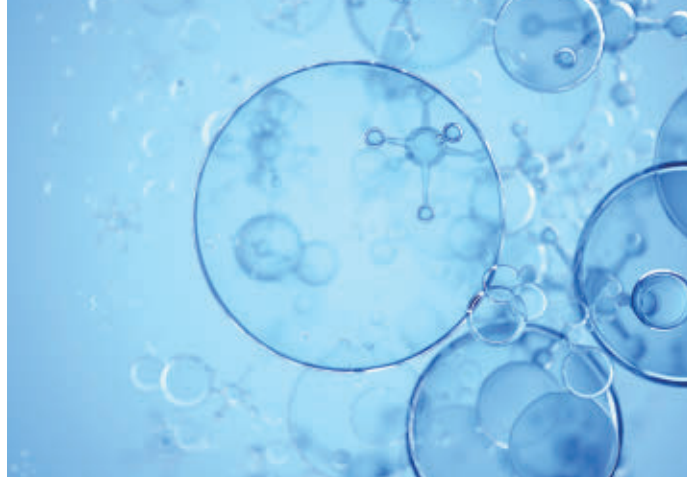
In other cases, pretreatment can be a permanent thin film organic that imparts fingerprint resistance or a temporary coating that enhances uniform formability while at the same time keeping the substrate surface pristine as the film “comes off in the (alkaline) wash,” exposing a perfectly active, undamaged surface ready for pretreating. There are even some thin film organic coatings that act as pretreatment/primers that are viable adhesion promoters for topcoats as long as two years after application.

However, the traditional construct of a pretreatment is to convert substrate surface oxide molecules in such a way as to promote adhesion, enhance long-term durability, and increase corrosion resistance of a painted or adhesive-bonded product.

For steel products, the most widely used pretreatments are zinc or iron phosphate. Iron phosphate pretreatment systems are alkali metal phosphates. The structure is amorphous and best suited for cold-rolled steel parts that do not require performance in highly corrosive environments. A sealing rinse is generally applied after iron phosphating.

For decades, a chrome rinse was the sealer of choice. However, stricter regulations surrounding hexavalent chrome-containing products have caused many industries to turn to other sealing technologies. The prepainted lighting fixture market is a good example where iron phosphate pretreatments are widely used.

Zinc and zinc alloy coated steels are typically pretreated with zinc phosphate systems. These systems are more complex, involving a conditioning step where the surface is prepared (or seeded) to accept phosphate, regulate coating weight, and determine crystal morphology. During the time that the surface is in contact with the acidic phosphate solution, it dissolves a tiny amount of the metallic coating. At that surface, the acidic



Unique aqueous formulations are replacing very old and traditional chemistries such as iron and zinc phosphates.

zinc phosphate produces a localized increase in pH that causes precipitation and deposition of insoluble zinc phosphate crystals onto the substrate surface. These coatings remain crystalline in nature, varying from large 25μ boulder-like particles with incomplete coverage to tightly packed acicular crystals, $5\text{--}10\mu$ in size. Following a hot-water rinse to remove excess zinc, a sealer is applied as the final step in enhancing corrosion protection.

Over the years, various additives have been added to zinc phosphate baths to accommodate new zinc alloy coatings, optimize crystal size and coverage, or make the phosphating process more efficient in mixed metal applications. Adding free fluoride to the solution allowed for better optimization of phosphate coatings on aluminum substrates. Elements such as nickel were removed in order to reduce the amount of metal ions in wastewater and reduce costs.

Sealers have traditionally been hexavalent chromic acid solutions because of their electrochemical advantage over other treatments. With the advent of more stringent effluent guidelines and the move toward eliminating hexavalent chromium wherever possible, most systems have effectively converted to trivalent chrome or non-chrome sealers.

For decades, the complaint against non-chrome sealers was that nothing provided the level of durability and corrosion protection imparted by hexavalent chromium solutions. Aqueous silane solutions, even though excellent for both enhanced adhesion and corrosion inhibition, were inherently unstable solutions in production environments.

Finally, in 1997, an organo-metallic polymer was synthesized that provided a very useful bifunctionality. One end of the polymer chain contained an organic molecule that was well suited to bond with liquid or powder paint resins that contained hydroxyl, carboxyl, or amino functionality. The other end of the chain reacted with metal oxides or pretreatments providing a reactive chemical bridge between the metal and the paint.⁴ This allowed the heretofore mostly mechanical bond between the high-surface-area pretreatment and paint to become a mechanical-chemical bond with enhanced physical properties.

Today, because of significant advances in this base sol-gel technology, several pretreatment manufacturers have polymeric-based dry-in-place sealer options that appear to perform as well as those containing hexavalent chromium.

In the “old days,” complex chrome oxide conversion coatings (CrO_4) often laced with cobalt or other trace elements followed by hexavalent chrome rinses were used to pretreat aluminum substrates or aluminized steel. These coatings provided excellent active corrosion protection, self-healing properties and promoted good adhesion with many topcoats.

Coatings Xperience

The toxicity of hexavalent chromium along with the high cost of wastewater treatment was a strong impetus for examining other technologies.

The push to exchange steel for aluminum for auto-body panels (as seen, for example, with the flagship Ford F-150 pickup truck) accelerated pretreatment developments that would be compatible with aluminum alloys. The trick was to provide the level of durability and corrosion protection required by the cost-conscious automotive industry.

As a result, there has been a flurry of activity to examine new technologies that will reduce or eliminate the use of zinc and nickel and at the same time, make pretreatment processes shorter (fewer stages) and more cost effective without compromising durability and corrosion resistance.

One option that was examined was a zirconium/titanium pretreatment conversion coating.⁵ The bath solution consisted of a mixture of fluorozirconic and fluorotitanic acids. The pretreatment coating was two layers—a 30 μ thick hydrated ZrO₂/TiO₂ outer layer and a 60-90 nm interfacial

layer. In this case, the titanium levels were twice the zirconium levels in the coating. Unfortunately, electrochemical examination of these coatings indicated that there was limited corrosion protection, probably due to the thin and porous structure of the two layers.

Since then, there have been more advancements that use zirconium or titanium as base elements with a number of clever organometallic and other additions that have become commercial successes.^{6,7} Unique

Today, because of significant advances in this base sol-gel technology, several pretreatment manufacturers have polymeric-based dry-in-place sealer options that appear to perform as well as those containing hexavalent chromium.

aqueous formulations are replacing very old and traditional chemistries such as iron and zinc phosphates.

One formulation yields homogenous inorganic coatings that form a thin nano-metallic matrix layer on metal surfaces. These films are extremely uniform in composition and significantly thinner than iron and zinc phosphates. The thickness of this organometallic coating is only 40-80 nm, while iron and zinc phosphates are 200-300 nm and 3,000-4,000 nm thick respectively.

Another advantage of these organometallic pretreatments is that the baths operate in the alkaline range (pH 7-11), unlike the very acidic baths typical of phosphate solutions (pH 2-3). This not only improves the efficacy of the silane deposition around adhesion, but the problem of flash rusting or bluish is significantly reduced. An added bonus is that no additional sealer is required.

Aluminum oxides provide a challenge for paint adhesion. A new sol-gel chemistry produces a very thin 50-500 nm film. The coating composition is an aqueous sol of cerium oxide and/or silica particles and a ureido silane compound. Rather than removing the protective oxide layer naturally present on aluminum, the molecules are designed to penetrate deeply into the nano-pores within the oxide layer and self-assemble up to 100 layers of crosslinked polymer.

Bath concentrations are used to control coating thickness. Organofunctional molecules on the non-oxide side of the polymer chain facilitate bonding with the organic paint film.⁸ Corrosion testing indicated that these new technologies exhibited excellent



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Corrosion testing indicated that these new technologies exhibited excellent corrosion resistance, especially as seen in creepback from scribe testing after exposure to corrosive environments.

corrosion resistance, especially as seen in creepback from scribe testing after exposure to corrosive environments.

These no-rinse pretreatments comprised of reactive liquids leave reaction products on the surface of the substrate. These conversion coatings are extremely uniform, thin and generally absent of phosphates, hexavalent chromium compounds, molybdates, tungstate or vanadates. This allows for shorter application cycles (usually with less steps than traditional pretreatments), improved effluent cleanliness and adhesion and corrosion resistance characteristics as good as traditional pretreatments.⁹ ❖

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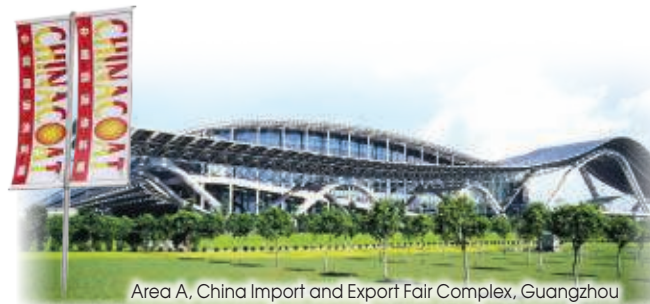
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Raw Materials 2022: On-going Difficulties But Faint Light— And Exciting New Raw Materials—At the End

Where to start? First and foremost, this article is not about the large, global paint and coatings companies, because we learn everything we need to know about their struggles with supply chain issues from public reports. What we don't typically hear about are the struggles of small and medium enterprise (SME) distributors and coatings producers and how they are dealing with the ongoing supply chain issues. Nor have we been hearing about raw material suppliers, both large and small, that despite the chaos surrounding them have nonetheless been able to continue, albeit at a slower pace, the R&D efforts that resulted in the introduction of new raw materials during the past 24-month period, that are of potential value to the paint and coatings formulators.

In a day and age when we are constantly bombarded with news, nothing ends up being actual news because we are inured to the whole concept. Similarly, in a paint and coatings industry where we are living with daily shortages, substitutions, price increases, transportation issues, allocations, force majeure, and lead times that can go beyond six months for certain types of raw materials, paint and coatings raw material suppliers, paint producers and paint and coatings users are basically becoming numb from the unending onslaught that made life so stressful in 2021 and is continuing into 2022.

About the best news I can offer, and it is qualified good news, as of the time of this writing in early March 2022, is that we appear to be seeing some stabilization in the overall situation, insofar as pricing increases seem likely to moderate, although pricing decreases do not appear to be on the horizon, with perhaps some isolated instances.



of the Tunnel

*By George R. Pilcher, The ChemQuest Group
and The ChemQuest Technology Institute*



“In 2022, many of the same forces that acted on 2021 are still in place, but now it seems that the most powerful driver is less the ability to make the desired chemicals, and more the labor shortages that are preventing sufficient amounts of these chemicals from being produced and shipped.”

The cost of transpacific container shipments originating in the Asia Pacific region (APAC—excluding India) has been mitigated to some degree, but only to the extent that “outrageous” has come down to the “unbelievably high.” Comments from a range of raw material producers, SME distributors, and SME paint producers are in agreement that containers from Asia are now down to \$10,000 to \$15,000, from as high as \$20,000 to \$30,000.

Lead times are improving, and containers are still a problem, but they are easier to get than in mid-2021, and there is greater vessel availability. It appears that shipments from India, however, which did not increase in cost in 2021 to the same degree as those from APAC, may not have peaked yet—early 2022 increases have taken the cost to ship a container to roughly eight to 12 times the cost for shipments pre-2020.

Shipping from major ports in Europe, such as Antwerp and Rotterdam, are expected, as of the date of this writing (early March), to increase in April 2022 from April 2021 multiples of three to four times pre-2020 to four to five times, with the potential for future increases later in 2022. Domestic transportation seems to be plateauing—the equipment issue is in better shape and beginning in Q2-Q3 of 2021 drivers were becoming more available. Cost is still roughly two to three times pre-2020, however, and not likely to decrease while fuel costs increase during 2022.

January 2022 saw essentially across-the-board raw material increases in the range of 15%-25%, with a bucket of additives as high as +50%, depending upon the specific products in the bucket. This on top of total increases for a bucket of all paint components that totaled 20%-30% in 2021 has created a scenario that is unprecedented within the U.S. paint and coatings industry.

In 2021, resins, especially epoxies, acrylics, and diamines seemed to be the hardest hit with a combination of price increases, force majeure declarations, strictly controlled allocations and long lead times; alkyds are extremely difficult to get, have increased in price by roughly 50%, and manufacturers of alkyd paints are being forced to reformulate, depending upon which alkyds are available and which are not. One major producer of alkyd resins is down for an extended period of time for repairs, and another has indicated that it is exiting the commercial marketplace. This is not a good situation.

Pigments, at least for the first two quarters of 2021, were relatively stable with low single-digit increases. But they have been reported to increase roughly 10% during Q3-Q4 on a basket of both colored inorganics and organics, driven more by the organics, some of which received Q1 2022 increases on the order of 20%. NOTE: Titanium dioxide was excluded from the basket—its price has been rising steadily over the course of the COVID-19 pandemic, ending up at the end of 2021 roughly 10% higher than in 2020, and it is expected to increase by an additional 7%-10% during 2022. With the current tariffs in place, Chinese TiO₂ is not really a current factor in the U.S. market for paints and coatings.

Additives, regardless of type, from catalysts to flow additives, have probably caused more problems than any other category of raw materials, insofar as they are of critical importance to the performance of the final paints and coatings in which they are incorporated, and are among the most difficult components for which acceptable substitutes can be identified.

Entering 2022, availability is becoming a bit less tight entering 2022 for certain additives, but others are becoming even more difficult to obtain. Various PET

additives, for example—and especially Fischer-Tropsch waxes—are in extremely short supply, with reports of lead times in excess of six months from multiple areas of the paint and coatings industry.

As supply chain issues improve, and paint makers go from lacking five or six raw materials to make any given batch of paint to perhaps only a single missing raw material, there is a tendency to breathe a sigh of relief. If that single raw material cannot be substituted, however, things really haven't gotten any better. U.S. paint and coatings companies across the board have more orders than they can fill—this was true for all of 2021 and will continue to be true in 2022. The lack of a pound or two of a critical additive becomes even more of an issue under these circumstances.

Mining is highly dependent upon energy costs, and there doesn't appear to be any end in sight as the cost of crude continues to rise: Brent Crude hit \$128/barrel on March 8 before settling down to \$111/barrel on March 9—and West Texas Intermediate (WTI) peaked at nearly \$124/barrel on March 8, then dropped \$15/barrel by the next day. Volatility on this scale clearly reflected increasing global anxiety as the situation in Ukraine and Russia escalated into a full-scale invasion while a desperately worried world looked on. As a result, mined filler pigments, such as clays, talcs, carbonates, et al., rose 20%-25% in 2021, and it is reasonable to expect further increases in 2022, not only for mined pigments, but also for all raw materials used in the paint and coatings industry that are affected by the price of oil.

Not just raw material and transportation cost and availability have been affected. The cost of containers, whether steel or high-density polyethylene, five-gallon pails, drums, or tote tanks, have doubled, tripled, and even quadrupled in

price, and are subject to spotty availability—when they become available, anyone who needs them jumps on the opportunity to purchase, regardless of price.

There seems to be no doubt that raw material suppliers are in the process of jettisoning certain individual products and product lines so that they can allocate financial and personnel resources to the products that are the most in need and very likely the most profitable, as well. While some of these products may be restored to production following the end of the current supply situation, the general feeling among the raw material suppliers and formulators is that these will be handled on a case-by-case basis and will not be extensive.

Fortunately, quality issues with raw materials appear to have been few and far between, at least with regard to anything that can be picked up during the raw material testing and manufacturing process. Many formulators have pointed out, however, that they are concerned that there may be hidden problems that might not manifest themselves for at least six months or more, either as a result of substitutions that they are making or because of substitutions that their raw material suppliers are making. At least one formulator has been shut down making a major product line, due to a raw material quality issue, and it is reasonable to assume that this is not an isolated case.

The burden that all of the supply chain problems are placing on coatings laboratories throughout the world is onerous in the extreme. Laboratories that hitherto spent approximately 50%-70% of their time developing new and improved products have found that that they are now only able to spend 15%-35% of their time on R&D, and for some organizations, it is even lower.

Ironically, after years of benign neglect by the U.S. paint and coatings community, a lot more talk about “sustainability” has arisen during the chaos of the past 12-18 months, but only minimal work has been done in this area by laboratories that are overwhelmed with seeking, testing, and approving alternate raw materials in significantly more attenuated timeframes than would have been the case in the past.

At a time when “sustainability” is attracting more serious attention than ever before, the loss of a significant

portion of R&D activity is doubly discouraging. Nonetheless, we should expect to see a significantly greater amount of emphasis placed on sustainability in formulation, production, packaging, and application as we move out of the current situation and can begin to concentrate on the way forward from here. In the past, “sustainability” has been largely a form of “green washing,” but the tide is turning, and the U.S. paint and coatings industry is beginning to become serious about this topic.

In characterizing 2021 and 2022, the temptation might be to simply indicate that 2022 looks like “more of 2021,” but with some improvements over the course of the year. This would not be a completely accurate picture, however. The shortages, price increases, long lead times, etc., that we experienced in 2021 had multiple causes, but a major one was the failure of the chemical industry to recover in a timely fashion from the freeze in the Permian Basin.

In 2022, many of the same forces that acted on 2021 are still in place, but now it seems that the most powerful driver is less the ability to make the desired chemicals, and more the labor shortages that are preventing sufficient amounts of these chemicals from being produced and shipped. As 2022 continues to unfold, it is very likely to be labor shortages, rather than raw material shortages, per se, that will be responsible for longer lead times, higher prices, ongoing allocations/closely controlled releases, etc. These factors began in 2019, were exacerbated in 2020, became crippling during 2021, and, all things being equal, will continue through 2022 and into Q1 of 2023, albeit likely at a less ferocious and less damaging pace as in 2021 and Q1 2022. Much, of course, depends upon the Russia/Ukraine situation, and especially upon China’s reaction to economic sanctions imposed on Russia by the West, but predicting the effects of a war requires a crystal ball that none of us possesses.

NEW AND EXCITING RAW MATERIALS

Not all of the news is bad news, and there is some very good news to report during this otherwise frustrating and chaotic period of time. I have often, in the past, included in my articles,

regardless of topic, an appendix listing new raw materials that have been introduced into the market within the past 24 months, and that have struck me as being particularly interesting.

Because R&D for raw material suppliers has also been dramatically reduced, just as it has for paint and coatings suppliers, I have noticed fewer new raw material introductions during the past two-year period than during similar periods of time during the past two decades. Nonetheless, there has still been a significant level of activity by producers of component materials for paints and coatings, and given that, even during the pre-COVID era, I heard almost continual complaints from formulators that the “Raw material suppliers don’t have anything that’s new,” it makes sense to highlight some of the new products that have come to my attention.

The products that I have chosen to include in this article are raw materials that their producers claim are not just “me too” products or “tweaks” of existing products, but new materials that truly have the potential to “make a difference” to the coatings formulator who needs to create properties that do not currently exist, or significantly improve properties that do. I see such materials every year, and—without endorsing or recommending any of them on behalf of myself, ChemQuest, *CoatingsTech*, or the American Coatings Association—I am including them in the table on the following pages because I understand that the products in this random and arbitrary selection of raw materials have all been introduced within the past 24 months, and it makes sense for paint formulators to take a look at them, especially if they appear to address any properties that would be helpful in their current product development projects.

Because it is often difficult to persuade paint makers to look at new raw materials, suppliers of new materials should also give serious consideration to having their new products tested and validated in a variety of coatings technologies by independent, third-party laboratories that can provide unbiased results that can then be presented to the paint formulators as “proof of concept” documentation.

Supplier	Product Name	Raw Material Type	Manufacturer's Suggested Uses	Email or "Contact Us" Form	URL
Allnex	SETAQUA® 6534	Additive	Acrylic polyol emulsion; 2K waterborne (W/B) urethane for concrete sealers; ultra-low VOC and odor; outstanding chemical and hot-tire pick-up resistance.	tim.kittler@allnex.com	www.allnex.com
Allnex	ADDITOL® dry CF Series	Additive	Cobalt-free paint driers. Low discoloration; compatible with W/B and solventborne (S/B) coatings. Early hardness development; little surface wrinkling. Improved corrosion resistance. CF103 offers the lowest VOC, reduced odor; improved performance in bio-based and long-oil based coatings.	tim.kittler@allnex.com	www.allnex.com
Borchers, a Milliken Brand	Borchj® Dragon	Additive	Cobalt-free drier for low-VOC formulations that utilize high-solids, long-oil alkyd resins. REACH compliant. Reduces the need for through driers; more sustainable option to decrease dry times.	molly.mauer@milliken.com	www.borchers.com
BYK Additives	BYK-1789	Additive	Solvent-free silicone defoamer for aqueous, high-build, and fast-drying coatings systems. Reduces microform and macrofoam and delivers outstanding internal air-release effect.	www.byk.com/en/contact	www.byk.com
BYK Additives	CERAFLOUR 999	Additive	Wax additive with a very fine, even particle distribution that is designed to increase the scratch and abrasion resistance of coatings.	www.byk.com/en/contact	www.byk.com
Dow Inc.	DOWSIL® 211S	Additive	Low-cyclic, ultra-high molecular weight silicone. For W/B systems. Enhanced mar resistance, slip, and block resistance. Recommended for wood coatings and acrylic, styrene acrylic, and VAE emulsion wall paints.	www.dow.com/en-us/contact-us.html	www.dow.com/coatings
Dow Inc.	DOWSIL® 402LS	Additive	Silicone additive to reduce COF of wood coatings, and to overcome blocking.	www.dow.com/en-us/contact-us.html	www.dow.com/coatings
DURA Chemicals	DriCAT CV 120	Additive	Cobalt 12% replacement; falls below threshold of EU carcinogen and reprotoxic labeling requirements; provide white films that yellow less when compared to conventional cobalt driers.	www.durachem.com/contactus.php	www.durachem.com
Evonik Industries	Surfynol® 104Z	Additive	Strikes a balance between dynamic wetting and molecular defoaming. Near 0 VOC. FDA approved.	www.coatino.com/en/contact	www.coatino.com/en/product/surfynol-104z
Evonik Industries	TEGO® Foamex 811	Additive	Solvent-free defoamer. Suitable for food packaging.	www.coatino.com/en/contact	www.coatino.com
Micro Powders, Inc.	AquaBead R331E	Additive	High-solids, nonionic, rice bran wax emulsion, providing water repellency and lubricity with excellent rub and abrasion resistance.	info@micropowders.com	www.micropowders.com
Micro Powders, Inc.	GraphShield 777	Additive	Dry graphene oxide composite powder, soluble in both solvent- and alkaline water-based systems for easy incorporation into most coatings. Can improve corrosion resistance, mechanical durability, and electrostatic dissipation properties.	info@micropowders.com	www.micropowders.com

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Supplier	Product Name	Raw Material Type	Manufacturer's Suggested Uses	Email or "Contact Us" Form	URL
Micro Powders, Inc.	PolyGlide 1226Xf	Additive	High-density polyethylene composite, reinforced with hard, inert ceramic microspheres and nanoceramic platelets. Offers improved Taber abrasion resistance, slip and lubricity, compared to PE/PTFE additives.	info@micropowders.com	www.micropowders.com
Nouryon B.V.	Arquad GS	Additive	Antimicrobial agent for robust and tintable anti-viral paint.	www.nouryon.com/contact/	www.nouryon.com
BYK Additives	DYK-3938 P	Matting agent	Matting agent for powder coatings, which may be added to a finished powder coating.	www.byk.com/en/contact	www.byk.com
Evonik Industries	SPHERILEX® DP-0115	Matting agent	Precipitated silica for matting of powder coatings. Improves hardness and flexibility. Works across various powder coating chemistries. Main applications are for super-durable polyesters and clear acrylics.	www.coatino.com/en/contact	www.coatino.com/en/product/spherilex-dp-0115
Evonik Industries	EXP 8018-1	Matting agent	Wax-treated, precipitated silica matting agent. Designed for applications using super-fine surface haptics, combined with high transparency. For wood and plastic applications. Part of the ACEMATT® product line.	thomas.lange2@evonik.com	www.coating-additives.com
Evonik Industries	ACEMATT® OK 390, HK 390, HK 520	Matting agent	Efficient, ultra-deep matting, high transparency, and extremely fine surface haptics. For use in S/B and W/B formulations. Shows little influence on viscosity of formulae and have excellent dispersion behavior.	www.productcenter.coating-additives.com/	www.coatings-additives.com
Lamberti S.p.A.	DECOSPHAERA®	Matting agent	Aliphatic polyurethane beads designed for low- to ultra-matt coatings. Imparts matt finish with haptic properties, as well as texturizing effect. Use in UV, W/B, S/B coatings; clear or pigmented low- to ultra-matt coatings. Free of formaldehyde, phthalates, tin, and silica. Designed for thin-film systems. DECOSPHAERA® BIO 8TR based on renewable content.	yasmin.sayed-sweet@lamberti.com	www.lamberti.com
Michelman, Inc.	Michem® 200 and 201	Matting agent	Designed to provide superior matting and abrasion resistance, for use in urethane/acrylic floor coatings.	www.michelman.com/contact/	www.michelman.com
W. R. Grace and Company	Syloid® AQ 800 & AQ 880	Matting agent	Silica matting agents for W/B low-gloss wood coatings; eliminates water spots and stains. Can be used alone or blended.	https://marketing.grace.com/syloidaq	www.Grace.com
W. R. Grace and Company	Syloid® CAT 11	Matting agent	Untreated silica matting agent; developed for high-performance polyurethane coil and general industrial coatings. Developed to reduce catalyst absorption.	https://marketing.grace.com/syloidaq	www.Grace.com
Zschimmer & Schwarz Interpolymer	SYNPRINT® AC 2910	Matting agent	Liquid matting agent based on acrylic chemistry. Offers improved coating clarity, adhesion, and resistance properties, compared with conventional silica matting agents.	d.charron@zschimmer-schwarz.com	www.zschimmer-schwarz.com/en/paints-coatings
Shepherd Color Company	Red 10K333	Pigment	Bipyramidal crystal structure; Yttrium, Indium, Cobalt. Magenta color chemically inert; non-bleeding. Used in coatings and plastics. Not yet TSCA listed but is available in the EU/REACH area.	www.shepherdcolor.com/customer-service/contact/	www.shepherd.com

Supplier	Product Name	Raw Material Type	Manufacturer's Suggested Uses	Email or "Contact Us" Form	URL
Shepherd Color Company	Blue 20G599	Pigment	Designed to be a radically improved cobalt aluminate blue. Highest chromaticity and tint strength, compared to other Co-Al blue pigments.	www.shepherdcolor.com/customer-service/contact/	www.shepherd.com
Hallstar	RX-14860	Plasticizer	Designed to be 50% more efficient at lowering the glass transition temperature of VAE resins, compared with the dibenzoate ester control. Can achieve -18° C temperature grades, at half the plasticizer loading (compared to the dibenzoate control), which leads to improved durability.	bpentzien@hallstar.com	www.hallstar.com
Hallstar	Plasthall® 114	Plasticizer	Aliphatic ester plasticizer used to modify high-polarity adhesives and sealants. This plasticizer has an extremely high efficiency in a variety of vinyl-acetate ethylene (VAE) and acrylic polymer systems compared with traditional dibenzoate plasticizers.	sneuenfeldt@hallstar.com	www.hallstar.com
Alberdingk Boley	AC 2305	Resin	Self-crosslinking, multiphase acrylic dispersion designed to have adhesion to varied substrates, for both interior and exterior applications. Enhances stain- and scrub-resistance.	info@alberdingkusa.com	www.alberdingkusa.com
Allnex	PHENODUR® PR 616/65B	Resin	Low free-formaldehyde (<0.1%) phenolic resin. May be used in combination with high molecular weight polyester or epoxy resins for rigid and flexible packaging, and drum lining.	tim.kittler@allnex.com	www.allnex.com
Allnex	Acure AQ 620-100	Resin	A malonate and acrylate functional non-ionic polyurethane dispersion resin with an optimized ratio of Michael Donor and Acceptor groups, for use as sole binder resin in water-based ACURE AQ systems. Fast curing, nonionic water-based resin for non-isocyanate systems. High-build capabilities without the risk of blistering; excellent early hardness development.	tim.kittler@allnex.com	www.allnex.com
Allnex	SETALUX® XCS 1518 BA-45	Resin	Modified acrylic polyol developed specifically for adhesion to polypropylene substrates. Targeted at replacing traditional chlorinated polyolefins-modified adhesion promoters for adhesion.	tim.kittler@allnex.com	www.allnex.com
Allnex	SETAQUA® 6722	Resin	Self-crosslinking, surfactant-free acrylic copolymer emulsion that offers exceptional clarity, excellent hardness, fast drying and good sandability. Highly durable and has excellent chemical resistance. Excellent flow and leveling properties, approaching that of a S/B product.	tim.kittler@allnex.com	www.allnex.com
Allnex	RESYDROL® SF 8002 50WA	Resin	Aqueous oil-modified, multi-domain acrylic dispersion, especially suitable as a sole binder for decorative gloss enamels. Excellent tanning blocking in industrial wood applications, without the use of stain blocking pigments.	tim.kittler@allnex.com	www.allnex.com

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Supplier	Product Name	Raw Material Type	Manufacturer's Suggested Uses	Email or "Contact Us" Form	URL
Arkema	ENCOR® Flex 192	Resin	Ambient crosslinking modified acrylic latex designed for elastomeric roof and wall coatings requiring adhesion to difficult substrates.	www.brenntag.com/en-us/contact.html	www.brenntag.com
Cardolite Corporation	Cardolite® NX-8402	Resin	Epoxy curing agent based on cashew nutshell liquid technology. Supplied in water and provides excellent performance to epoxy primer and coatings for metal and concrete.	marketing@cardolite.com	www.cardolite.com/contact/inquiry
Cardolite Corporation	Cardolite® NX-9212	Resin	Low viscosity and light-colored polyether diol based on cashew nutshell liquid technology. Excellent hydrolytic stability, reduced moisture sensitivity and excellent compatibility with various diols and polyols. Suitable in prepolymer synthesis for use in 1K polyurethanes, TPU, PUD, and other applications.	marketing@cardolite.com	www.cardolite.com/contact/inquiry
Cardolite Corporation	Cardolite® NX-9018	Resin	Low-viscosity, branched polyether polyol suitable for 2K polyurethane coatings, adhesives, and composites. Provides improved color stability, excellent mechanical strengths, and excellent bond strength on steel and aluminum.	marketing@cardolite.com	www.cardolite.com/contact/inquiry
Eastman Chemical Company	Tetrashield™ MP2104	Resin	High-performance BPA-NI resin provides formulators leading chemical resistance latitude without sacrificing performance in adhesion or reactivity.	tetrashield@eastman.com	www.eastman.com/Brands/Tetrashield/Metal-Packaging/Pages/Metal-Packaging.aspx
Hexion Inc.	AQUAREOUS™ System	Resin	High-performance, solid epoxy dispersion (EPI-REZ™ Resin 7720-W-50) with either EPIKURE™ Curing Agent 6870-W-50 or EK 8530-W-75; meets <50 g/L VOC limits. Superior corrosion and chemical resistance on metal and concrete substrates. Used to replace S/B epoxy/polyamides in a variety of applications.	dan.weinmann@hexion.com	www.hexion.com/en-us/brand/aquareous-systems
Hexion Inc.	INFINIUM™ System	Resin	Lower-yellow epoxy performance; EPON LY™ Resin 1810 and EPIKURE LY™ Curing Agent 3801. Designed for concrete or wood coatings. INFINIUM™ System was developed to help formulators significantly improve yellowing resistance.	dan.weinmann@hexion.com	www.hexion.com
Shark Solutions ApS	Shark Dispersions™ SX2™, FX2™ and FX6™	Resin	W/B made of 100% post-consumer recycled Polyvinyl Butyral in various grades. Homogeneous stable dispersions; meets industry requirements for Sustainability and Circular Economy. Forms a homogeneous film when dried at ambient temperature, without the need for additional film forming additives or coalescing agents.	andrew.zudans@shark-solutions.com	www.shark-solutions.com
StanChem Inc.	StanChem SC 6908	Resin	Acrylic emulsion binder for architectural applications. Outstanding tannin and stain blocking properties. Unique polymerization method.	csullivan@stanchem-inc.com	www.stanchem-inc.com

Supplier	Product Name	Raw Material Type	Manufacturer's Suggested Uses	Email or "Contact Us" Form	URL
Vencorex	Tolonate™ X F 450	Resin	Solvent-free, low-viscosity polyisocyanate based on HDI. Provides elasticity while maintaining high hardness. Especially suitable for fast-drying formulations such as aliphatic polyureas and polyaspartics.	www.vencorex.com/contact-us/	www.vencorex.com
Evonik Industries	HDK® H21	Rheology modifier	Hydrophobic pyrogenic silica for use in highly polar systems. Easy to disperse, with excellent rheology control and prolonged storage stability.	www.brenntag.com/en-us/contact.html	www.brenntag.com
King Industries	K-STAY® 560	Rheology modifier	Zero-VOC; based on unique sulfonate technology. Designed to be highly efficient at low-dosage levels. Improves sag control and pigment suspension, flow and leveling without the hassle of other rheology modifiers.	coatings@kingindustries.com	www.kingindustries.com/k-stay-560/

CONCLUSIONS

Value Purchasing is Important—

I have definitely come to be under the impression that “A” customers have been much better taken care of with regard to more generous allocations and shorter lead times than “B” and “C” customers, which should probably surprise no one. The days are past when purchasing on the lowest possible price makes sense. The future will be built on value purchasing, not on the lowest price, or just-in-time (JIT) supply chains, which have crumbled—and were destined to crumble—when the kind of pressure seen during the past two years was applied to them. All industries, not just paints and coatings, are in the process of learning this necessary lesson. I cannot emphasize how important this is, because—while the future may or may not hold another pandemic in store—pressure on global supply chains will be with us for decades to come, and the time to adjust to a new, more appropriate way of surviving and flourishing in the face of such pressures is now.

Price Increases Will Continue—

Overall, my sense is that the industry is in for “more of the same” during 2022. Pricing *increases*, overall, are likely to be moderated, but it would be premature to expect too many actual decreases. Quarterly pricing contracts and/or annual volume contracts with quarterly escalator clauses will continue to be the norm throughout 2022, and into at least Q1-Q2 of 2023. Lead times are beginning to shorten for many raw materials in Q1

“The days are past when purchasing on the lowest possible price makes sense. The future will be built on value purchasing, not on the lowest price, or just-in-time (JIT) supply chains”

2022, as are delivery times, although the cost to ship will continue to fluctuate, depending upon the part of the world from which the shipments are coming, the price of oil, availability of shipping containers, and access to labor. The wild card is, of course, the situation in Ukraine: as of this writing, Russia has invaded, and the major governments of the West are on high alert and contemplating a variety of punitive options. Adding to the potential disruptions is the fact that China appears to be supporting Russia, at least with moral support, but this could all change if sanctions or military intervention from NATO are invoked against Russia, some combination of which is certainly within the realm of possibility. A conflict of this magnitude has the potential to inflict severe damage on all of the global supply chains. The reader will be in a much better position to judge what

the “situation in Ukraine” means when reading this article in April than I am, while writing it in February and March.

Continued R&D is Critical—Despite COVID-19, despite devastating supply issues, and despite the fact that paint and coatings companies have been forced for nearly two years to divert their R&D resources from product improvement and product development to survival mode, in which the daily emphasis was on identifying and approving raw material substitutions, the raw material producers soldiered on ahead, whenever possible, to provide a stream of new and improved products. Many of these have received scant attention from coatings formulators, who simply have not had the time or resources to evaluate new raw materials, unless they had the potential to become substitutes for existing materials that were in short supply. When the current situation finally abates, and things return to yet one more “New Normal,” the paint and coatings producers who are the first out of the gate with new and/or improved products will have a distinct advantage over their competitors, and the raw material suppliers have given them the products to enable them to do so. This is good news in an otherwise chaotic and uncertain time. Now is the time to proactively take this good news, and these new raw materials, and—either on your own, or with the expert assistance of a third-party formulating expert—turn them into future race-winning products. ❄

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Current Trends in Interior Architectural Coatings

Industry Experts Weigh In on What is New and Now

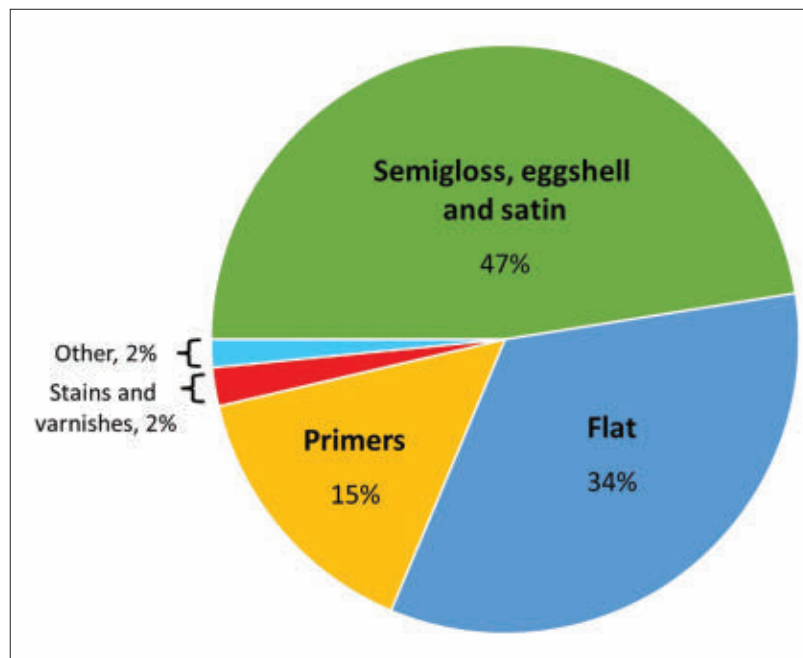
By Leo J. Procopio, Paintology Coatings Research LLC

Architectural coatings consist of a wide array of paints and coatings for both interior and exterior surfaces found in residential and commercial buildings. Surfaces being painted include drywall, concrete block, wood, brick, stucco, metal, and others. Applications include primers and paints for walls and ceilings, stains and coatings for exterior decks, interior wood stains and sealers, floor coatings, basement waterproofers, and trim paints, among others.

As a group, architectural coatings comprise the largest segment of the U.S. paint and coatings market, approximately 60% by volume and 50% by value.^{1,2} The total volume of architectural coatings is estimated at approximately 900 million gallons for 2021.³ Roughly two-thirds of the total volume is applied in interior spaces, and waterborne latex is the dominant technology. About 85% of the interior coatings are waterborne, and they can be divided up into the types of coatings shown in *Figure 1*.

During the past two years, the paint industry has not been a stranger to the turmoil caused by the COVID-19 pandemic, raw material shortages, and supply chain disruptions. The architectural coatings segment has actually seen some positive effects from the pandemic, as consumers spent more time at home and focused more energy and money towards do-it-yourself (DIY) home remodeling.

FIGURE 1—Approximate breakdown by volume of waterborne interior architectural coatings for the U.S. market in 2020.¹





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The percentage of painting done by DIYers versus professional painters increased, reversing a trend of many years. Professional painters were applying approximately 60%-65% of the paint before the pandemic. After the pandemic initially hit, professional painters were given less access to homes and commercial sites due to safety concerns. Paint application by DIYers increased in 2020 to an approximately 44% share,³ but professional painting has increased since 2021.

Driven by robust demand in the DIY segment, the overall growth in architectural coatings has been strong for 2020 and 2021. It is estimated that the U.S. architectural coatings market grew by 3.8% in 2020, with the DIY segment growing by approximately 15%.¹ The trend will probably continue in 2022.

Looking at home remodeling as a leading indicator, growth is expected to peak in 2022, according to the recent Leading Indicator of Remodeling Activity (LIRA) released by the

Remodeling Futures Program at the Joint Center for Housing Studies of Harvard University.⁴ The LIRA projects double-digit gains in homeowner renovation, with maintenance expenditures peaking in the third quarter of 2022 before beginning to return to more sustainable levels.

Of course, the industry is also still dealing with headwinds such as raw material shortages and supply chain disruptions. Against this backdrop of two years of growth in spite of the pandemic as well as remaining headwinds, *CoatingsTech* asked several paint manufacturers for their views on the interior architectural coatings market.

In the Q&A section that follows, they provide comments on how the pandemic affected the interior coatings market and talk about trends influencing product development and consumer aesthetic choices. They also describe recently introduced products and offer thoughts on the importance of topics such as online ordering and sustainability for the future of interior coatings.

PARTICIPANTS IN THIS ARTICLE INCLUDE LEADERS AT SEVERAL PAINT AND COATINGS MANUFACTURERS THAT ARE INVOLVED IN THE INTERIOR ARCHITECTURAL COATINGS SEGMENT.

The industry experts providing comments include:

Jodi Allen, global chief marketing officer at Behr Paint Company

Derek Ward, vice president of operations at Farrell-Calhoun Paints

Daniel Claybaugh, vice president of marketing and business development at Kelly-Moore Paints

Kyle Mooney, product management director for architectural coatings at PPG



What effect has the ongoing pandemic had on the interior paint market? Has it affected the DIY versus contractor-applied markets differently?

Mooney, PPG: The pandemic transformed our homes into gyms, classrooms and offices, while also remaining our primary living space. As we continue to spend more time at home, it's only natural that homeowners are taking a closer look at the functionality of their homes. Consequentially, home improvement projects surged in 2020 and 2021, including purchases of both interior and exterior paint. Notably, online paint sales were boosted as a result of the pandemic, a trend that has continued this year. After elevated DIY product sales spiked at the height of the pandemic, demand for those products has expectedly contracted back down to 2019 levels. We believe there is more upward growth potential in the DIY paint space as we move through the year and supply chain constraints are alleviated.

Reverse urbanization nationwide was another result of the pandemic as millennials and younger generations entered the home buying market earlier than expected. The increase in home buying has established a strong demand for paint and an increase in residential jobs for professionals (pros). In addition to an uptick in demand for pro painters in the residential space, we also see increased opportunity for pros in the commercial sector, as the world continues to re-open and patrons are returning to places like hotels and restaurants.

Claybaugh, Kelly-Moore: The pandemic has definitely had an impact on supply chain disruption for all paints and coatings. But the bigger disruptor has been the 2021 freeze in the Southwest that caused the great raw material shortage; a perfect storm in a high-demand market. Transportation has played a key role in supply chain disruption as well. Many truck drivers have been recruited to other industries and companies like Amazon and Walmart because of the need for drivers in this inflationary period.

Ward, Farrell-Calhoun: The pandemic has increased the overall paint market. Customers have been painting more during the pandemic, because they have more time and money. Historically low interest rates, a strong stock market and an influx of government supplied money has fueled the market. The pandemic has also caused supply shortages, supply chain problems and labor shortages to date. Farrell-Calhoun experienced historically high DIY sales early in the pandemic, and strong DIY and contractor sales since mid-2021. Overall paint supply has been problematic since Ice Storm Uri froze the Gulf Coast. The biggest factor is availability on both fronts.

Allen, Behr: Over the past couple of years, the pandemic has contributed to a growing DIY market as an insurgence of millennials and first-time painters entered the category. With people continuing to work from home, many are finding renewed energy to take on paint refreshes, particularly in spaces where we're spending a lot of time, like the home office, kitchen, and living room. More recently, there has been a steady increase in professional projects as consumers are feeling more comfortable opening their homes to professional painters.



What are some of the key trends or drivers that are influencing your product development efforts for interior architectural coatings? Are these trends/drivers different for commercial versus residential applications, or for paints applied by DIYers versus contractors?

Ward, Farrell-Calhoun: Product development has been very slow during these times due to lack of available raw materials, allocations and labor shortages. Most of the time that was traditionally used for development was allocated towards production and raw material procurement. The biggest driver has been what resin can we actually get. We would like to have launched some new products but could not get resin for them and had no lab time to develop anything.

Mooney, PPG: The pandemic has brought health and hygiene to the forefront of everyone's minds and increased awareness of the benefits of antibacterial and antiviral coatings. These innovative products can provide supplemental protection from germs that live on surfaces between regular cleanings, and they can be used in both residential and commercial spaces.

Claybaugh, Kelly-Moore: Painting contractors need products designed for ease of application and product performance. It is important to target specific segments with the right working properties that are required for that specific segment at a price point to be competitive in the market. It really boils down to application properties, hide, and durability. If we can build a better technical solution to meet these key objectives, while reducing raw material cost, that's a winning combination.



What are the most important properties end-users should focus on when selecting an interior coating and comparing paints from different manufacturers?

Claybaugh, Kelly-Moore: It depends on the objective of the project. If the objective is to clean up a house for sale, the end-user wants something that will hide well at an economy price. If you are buying a home, you may want a higher-quality product that will hold up to kids and everyday life for several years and if you are willing to pay more for that result. If it is for new residential housing, the product must hide and touch up at a commodity price point. So, depending on the objective of the project, application, hide, product attributes and price will vary based on the job type.

"It really boils down to application properties, hide, and durability."

—DANIEL CLAYBAUGH, KELLY-MOORE PAINTS

Ward, Farrell-Calhoun: Normally we would focus on hiding, touch-up, and flow, but currently it is more about who has product in stock. I would add that using the higher sheen paints in highly traveled areas for better overall wear and cleanability is an important consideration. For interior trim work, make sure that surface preparation and an appropriate primer (if needed) is used to ensure adequate adhesion to the previous coat. Most paint failures are due to lack of surface preparation on previously painted surfaces. Flat wall paints are normally easy to paint over, while trim enamels are not.



What new products have you introduced recently, and what unique properties do they bring to the interior coatings market?

Allen, Behr: Last year we introduced BEHR DYNASTY™ Interior Paint, the brand's most stain-repellent, scuff-resistant paint that is fast-drying with the added benefit of one-coat hide. This latest product innovation delivers beautiful and durable results that stand up to any project and provides users with everything they could want in a paint, now all in one can. The product addresses the needs of DIY, design, and paint professionals today when it comes to durability, application, and time.

Additionally, KILZ® Mold & Mildew Primer is another offering we introduced recently to further improve product quality and adhesion. This water-based primer is a perfect solution for spaces like kitchens, bathrooms, and laundry rooms, as these are prone to high humidity, moisture, and temperature. The primer formula creates a mold- and mildew-resistant film that protects the primer film from mold and mildew growth.

Ward, Farrell-Calhoun: New product introductions have been complicated by the difficulty in procuring resin. Our latest product that preceded the pandemic was our Enamlex Satin Interior Trim line, which exhibits excellent adhesion to a variety of previously painted, properly prepared substrates.

Mooney, PPG: In October 2021, PPG received U.S. Environmental Protection Agency (EPA) registration for its PPG Copper Armor™ antimicrobial paint containing Corning® Guardian® technology, proven to kill 99.9% of bacteria and viruses on painted surfaces, including SARS-CoV-2, the virus that causes COVID-19, in two hours.* The Copper Armor product's efficacy was measured using tests that simulate real-world contamination that are mandated by the EPA for products making claims against harmful pathogens. PPG is now pursuing state-by-state registration with the EPA.

PPG Copper Armor paint was developed for use in high-traffic areas such as health care, hospitality, office, and educational environments, as well as residential locations. In addition to its anti-viral technology, the product also provides a mold- and mildew-resistant coating on the dry paint film.

PPG Copper Armor is available for sale on a state-by-state basis. Available in eggshell, satin, and semi-gloss, PPG Copper Armor can be tinted to more than 600 colors from the PPG paint palette.

* Kills 99.9% of bacteria *Staphylococcus aureus* (Staph), *Pseudomonas aeruginosa*, *Enterococcus faecium*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Enterobacter aerogenes*, Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant enterococci (VRE), *Escherichia Coli* (E. coli), and *Salmonella*, and viruses *Feline Calicivirus* and SARS CoV-2 within 2 hours of exposure to paint surfaces.



Claybaugh, Kelly-Moore: Kelly-Moore has introduced a few new products recently. Kel-Bond Quick Sand is an extremely fast drying, easy-to-sand waterborne primer designed for interior fine wood finishing. This product allows quick turnaround on doors, trim, and cabinets so that they can be put back into use the same day. Kelly-Moore's premium Ceiling Paint is a flawless dead flat finish intended to diffuse light and hide imperfections across a variety of ceiling surfaces. This product is very low-odor and low-VOC so that it can be used in occupied space. It is also non-bridging for use over acoustic tiles.

Our high-performance DTM is a single-component waterborne coating that provides a smooth, durable finish over a variety of metal surfaces. The self-priming formula provides superior adhesion, outstanding corrosion resistance, and long-lasting UV protection. Its corrosion-inhibiting properties allow for application over light surface rust and reduce preparation time. Kelly-Moore's Inspire Interior is an economical solution for the residential repaint and DIY customer. Designed to provide a smooth, beautiful finish with lasting durability, the self-priming, high-hide formula allows for easy application in fewer coats. The stain-resistant, easy-to-clean finish keeps surfaces looking better for longer.

“PPG Copper Armor™ paint was developed for use in high-traffic areas such as health care, hospitality, office, and educational environments, as well as residential locations.”

—KYLE MOONEY, PPG



What do you see as the trends in color choice, and what influences end-users most in their ultimate choice? Do you have a color/palette of the year for 2022?

Ward, Farrell-Calhoun: White/off-white wall and trim with a black/bronze-tone accent still dominate the current paint color palettes. Most new houses and most repainted houses have been using this color scheme for the past five years or so.

Farrell-Calhoun's Color of the Year for 2022 is Mellow Blue 0468 (Figure 2). Simple and fresh, Mellow Blue restores a sense of newness, ease, and balance. Mellow Blue provides a break in the clouds, a gentle optimism, and it is the renewing color of self-care and mindfulness, enhancing calm that nourishes well-being in any interior or exterior. With a promise of the vibrancy and ease of nature, this soft green blue doesn't overwhelm but instead inspires present-time focus and encourages restored confidence.

Claybaugh, Kelly-Moore: Instead of choosing a single color for 2022, we are focusing on color trends we see making the scene this year. Our blog at kelly-mooreshop.com/blogs/our-blog has two articles on our 2022 Color Trends and describes the colors that bring those trends to life. We also have a whole page of exterior color scheme articles to help homeowners find their perfect color palettes with confidence. The most popular articles include one "typical" style house that we render in several color schemes to show readers all the ways they can imagine their homes and maybe even find their perfect palette right in the article.

"White/off-white wall and trim with a black/bronze-tone accent still dominate the current paint color palettes."

—DEREK WARD, FARRELL-CALHOUN PAINTS

FIGURE 2—Mellow Blue 0468 is the 2022 Color of the Year from Farrell-Calhoun Paints, signifying the restoration of a sense of newness, ease, and balance. Photos courtesy of Farrell-Calhoun Paints.



We've created several color tools to help people get to their perfect colors faster and easier. And we sell them all online now. Look for our two beautiful, easy-to-carry-in-your-purse fan decks, THE essential COLOR SET with 100 of our top-selling home colors, and THE Historic COLOR SET with 110 vintage colors that definitely feel fresh today. We also just launched our 8 1/2 x 11 COLOR swatches in all 1,721 of our amazing colors. Now consumers can order these big, gorgeous sample pages of color to help them envision in their color ideas. Most people order three or four samples in similar colors so they can decide which version will look best in their space. And we have our COLOR Swatch Collections where we've pre-selected seven trending color families to help consumers get excited about seeing their room in a whole new light at KellyMooreShop.com.

Allen, Behr: Last summer, we announced the BEHR® 2022 Color of the Year, Breezeway MQ3-21, which is an approachable silvery green that lives within the BEHR® 2022 Color Trends Palette (Figure 3). Breezeway evokes feelings of tranquility and peace while representing the intention to move forward. With its timeless appeal and versatile nature, Breezeway has enough personality to go from casual to coastal and modern to vintage styling. The seasonless hue seamlessly pairs with other colors in the 2022 palette to create unique looks and moods that appeal to any decor style.

The 20-color palette collection consists of soothing and grounding hues to help provide a peaceful sanctuary in any space. You'll see colors from frosty gray-blue Wave Top M450-3, to softened black Cracked Pepper PPU18-01, and earthy terracotta Basswood MQ2-46, among others.

Mooney, PPG: During difficult inflection points throughout history, we often see consumers gravitate toward more colorful selections, as previously seen during the Roaring Twenties or after the Great Depression. As part of this cyclical history, PPG is seeing post-pandemic optimism start to infiltrate residential design spaces to create a sense of escapism. Just as trends in the 1920s

FIGURE 3—Breezeway MQ3-21 is the 2022 Color of the Year from Behr Paint, symbolizing the perfect connection where a breath of fresh air meets a coat of fresh paint. Photos courtesy of Behr Paint.



were marked by opulence, metallics, rich woods, layers, moody colors, and angular shapes, today's home décor is drawing inspiration from the Antiquity, Baroque, and Renaissance eras of art, sculpture, and architectural forms. This colorful embrace is thought to reflect an optimistic rebellion, a sign of personal expression, or soothing self-care.

In 2022, we anticipate that homeowners, designers, and architects will opt for more colorful palettes, shifting from the neutral, minimalist palettes of the last few years. Olive Sprig (PPG1125-4), PPG's 2022 Color of the Year, is a soft, muted green that's both elegant and grounded (Figure 4). It's a highly versatile shade that emulates nature's resiliency and brightens any space with its natural liveliness. Olive Sprig represents the tone of 2022 as it embodies the regrowth and renewal that we're all craving.

In addition to the Color of the Year, PPG's color experts have also identified three color stories that will resonate for homeowners, designers, architects, and facility and property managers in 2022:

- **Invaluable.** The Invaluable palette culminates a rich library of cultural references to imagine its perfect place in today's world. Drawing Gatsbyesque inspiration from the past to create the go-to glamorous palette of the present, this color story is not afraid to be bold. Grounded with rich hues like PPG's Gooseberry, Castle Stone, and Ancient Copper, the Invaluable palette adds depth and warmth to any space. Pair these colors with rich, dark woods and brass accents to really turn up the drama—especially in the home, restaurants, or hotels.
- **Introspective.** The Introspective color story is for those that prioritize self-care and appreciate life's simple pleasures. Create a serene and intimate space with colors like PPG's Tea Time, Peace, Silver Service, and Pine Whisper, which complement the soothing comfort of Olive Sprig. These hues are perfect for the private yet soulful consumer looking to create an ethereal bedroom retreat, a thoughtful office space, or add a hint of color to an otherwise neutral-toned kitchen.



FIGURE 4—Olive Sprig (PPG1125-4) is the 2022 Color of the Year from PPG, representing regrowth in a post-pandemic world, mimicking nature's resiliency. Photos courtesy of PPG

- **Inspired.** Those drawn to the Inspired color palette cannot be pinned down. These mood-boosting shades are sure to turn up the volume in any space and add an optimistic jolt of energy for spaces that need it most—like a statement-making front door, a unique retail environment, or an inspiring child's playroom. PPG's Cenote, Aloha, and Lettuce Alone offer liveliness and mimic high-tech greens and blues that are sure to turn heads. Warm hues like Paris Pink, Coral Silk, and Crushed Pineapple are perfect picks for the confident, social, and adventurous painter who wants to spread joy, embrace change, and break free from minimalist designs of years past. PPG's Olive Sprig acts as a muted neutral in this palette to ground the bolder, brighter-color counterparts.



What will be the role of online versus in-store purchasing of architectural paint will be in the future?

Allen, Behr: In-store and online both remain highly active pathways to purchase paint. Although we have seen significant growth in our ecommerce business, our focus is on improving the interconnected experience to create a seamless integration from online to in-store. We continue to leverage our partnership with The Home Depot to improve experiences for DIYers and pros including the successful launch of BOPIS (buy-online-pick-up-in-store). These types of programs and initiatives will be ongoing as we continue to focus on improving the paint purchase journey.

Claybaugh, Kelly-Moore: The pandemic has accelerated the incorporation of online shopping for architectural paint. It's now becoming the "cost of entry" in the industry. While it still represents a nominal amount versus brick-and-mortar sales, it continues to grow every year. Homeowners are now able to start a project from the comfort of their home online, then visit the local paint store to pick up their paint and supplies from their online order. Contractors are seeing the time savings and accuracy from placing online orders for pick up or delivery.

Mooney, PPG: According to research commissioned by PPG in partnership with the Cleveland Research Company, in the next three years it is estimated that professional painters will make more than half of their purchases online, seeking faster, more cost-effective ways to purchase products. In fact, 70% of pro painters have already started placing more orders online and/or had paint delivered to a job site as a direct result of the pandemic. Two-thirds of those pros are expected to continue to order online in the future. Additionally, the research found that pro painters use their phones to conduct research on paint in store more often than in any other construction category, and they are now making 1.5 times more paint purchases online than in any other category across home improvement.

To proactively address the evolving needs of professional painters, PPG launched e-commerce ordering capabilities available to pro painters globally. The new U.S. model offers improved convenience and ease of purchase through digital ordering at PPGpaints.com. In addition to ease of ordering, the platform also offers more options for having orders delivered directly to the job site. Through our improved e-commerce platform and digital order fulfillment, PPG is able to deliver the right product, to the right place, at the right time; enable customers to order paint anytime, anywhere 24/7; and ensure that pros never have to leave the job site therefore increasing productivity, output, and ultimately allowing them to grow their top line.



Ward, Farrell-Calhoun: We still see in-store purchasing dominating. We expect online purchasing to be a factor, but there are some problems with online ordering. Colors are not represented properly on a computer screen, so it is hard to order colors without having a physical representation of the color. Wet samples are easily shipped after online ordering, but paints are problematic to ship due to the weight of the product and the damage that incurs when it is not handled properly, and product returns are problematic and unwanted by the retailer.



How do the concepts of green technology and sustainability affect end-users' attitudes toward a paint brand, and how is your company responding for your interior paint lines?

Claybaugh, Kelly-Moore: The environment is in the forefront of the minds of most consumers and continuing to leverage green technologies and sustainability is good for the market and the brand. Kelly-Moore Paints continues to scan the horizon for the most innovative technologies and ways to improve processes in conservation. Recently we installed a water recycling program that cleans wastewater that can then be safely disposed. Any Kelly-Moore product development must meet or exceed the most stringent environmental regulations in the country regardless of where it is sold.

"The research found that pro painters use their phones to conduct research on paint in store more often than in any other construction category, and they are now making 1.5 times more paint purchases online than in any other category across home improvement."

—KYLE MOONEY, PPG

Ward, Farrell-Calhoun: The biggest factor right now is availability, but consumers, contractors, and architects are continually driven towards green technology, sustainability, lower odors, and lower VOCs. Contractors are also concerned with performance, price, and availability.

Farrell-Calhoun has continued to work towards lower-odor and lower-VOC options with equal or better performance. Interior trim enamels are the area where we have seen the most advancement in this area. Changes in resin technology to incorporate ambient cure technology and better emulsion polymerization have allowed the formulator to decrease co-solvent loading and maintain or increase overall hardness of the coating.

Most waterborne paint resins are derivatives of petroleum and natural gas, but these resins have been processed to provide lower VOCs and lower-odor paints. There are waterborne alkyd emulsions based on oils such as soybean that are derived from a renewable source and are used in some trim enamels. Solventborne alkyd resins are also based upon oils, but these products are much higher in VOC content. All paints will emit some type of odors, and it is proper for consumers to understand the need to ventilate areas after they paint to remove unwanted odors and chemicals that are emitted from the paint after application.

“Environmental awareness and efforts are on the rise....”

—JODI ALLEN, BEHR PAINT COMPANY

Mooney, PPG: We remain steadfast in our commitment to serve the communities where we operate and develop innovative products and sustainable solutions that create value for our stakeholders. In 2020, 35% of PPG sales came from sustainably advantaged products and processes. Our products and processes help make our customers, and the world, more sustainable. Some recent examples of this sustainability in action include increased offerings of antibacterial and antiviral coatings.

The PPG Sustainability Report is available online at <https://sustainability.ppg.com>.

Allen, Behr: Environmental awareness and efforts are on the rise, and we're working toward making relevant information easily accessible to consumers, contractors, architects, and designers across our digital platforms and in-store offerings. More recently, we introduced

the new BEHR Simple Pour Lid—a 100% recyclable lid designed to reinvent traditional metal paint can lids and offer an eco-friendly approach while helping to make the painting process more convenient. Additionally, more than 40 BEHR® and KILZ® products are certified by UL Environment's GREENGUARD Gold and Formaldehyde Free Claim Validation. ❄️

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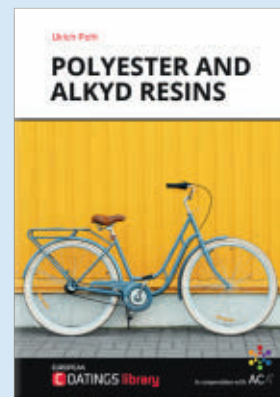
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AC AMERICAN COATINGS
BOOKSHOP



Diving Deeper into VOCs:

Predicting Formulation Component GC-MS
Response Factor Using Quantitative
Structure-activity Relationships
Coupled with Artificial Neural Networks

*By Jessica Lum, Madeline Schultz, and Erik Sapper,
Department of Chemistry and Biochemistry,
California Polytechnic State University*



Volatile
Organic
Compounds

The identification, measurement, and reduction of volatile organic compounds (VOCs) has been a key motivator in recent coatings research and development efforts. Analytical methods for determining VOC levels in organic coatings continue to improve, as chromatographic and spectroscopic approaches afford a means of quantifying VOC content directly in waterborne as well as solventborne coatings.

Heuristic methods for estimating the volatility of formulation components are common but are not extensively validated using quantitative structure-property relationships. Thus, a clearer link between component transport through an evolving coating matrix during curing processes, the bulk volatility of a compound, and the elution and quantification of compounds in a gas chromatograph (GC) still must be made to promote innovation in this area.

To address these issues, digital tools such as molecular descriptors and machine learning models are being combined with experimental measurements to better understand the time-dependent mechanistic nature of VOCs in coatings and to enable predictive control over the volatility and in-coating behavior of newly developed formulation components.

Here, we present the development and validation of a molecular structure-based neural network for the prediction of response factor for formulation components in a gas chromatography (GC) analysis. This represents an important step in creating large-scale computational design tools that enable in silico formulation, optimization, and end-use property prediction of environmentally benign coatings.

INTRODUCTION

Consumer and market demand within the coatings industry continues to put pressure on formulators to create high-performance coatings that also have adequately low levels of volatile organic compounds. An ongoing challenge is the creation and optimization of important end-use coating properties while still meeting environmental regulation specifications.

As formulators are urged to innovate more quickly, it has become apparent that traditional empirical and Edisonian (guess-and-test) methods, even statistically designed methods of formulation discovery, must be augmented with newer technologies, such as those represented by digitization, automation, machine learning, and artificial intelligence.

There is also an increased emphasis on understanding chemical and physical interactions within the formulation at all stages of the paint production, application, and film-forming process. The growing consumer demand for environmentally benign “green” coatings has led to a push within the paint industry for improved predictive models and developmental workflows that make use of these next generation technologies.

Consider, for example, the recent South Coast Air Quality Management District (SCAQMD) Test Method 319 (Determination of Exclusion Status for Compounds in Film-Forming Coatings), where measurement, estimation, or prediction of the low vapor pressure of a formulation component may lead to its exclusion in VOC calculation and reporting.

Environmentally conscious consumers and regulatory agencies such as the U.S. Environmental Protection Agency (EPA) have continued to drive the paint and coatings industry towards greener formulating methods, such as shifting from solvent-based to water-based coatings as a method of reducing VOCs.

Throughout the late 1960s and 1970s, there was an increased concern regarding air pollution and the detrimental effects to both human and environmental health.



Diving Deeper into VOCs

From this pollution arose the need to define and regulate the effect of paints and coatings on the local environment by limiting the amount of certain additives in paint which are damaging to the environment.

The EPA identified volatile organic compounds as “any compound of carbon, excluding carbon monoxide, carbon dioxide, carbonic acid, metallic carbides or carbonates, and ammonium carbonate, which participates in atmospheric photochemical reactions, except those designated by the EPA as having negligible photochemical reactivity.”¹

The EPA calculates compliance with VOC content regulations (Title 40, Chapter I, Subchapter C, Part 59, Subpart D—National Volatile Organic Compound Emission Standards for Architectural Coatings S: 63 FR 48877, Sept. 11, 1998, §59.406) according to Equation 1:

$$\text{VOC content} = \frac{(W_v - W_w - W_{ec})}{(V - V_w - V_{ec})} \quad (1)$$

In Equation 1, VOC content = grams of VOC per liter of coating; W_v = mass of total volatiles, in grams; W_w = mass of water, in grams; W_{ec} = mass of exempt compounds, in grams; V = volume of coating, in liters; V_w = volume of water, in liters; and V_{ec} = volume of exempt compounds, in liters.

In 1984, the EPA introduced Method 24 to quantify the amount of VOCs in coatings and inks sold in the United States. Method 24 is an indirect method of VOC determination, wherein the water content, solids content, and density of the coating are directly measured and used to back-calculate the amount of VOCs by a mass difference approach.

Method 24 is insufficient for waterborne coatings with low VOC content, as the indirect method erroneously determines small mass fractions of VOCs as compared to the much larger water weight percent, with exponentially increasing error below VOC content of approximately 250 g/L.

As coatings shifted from solvent-based formulations to more environmentally friendly water-based formulations, the insufficiencies in this method motivated the need for new standardized regulatory methods and measurement procedures.

Despite the need for improved methods, EPA Method 24 is currently the regulatory method federally mandated across the United States.

States and regions throughout the United States have various guidelines that extend beyond federal rules. California, particularly the Los Angeles air basin, has faced, and continues to face, high prevalence of air pollution known as “smog,” a portmanteau coined in the 1900s to describe the uniquely industrial mixture of smoke and fog becoming increasingly prevalent in large urban areas.

Regulatory agencies such as the California Air Resource Board (CARB), and more specifically SCAQMD, formed the most stringent regulations in the United States to reduce the local effects of this increasing pollution. Method 313 is a direct method for the measurement and quantitation of VOCs using a gas chromatograph with flame ionization detector (GC-FID) applied to samples with less than 150g/L of VOCs.

The complexity of this method is the main deterrent to its use. VOCs are quantified via multilevel calibration curves generated for each analyte used in the coating formulation.² Relative response factors allow for the calculation of volatiles through this direct method. The regulation of VOCs is relative to the retention time of methyl palmitate. Compounds that elute prior to methyl palmitate are not included in the calculation of volatiles per liter coating. The complexity and laborious sample preparation associated with this method render its use undesirable and drove the innovation of a new standard: ASTM D6886.

ASTM D6886 is a non-regulatory analytical method suitable for the analysis of coatings with less than 150g/L of VOCs, which resulted from an in-depth study by California Polytechnic State University for the California Air Resource Board.³ This method does not define a VOC as Method 313 does, rather it identifies and quantifies *all* volatiles within a formulation. Although it is not regulatory in nature, it has been widely adopted by SCAQMD as it provides for a less labor-intensive direct measurement of VOC content in coatings as compared to Method 313.

Like Method 313, GC-FID is used in ADTM D6886 to quantify the volatile compounds present in the material. This method utilizes an internal standard, ethylene glycol diethyl ether (EGDE), for the calculation of response factors for an analyte of interest, as discussed in subsequent sections of this manuscript. Herein all response factors discussed were collected according to ASTM D6886.

Globally, VOCs are regulated by federal and local governments. Looking beyond the United States, Europe developed ISO 11890, a widely employed direct method for the analysis of samples with expected VOC content between 0.1% and 15% by mass.⁴

While Method 313 defines a VOC as anything that elutes before methyl palmitate, ISO 11890 defines a VOC as compounds with a boiling point below 250 °C. This is dictated by EU Directive 2004/42/EU.⁴ ASTM-D6886 and ISO 11890 are very similar in practice, with direct measurements performed via GC-FID, and primarily differ in the associated VOC determination that follows as dictated by regulatory agencies within relevant regions.

Here, we combine structure-property relationships, neural networks, and gas chromatographic analytical methods to create a digitally enabled workflow that can support the formulator chemist while evolving as quickly as the regulations themselves.

We present a multipronged approach to working with, measuring, and understanding the nature of VOCs in coatings formulations. First, we present a method of improved prediction for quantifying the response factor (RF) of compounds being analyzed by gas chromatography, as a means of augmenting and expediting VOC determination by ASTM D6886 and other chromatographic approaches.

Ongoing work is employing vapor pressure (VP) prediction and measurement to improve the working definition of VOC as it applies to coating production, application, and film-formation processes. Finally, we propose new directions for incorporating these predictive approaches into the formulation development process.

TABLE 1—Calculated molecular descriptor with the largest positive or negative correlation with compound response factor.

Number	Descriptor	Definition	Correlation
1	O%	Percentage of oxygen atoms	-0.8480
2	AAC	Mean information index on atomic composition	-0.8194
3	ICO	Information Content index (neighborhood symmetry of 0-order)	-0.8194
4	MLOGP	Moriguchi octanol-water partition coeff. (logP)	0.8071
5	BLTA96	Verhaar Algae base-line toxicity from MLOGP (mmol/l)	-0.8071
6	BLTD48	Verhaar Daphnia base-line toxicity from MLOGP (mmol/l)	-0.8071
7	BLTF96	Verhaar Fish base-line toxicity from MLOGP (mmol/l)	-0.8071
8	Me	Mean atomic Sanderson electronegativity (scaled on Carbon atom)	-0.7739
9	Mor31s	Signal 31 / weighted by l-state	0.7641
10	SM1_Dz(p)	Spectral moment of order 1 from Barysz matrix weighted by polarizability	0.7614
11	SpMin1_Bh(m)	Smallest eigenvalue n. 1 of Burden matrix weighted by mass	0.7566
12	Psi_i_A	Intrinsic state pseudoconnectivity index - type S average	-0.7494
13	Psi_e_A	Electrotopological state pseudoconnectivity index - type S average	-0.7494
14	BICO	Bond Information Content index (neighborhood symmetry of 0-order)	-0.7478
15	CATS2D_00_LL	CATS2D Lipophilic-Lipophilic at lag 00	0.7474
16	CATS2D_01_LL	CATS2D Lipophilic-Lipophilic at lag 01	0.7463
17	SM1_Dz(v)	Spectral moment of order 1 from Barysz matrix weighted by van der Waals volume	0.7363
18	SICO	Structural Information Content index (neighborhood symmetry of 0-order)	-0.7325
19	SM1_Dz(Z)	Spectral moment of order 1 from Barysz matrix weighted by atomic number	-0.7308
20	Eta_alpha_A	Eta average core count	0.7307

MATERIALS AND METHODS

Response factor determination by GC

The response factor, or RF, of an analyte compound is the ratio between the chromatographic signal produced by the compound and the quantity or amount of analyte which produces the signal. Ideally, this ratio is 1.0, or unity, allowing for simple quantification and comparison of analyte composition in a tested mixture, although differences in compound activity within an analytical instrument usually cause deviations from unity.

The role of accurate RF measurements in VOC analysis is critical; with faulty RF information, calculations of VOC content in a tested formulation may not be reliable. Further, newly created compounds or additives must be characterized against an internal standard to empirically determine the RF before analysis of chromatograms may occur.

RF allows for the quantitation of analyte in a mixture as compared to an internal standard, as defined by Equation 2.

$$RF = \frac{MA \times AA}{MI \times AI} \quad (2)$$

Standards with equal weights of a chosen analyte and internal standard are used to determine the response factor for analyte of interest. The mass of the analyte added (MA) and the relative peak area (AA) from the FID spectrum are standardized by the mass of an internal standard (MI) and the associated peak area for that internal standard (AI). Ethylene glycol diethyl ether (EGDE) was used as the internal standard.³

Quantitative structure activity relationships for identifying molecular features relevant to response factor

The quantitative structure activity relationship (QSAR) approach makes use of large numbers of chemical and topological descriptors that correlate molecular structure to activities or properties of interest.⁵ The use of QSAR serves two purposes: 1) discover or validate heuristic relationships and 2) provide a list of relevant features or inputs for use in subsequent modeling and prediction exercises.

A set of 80 compounds commonly seen in VOC analysis of coatings by GC-MS was chosen as a dataset for this study. Molecular structures were represented using simplified molecular-input

line-entry system (SMILES) strings, which were generated for all 80 compounds in the dataset on a Dell XPS 13 9360 laptop running Windows 10.

The Avogadro molecular editor⁶ was used to create rough three-dimensional geometries for each compound, which were then optimized using a quick energy minimization algorithm. Then, a total of 5,270 descriptors were calculated for each compound using Dragon 7.⁷ Of these, 2,130 were constant, showing no change across the entire set of compounds; 2,301 were near constant, showing negligible change across the compound set; 155 had at least one value missing or incalculable due to molecular structure; and 15 had all values missing or incalculable. These descriptors were removed from the analysis.

The resultant set of 669 descriptors for each of the 80 compounds in the dataset was then subjected to correlation analysis to identify the 20 descriptors with the highest positive or negative correlation to RF. These descriptors are listed in Table 1.

The data were normalized with by applying Equation 3:

$$(RF_{norm})_y = \frac{RF_y - RF_{min}}{RF_{max} - RF_{min}} \quad (3)$$



Diving Deeper into VOCs

where RF_{norm} is the normalized RF of compound y , RF_y is the response factor of a generic compound y , RF_{max} is the highest RF measured, and RF_{min} is the lowest RF measured, as shown in Table 2. Normalizing RF constrains all data to a range between 0 and 1, with 0 being the lowest RF and 1 being the highest RF, which allows for greater efficiency and accuracy during training.⁸ The same formula was used to normalize all descriptors to values between 0 and 1.

Deep-learning artificial neural networks (DLANN) for creating production-grade predictive models for new compound response factor estimation

After normalization, the data were randomly divided into two groups; 60 molecules (75%) were allocated to a training set to be used to build and teach the machine learning model, while 20 molecules (25%) were withheld for the validation set. The holdout validation set quantifies the ability of the model to generalize its ruleset to compounds that it has never seen before.

A deep-learning artificial neural network as a nonlinear regression model with Adam optimizer was created in Python 3 in a Jupyter Notebook 6.3.0 using TensorFlow and Keras deep learning libraries. Loss was calculated as mean square error (MSE). Hyperparameter tuning revealed that the model achieved optimal performance in the training and holdout validation sets with 19 descriptors, 500 epochs (or cycles of model learning with exposure to the data), and one hidden layer of consisting of three nodes, or perceptrons.

RESULTS

Figure 1 shows the correlation between predicted and actual values of RF during a training and validation of a neural network with up to 1,000 learning cycles through the data.

Figure 1 shows that with repeated learning, the trained neural network performs better, while the unseen data in the validation set is less able to be appropriately captured by these long-trained models. This is an indication of overfitting; the trained neural network

is effectively learning how to memorize the data in the training set. A compromise must be selected that balances performance of the trained model against performance of the model when used with new data. Here, hyperparameter selection indicated that 500 epochs of learning were a suitable stopping point during the model build process.

Figure 2 shows the performance of the RF prediction neural network after being trained on the dataset after 500 epochs of model evolution. The trained neural network shows good agreement between predicted and measured (experimental) values of RF, indicated by the close linear fit to the identity ($x=y$) line, with an R^2 value of 0.90.

FIGURE 1—Epoch selection for a single-layer artificial neural network using molecular 19 descriptors as input nodes.

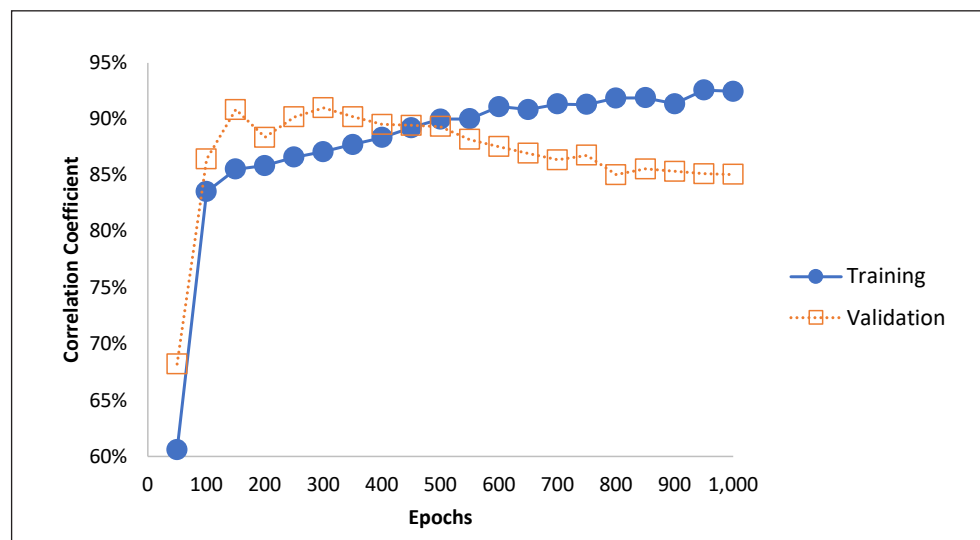


FIGURE 2—Performance of the RF predictive neural network after 500 learning cycles on the dataset. A close linear fit and high R^2 value (0.90) indicates that the model has adequately learned from the dataset.

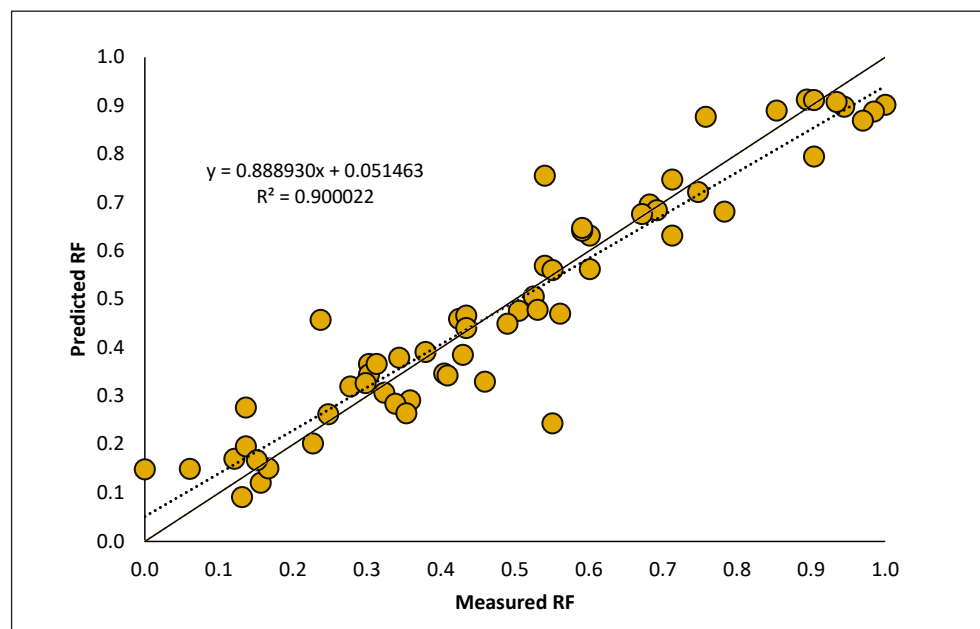


TABLE 2—Response factors and retention times for 80 compound dataset for VOC analysis, with absolute and normalized values provided.

#.	Compound	SMILES	RF	Norm RF	RT	Norm RT
1.	(3-Hydroxy-2,2,4-trimethylpentyl) 2-methylpropanoate	CC(C)C(C)(C)COC(=O)C(C)O	1.31	0.5354	856	0.66589327
2.	[2,2,4-Trimethyl-1-(2-methylpropanoyloxy)pentyl] 2-methylpropanoate	CC(C)C(C)(C)C(OC(=O)C(C)O)C(=O)C(C)C	1.32	0.5404	961	0.76798144
3.	1,2-Diethoxyethane	CCOCCOCC	1.00	0.3788	520	0.34106729
4.	1,3,5-Trimethylbenzene	CC1=CC(=CC=C1)C	2.23	1.0000	657	0.47389791
5.	1,4-Xylene	CC1=CC=C(C=C1)C	2.20	0.9848	592	0.41067285
6.	1-[2-(2-Methoxypropoxy)propoxy]butane	CCCCOCC(C)OCC(C)OC	1.07	0.4141	791	0.60382831
7.	1-Butoxybutane	CCCCOCCCC	1.60	0.6818	590	0.40893271
8.	1-Butoxypropan-2-ol	CCCCOCC(C)O	1.15	0.4545	630	0.44779582
9.	1-Chloro-4-(trifluoromethyl)benzene	C1=CC(=CC=C1(F)(F)F)Cl	1.10	0.4293	574	0.39327146
10.	1-Methoxy-2-[2-(2-methoxyethoxy)ethoxy]ethane	COCCOCCOCCO	0.77	0.2626	781	0.59338747
11.	1-Methoxypropyl acetate	CCC(O)CC(=O)C	0.88	0.3182	572	0.39153132
12.	1-Methylpyrrolidin-2-one	CN1CCCC1=O	0.96	0.3586	692	0.50812065
13.	1-Phenoxypropan-2-ol	CC(COC1=CC=CC=C1)O	1.29	0.5253	804	0.61600928
14.	2-(2-Butoxyethoxy)ethanol	CCCCOCCOCCO	1.06	0.4091	769	0.58178654
15.	2-(2-Hydroxyethoxy)ethanol	C(COCCO)O	0.49	0.1212	641	0.45823666
16.	2-(2-Methoxyethoxy)ethanol	COCCOCCO	0.70	0.2273	624	0.44199536
17.	2-(2-Methoxypropoxy)propan-1-ol	CC(CO)OCC(C)OC	0.89	0.3232	663	0.47969838
18.	2-(2-Propoxyethoxy)ethanol	CCCCOCCOCCO	0.80	0.2778	718	0.53248260
19.	2,4,7,9-Tetramethyldec-5-yne-4,7-diol	CC(C)CC(C)(C#CC(C)(CC(C)O)O)	1.62	0.6919	867	0.67691415
20.	2-[2-(2-Hydroxyethoxy)ethoxy]ethanol	C(COCCOCCO)O	0.37	0.0606	755	0.56844548
21.	2-[2-(2-Methoxypropoxy)propoxy]propan-1-ol	CC(CO)OCC(C)OCC(C)OC	0.92	0.3384	813	0.62470998
22.	2-[2-[2-(2-Hydroxyethoxy)ethoxy]ethoxy]ethanol	C(COCCOCCOCCO)O	0.56	0.1566	917	0.72563805
23.	2-[2-[2-[2-(2-Hydroxyethoxy)ethoxy]ethoxy]ethoxy]ethanol	C(COCCOCCOCCOCCO)O	0.51	0.1313	1088	0.89095128
24.	2-[Butyl(2-hydroxyethyl)amino]ethanol	CCCCN(CC)CCO	1.10	0.4293	836	0.64733179
25.	2-Amino-2-ethylpropane-1,3-diol	CCC(CO)(CO)N	0.52	0.1364	737	0.55162413
26.	2-Amino-2-methylpropan-1-ol	CC(C)(CO)N	0.85	0.3030	488	0.31032483
27.	2-Benzofuran-1,3-dione	C1=CC=C2C(=C1)C(=O)OC2=O	0.46	0.1061	845	0.65545244
28.	2-Butoxyethanol	CCCCOCCO	0.72	0.2374	607	0.42575406
29.	2-Butoxyethanol	CCCCOCCO	1.15	0.4545	607	0.42575406
30.	2-Ethoxyethyl acetate	CCOCCOCC(=O)C	1.34	0.5505	599	0.41763341
31.	2-Ethyl-2-(hydroxymethyl)propane-1,3-diol	CCC(CO)(CO)CO	1.05	0.4040	817	0.62819026
32.	2-Ethylhexanal	CCCCC(CC)=O	1.73	0.7475	683	0.49941995
33.	2-Ethylhexyl benzoate	CCCCC(C)COC(=O)C1=CC=CC=C1	1.58	0.6717	1041	0.84512761
34.	2-Methylpentane-2,4-diol	CC(C)C(C)O)O	1.09	0.4242	616	0.43387471
35.	2-Methylprop-2-enoic acid	CC(=C)C(=O)O	0.95	0.3535	505	0.32656613
36.	2-Methylpropan-1-ol	CC(C)CO	1.44	0.6010	328	0.15545244
37.	2-tert-Butylphenol	CC(C)(C)C1=CC=CC=C1O	1.66	0.7121	818	0.62935035
38.	3-iodoprop-2-ynyl N-butylcarbamate	CCCCN(C=O)OCC#CI	0.25	0.0000	1007	0.81264501
39.	4-Methyl-1,3-dioxolan-2-one	CC1COC(=O)O1	0.59	0.1717	659	0.47621810
40.	4-Methylpentan-2-one	CC(C)CC(=O)C	1.44	0.6010	473	0.29640371
41.	5-Isocyanato-1-(isocyanatomethyl)-1,3,3-trimethylcyclohexane	CC1(CC(CCC1))C(N=C=O)N=C=O	1.25	0.5051	960	0.76682135
42.	Benzoic acid	C1=CC=C(C=C1)C(=O)O	1.11	0.4343	753	0.56670534
43.	Bis(2-methylpropyl) hexanedioate	CC(C)COC(=O)CCCC(=O)OCC(C)C	1.30	0.5303	1003	0.80858469
44.	Butan-1-ol	CCCCO	1.34	0.5505	395	0.22041763
45.	Butan-2-one	CCC(=O)C	0.87	0.3131	328	0.15603248
46.	Butanal	CCCC=O	1.20	0.4798	319	0.14733179
47.	Butyl acetate	CCCCOC(=O)C	1.22	0.4899	535	0.35614849
48.	Butyl prop-2-enoate	CCCCOC(=O)C=C	1.36	0.5606	598	0.41705336
49.	Decane	CCCCCCCCC	2.12	0.9444	667	0.48375870
50.	Diethyl hexanedioate	CCOC(=O)CCCC(=O)OCC	1.06	0.4091	851	0.66183295
51.	Diphenylmethanone	C1=CC=C(C=C1)C(=O)C2=CC=CC=C2	2.04	0.9040	1012	0.81728538
52.	Dodecane	CCCCCCCCCCCC	2.10	0.9343	773	0.58584687
53.	Ethane-1,2-diol	C(CO)O	0.52	0.1364	422	0.24651972
54.	Ethanol	CCO	0.85	0.3030	193	0.02552204
55.	Ethenyl acetate	CC(=O)OC=C	0.52	0.1364	309	0.13747100
56.	Heptan-2-one	CCCCCC(=O)C	1.58	0.6717	595	0.41415313
57.	Heptane	CCCCCC	1.94	0.8535	435	0.25928074
58.	Hexanal	CCCCCC=O	1.42	0.5909	528	0.34918794
59.	Hexane	CCCCCC	1.75	0.7576	325	0.15255220
60.	Methanol	CO	0.58	0.1667	167	0.00000000
61.	Methyl acetate	CC(=O)OC	0.55	0.1515	249	0.07946636
62.	Methyl hexadecanoate	CCCCCCCCCCCCCCCC(=O)OC	1.32	0.5404	1201	1.00000000
63.	Methyl nonanoate	CCCCCCCCC(=O)OC	1.42	0.5909	778	0.59048724
64.	N,N-diethylethanamine	CCN(CC)CC	1.80	0.7828	419	0.24361949
65.	N-butan-2-ylidenedihydroxylamine	CCC(=NO)C	1.16	0.4596	504	0.32598608
66.	N-butylbutan-1-amine	CCCCNCCCC	1.70	0.7323	641	0.45881671
67.	N-methyl-sarcosinol	CN(C)CCO	0.84	0.2980	460	0.28364269
68.	Nonane	CCCCCCCCC	2.11	0.9394	604	0.42227378
69.	Octane	CCCCCCCC	2.02	0.8939	527	0.34860789
70.	Oxolane	C1CCOC1	1.11	0.4343	369	0.19547564
71.	Pentadecane	CCCCCCCCCCCCCCC	2.04	0.9040	909	0.71751740
72.	Phenylmethanol	C1=CC=C(C=C1)CO	1.66	0.7121	691	0.50696056
73.	Propan-2-ol	C(C)C(O)C	0.93	0.3434	232	0.06264501
74.	Propan-2-one	CC(=O)C	0.87	0.3131	218	0.04930394
75.	Propane-1,2,3-triol	C(C(CO)O)O	0.55	0.1515	652	0.46867749
76.	Propane-1,2-diol	CC(CO)O	0.74	0.2475	467	0.29002320
77.	tert-Butyl acetate	CC(=O)OC(C)(C)C	1.24	0.5000	435	0.25928074
78.	Toluene	CC1=CC=CC=C1	2.17	0.9697	507	0.32888631
79.	Tridecane	CCCCCCCCCCCCC	2.10	0.9343	819	0.63051044
80.	Undecane	CCCCCCCCCCC	2.13	0.9495	722	0.53712297

FIGURE 3—Using the trained neural network to predict the RF for new compounds. A close linear fit between predicted and actual RF, along with a high R2 value (0.89), all indicate that the model has adequately learned from the dataset and is able to make reasonable predictions on new compounds.

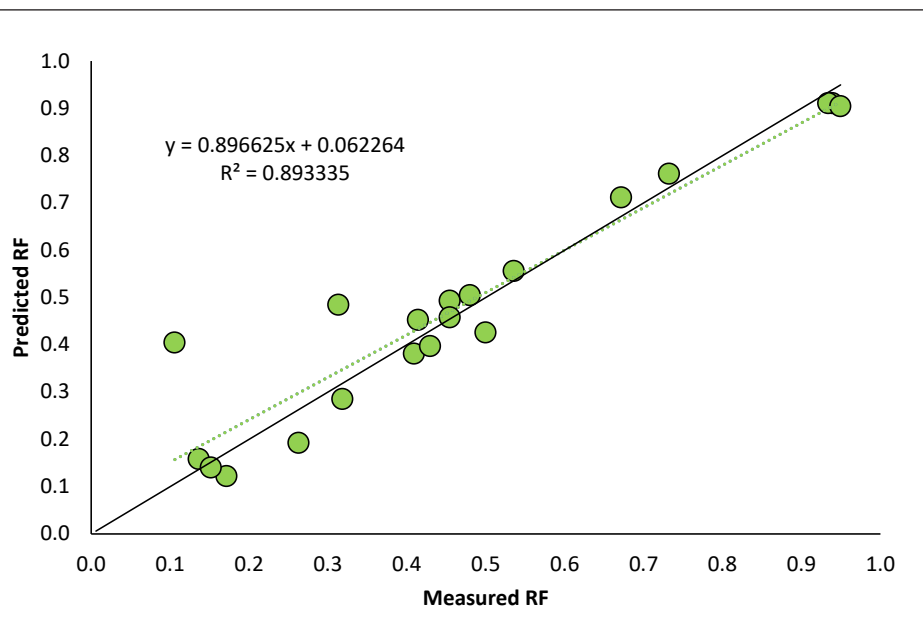


Figure 3 shows the performance of the RF prediction neural network after being trained on the dataset after 500 epochs of model evolution and after being predicting the RF of a validation set of test compounds that were not included in the training of the model.

The neural network shows good agreement during this validation stage, as indicated by the predicted and measured (experimental) values of RF. As with the training of the model in Figure 2, the close linear fit to the identity ($x=y$) line, and an R^2 value of 0.89 indicate a suitably high level of model performance and predictivity.

The final, production-ready neural network had 19 input nodes (the list of most-correlated descriptors), one hidden layer with a modest number of three perceptron or computing nodes, and a singular output—the predicted response factor. The architecture of the resultant neural network is shown in Figure 4.

DISCUSSION

For the first time, a quantitative structure-activity relationship approach was combined with neural networks to create a machine learning model custom-built for the performance prediction of formulation components being subjected to VOC identification and quantification.

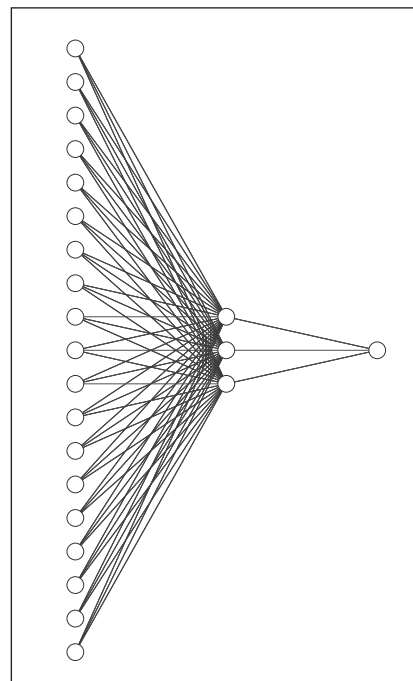
Review of the correlated descriptors (Table 1) indicates that the chemical

descriptor most correlated with experimental response factor is 0%, the percentage of oxygen atoms in the molecule. This confirms a commonly stated heuristic (or rule of thumb) regarding off-the-cuff estimation of response factors: as the ratio of elemental oxygen to carbon in the molecule increases, the observed response factor will decrease as the flame ionization detector will oxidize proportionally less of an oxygen-rich molecule as compared to a molecule containing less or no elemental oxygen. Implications for the design of new formulation additives based on the remaining descriptors is forthcoming in a manuscript being prepared by the authors.

The trained neural network model predicted 90.0% of the variance in the actual RF in the training set as shown in Table 3, with 3.89% mean squared error (MSE) and 89.3% in the validation set with 6.16% mean squared error MSE as shown in Table 4, indicating a high degree of accuracy and flexibility across many different chemical functionalities and a variety of GC column retention time behavior.

The neural network produced here may be implemented in predictive, digital lab workflows that are focused on in silico or virtual formulation and coating property prediction. Predictive tools that are derived from chemical structure and empirical measurements will be critical for moving research and

FIGURE 4—The trained artificial neural network with 19 descriptors as inputs, one hidden layer with three nodes, and one output layer (predicted RF). Image generated using the online tool NN-SVG.⁹



development efforts into more accelerated, digitally enabled regimes.

As more predictive tools become available, the hope is that a common set of predictive tools may be used by both formulators as well as those concerned with the end-use properties and environmental impacts of new products as they enter the market. The goal is to bridge the divide between regulatory agencies and coatings formulators, provide a science-backed means of prediction and regulation that enables innovation, and facilitate the free market design of new products while respecting the product life cycle and the best practices of corporate stewardship.

FUTURE WORK

This first successful implementation of a neural network applied to VOC analysis workflows opens the door for further development and integration of machine learning tools for formulation research, optimization, and characterization. Current work in progress is employing similar approaches to the estimation of compound retention time and vapor pressure; both properties may be used in an inverse design, genetic algorithm-enabled workflow for the discovery of new molecular formulation components.

Future implementations of these models will be able to predict a

TABLE 3—Predicted and experimental response factors (absolute and normalized) in the training set.

Compound	RF	Pred RF	Norm RF	Norm Pred RF
	<i>RF=Response Factor; Pred RF=Predicted Response Factor; Norm RF=Normalized Response Factor; Norm Pred RF=Normalized Predicted Response Factor</i>			
[2,2,4-Trimethyl-1-(2-methylpropanoyloxy)pentyl] 2-methylpropanoate	1.32	1.376	0.540	0.569
1,2-Diethoxyethane	1.00	1.023	0.379	0.391
1,3,5-Trimethylbenzene	2.23	2.034	1.000	0.901
1,4-Xylene	2.20	2.006	0.985	0.887
1-Butoxybutane	1.60	1.627	0.682	0.696
1-Chloro-4-(trifluoromethyl)benzene	1.10	1.012	0.429	0.385
1-Methylpyrrolidin-2-one	0.96	0.826	0.359	0.291
1-Phenoxypropan-2-ol	1.29	1.251	0.525	0.506
2-(2-Hydroxyethoxy)ethanol	0.49	0.587	0.121	0.170
2-(2-Methoxyethoxy)ethanol	0.70	0.650	0.227	0.202
2-(2-Methoxypropoxy)propan-1-ol	0.89	0.858	0.323	0.307
2-(2-Propoxyethoxy)ethanol	0.80	0.883	0.278	0.320
2,4,7,9-Tetramethyldec-5-yne-4,7-diol	1.62	1.604	0.692	0.684
2-[2-(2-Hydroxyethoxy)ethoxy]ethanol	0.37	0.546	0.061	0.150
2-[2-(2-Methoxypropoxy)propoxy]propan-1-ol	0.92	0.812	0.338	0.284
2-[2-[2-(2-Hydroxyethoxy)ethoxy]ethoxy]ethanol	0.56	0.490	0.157	0.121
2-[2-[2-[2-(2-Hydroxyethoxy)ethoxy]ethoxy]ethoxy]ethanol	0.51	0.431	0.131	0.091
2-Amino-2-ethylpropane-1,3-diol	0.52	0.797	0.136	0.276
2-Amino-2-methylpropan-1-ol	0.85	0.976	0.303	0.366
2-Butoxyethanol	0.72	1.156	0.237	0.458
2-Ethoxyethyl acetate	1.34	0.732	0.551	0.243
2-Ethyl-2-(hydroxymethyl)propane-1,3-diol	1.05	0.935	0.404	0.346
2-Ethylhexanal	1.73	1.678	0.747	0.721
2-Methylpentane-2,4-diol	1.09	1.160	0.424	0.459
2-Methylprop-2-enoic acid	0.95	0.773	0.354	0.264
2-Methylpropan-1-ol	1.44	1.362	0.601	0.562
2-Tert-butylphenol	1.66	1.729	0.712	0.747
3-Iodoprop-2-ynyl N-butylcarbamate	0.25	0.544	0.000	0.149
4-Methylpentan-2-one	1.44	1.500	0.601	0.631
5-Isocyanato-1-(isocyanatomethyl)-1,3,3-trimethylcyclohexane	1.25	1.193	0.505	0.476
Benzoic acid	1.11	1.173	0.434	0.466
Bis(2-methylpropyl) hexanedioate	1.30	1.197	0.530	0.478
Butan-1-ol	1.34	1.359	0.551	0.560
Butyl acetate	1.22	1.139	0.490	0.449
Butyl prop-2-enoate	1.36	1.181	0.561	0.470
Decane	2.12	2.028	0.944	0.898
Diethyl hexanedioate	1.06	0.928	0.409	0.342
Diphenylmethanone	2.04	1.823	0.904	0.794
Dodecane	2.10	2.047	0.934	0.908
Ethanol	0.85	0.932	0.303	0.344
Ethenyl acetate	0.52	0.639	0.136	0.196
Heptan-2-one	1.58	1.589	0.672	0.676
Heptane	1.94	2.011	0.854	0.889
Hexanal	1.42	1.519	0.591	0.641
Hexane	1.75	1.987	0.758	0.877
Methanol	0.58	0.547	0.167	0.150
Methyl acetate	0.55	0.582	0.152	0.168
Methyl hexadecanoate	1.32	1.744	0.540	0.754
Methyl nonanoate	1.42	1.531	0.591	0.647
<i>N,N</i> -diethylethanamine	1.80	1.599	0.783	0.681
<i>N</i> -butan-2-ylidenehydroxylamine	1.16	0.903	0.460	0.330
<i>N</i> -methyl-sarcosinol	0.84	0.897	0.298	0.327
Octane	2.02	2.056	0.894	0.912
Oxolane	1.11	1.123	0.434	0.441
Pentadecane	2.04	2.054	0.904	0.911
Phenylmethanol	1.66	1.501	0.712	0.632
Propan-2-ol	0.93	1.001	0.343	0.380
Propan-2-one	0.87	0.975	0.313	0.366
Propane-1,2-diol	0.74	0.770	0.247	0.262
Toluene	2.17	1.970	0.970	0.869



Diving Deeper into VOCs

TABLE 4—Predicted and experimental response factors (absolute and normalized) in the validation set.

Compound	RF	Pred RF	Norm RF	Pred Norm RF
(3-Hydroxy-2,2,4-trimethylpentyl) 2-methylpropanoate	1.31	1.39	0.535	0.555
1-[2-(2-Methoxypropoxy)propoxy]butane	1.07	1.21	0.414	0.452
1-Butoxypropan-2-ol	1.15	1.28	0.455	0.493
1-Methoxy-2-[2-(2-methoxyethoxy)ethoxy]ethane	0.77	0.78	0.263	0.192
1-Methoxypropyl acetate	0.88	0.94	0.318	0.285
2-(2-Butoxyethoxy)ethanol	1.06	1.10	0.409	0.380
2-[Butyl(2-hydroxyethyl)amino]ethanol	1.10	1.12	0.429	0.396
2-Benzofuran-1,3-dione	0.46	1.13	0.106	0.404
2-Butoxyethanol	1.15	1.22	0.455	0.458
2-Ethylhexyl benzoate	1.58	1.65	0.672	0.711
4-Methyl-1,3-dioxolan-2-one	0.59	0.66	0.172	0.122
Butan-2-one	0.87	1.27	0.313	0.484
Butanal	1.20	1.30	0.480	0.504
Ethane-1,2-diol	0.52	0.72	0.136	0.158
N-butylbutan-1-amine	1.70	1.73	0.732	0.761
Nonane	2.11	1.98	0.939	0.910
Propane-1,2,3-triol	0.55	0.69	0.152	0.140
t-Butyl acetate	1.24	1.17	0.500	0.426
Tridecane	2.10	1.98	0.934	0.910
Undecane	2.13	1.97	0.949	0.903

RF=Response Factor; Pred RF=Predicted Response Factor;
Norm RF=Normalized Response Factor;
Pred Norm RF= Predicted Normalized Response Factor

quantified VOC content profile for a proposed formulation, even if certain components of the formulation are novel and have not been fully characterized by laboratory methods. This computational approach to additive and formulation design will assist the next generation of formulation scientists tasked with quickly and efficiently formulating and optimizing environmentally benign high-performance coatings. ❁

ACKNOWLEDGMENTS

The authors would like to thank Professor Dane Jones for countless fruitful and informative discussions about the field of VOC quantification.

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ACA and the WCC: An Update on Global Regulatory Developments

By Heidi McAuliffe,
American Coatings Association

As an advocate and voice for the coatings industry, the American Coatings Association engages with regulatory agencies and legislators at the federal, state, and local levels in the areas of air quality, environmental requirements, chemicals management, occupational safety and health, and sustainability. In the global arena, ACA monitors and tracks these same issues, conducting its advocacy under the umbrella of the World Coatings Council (WCC) and its members.

The WCC is a network of trade associations for the paint and coatings industry in nations around the world. It provides a forum for the exchange of information and cooperation on major issues and priorities facing the industry. Founded in the early 1990s, the WCC established itself as a global voice for the industry. The council was established to ensure that the industry, in coordinating the development of policy on international issues, fully discussed and analyzed global implications.

When legislative or regulatory issues arise around the globe, usually the nation where the issue originates will become the lead advocate for the paint industry. ACA, WCC, and other council members will provide technical and strategic assistance to the nation's trade association that is most knowledgeable about the domestic paint industry and the regulatory agency. This framework allows the global industry to



World Coatings CouncilSM

participate in the advocacy effort and impact the course of the issue.

Here is a short list of issues that ACA is working on in the international arena:

MEXICAN PROPOSED RULEMAKING ON ARCHITECTURAL COATINGS

Mexico is currently revising its architectural coating volatile organic compound (VOC) official Mexican standard—Normas Oficiales Mexicanas, or NOM. The proposal applies to eight categories and proposes corresponding limits consistent with the 2019 California Architectural and Industrial Maintenance (AIM) Suggested Control Measure (SCM).

However, the draft of the Mexico architectural coatings proposal contains many other provisions that are not consistent with the 2019 SCM regulation in several respects. The proposal's definitions and small-container exemption are different. In addition, the proposed NOM includes burdensome conformity assessment provisions that would require coatings

manufacturers to register with the Mexican government and submit a declaration of compliance and sample product labels to confirm VOC content.

To demonstrate compliance, the proposal requires supporting documentation that will be requested by border officials for products imported to Mexico. There is not a similar requirement for domestically manufactured products. As a result, manufacturers will likely need to obtain a conformance assessment opinion from the Mexican government before products can be imported into Mexico.

At the time of publication, the draft regulation was anticipated to be published in early 2022.

EU CHEMICALS STRATEGY FOR SUSTAINABILITY, GREEN NEW DEAL

In October 2020, the European Commission (EU) published a policy document, "Chemicals Strategy for Sustainability Towards a Toxic-Free Environment," to update the EU's chemicals management requirements and to advance toward the goal of zero pollution articulated in the European Green Deal.

The commission recommends significant changes to the EU Classification, Labelling and Packaging (CLP) and Registration, Evaluation, Authorisation, and Restriction of Chemicals (REACH) regulations as the foundation for policy changes, generally advancing the commission's goal of zero environmental chemical pollution.

As a result, companies placing products on the EU market will see significant changes in how those products are evaluated for safety with increased restrictions to market access. Companies may be required to update labels based on new hazard classes.

Certain hazard classes may trigger bans of consumer products and increased worker protections for industrial use, as EU regulators specify general risk mitigation measures by hazard class under the new strategy. The strategy may expand the scope of products subject to restriction for containing substances of very high concern. Products with endocrine disruptors or per- and polyfluoroalkyl (PFAS) chemicals may also be subject to restrictions. Coatings manufacturers may be required to submit information about polymers in products.

Note that there is an emphasis on responding to an identified hazard, rather than the risk of exposure. These policy changes clearly embrace the precautionary principle. The commission also plans to implement a hazard-based approach on a global scale by introducing new hazard classes into the Global Harmonized System (GHS) and seeking to phase out chemical groups and hazard classes through international conventions and agreements.

As a result, companies placing products on the EU market will see significant changes in how those products are evaluated for safety with increased restrictions to market access.

BIOCIDES UNDER SCRUTINY BY REGULATORS

As regulators express increased concerns about the safety of biocides in products, several biocides are being restricted in ways that limit paint and coatings formulators with options for reformulation and/or limit the types of claims that can be made on a product label. Canada and the EU have been fairly active in addressing biocides.



NEW PFAS REGULATIONS IN THE EU

The European Union has adopted several regulations that restrict the use of perfluorooctanic acid (PFOA) and PFAS. In 2021, five nations announced their intention to restrict PFAS substances. In addition, the Organisation for Economic Cooperation and Development (OECD) has circulated a draft report entitled, "Per- and Polyfluoroalkyl Substances and Alternatives in Coatings, Paints and Varnishes (CPVs), Report on the Commercial Availability and Current Uses," which will likely lead to additional scrutiny of the use of PFAS in coatings as well as available alternatives.

MICROPLASTIC: CANADA, THE EUROPEAN UNION, JAPAN RESOLUTION, AND INTERNATIONAL MARITIME ORGANIZATION

There has been an increasing focus on microplastics, given possible effects on the marine and land environments.

The EU is introducing a proposal that will apply to intentionally added microplastics. The regulation would regulate "primary microplastics," which refer to intentionally added materials such as "micro-beads," "micro-fibers," and "secondary microplastics," which are the "polymeric fragments" released into the environment over time from plastic-containing products, largely through the degradation of larger materials (i.e., macroplastic).

These secondary microplastics include releases from synthetic fibers in clothing (primarily from the laundering process), weathering of macroplastic wastes, degradation of polymeric surfaces (such as paint) on exterior substrates, and wastewater streams that may receive discharges and/or releases of secondary microplastics from all sources. While the European regulation will likely not restrict coatings, the regulation will likely include labeling and reporting requirements.

In January 2020, the Canadian minister of environment and climate change published the "Draft Science Assessment of Plastic Pollution" and committed to ban harmful single-use plastics as soon as 2021. Further, in October 2020, the minister proposed an "order" designating "plastic products" as toxic on Schedule 1 of the Canadian Environmental Protection Act.

At the International Maritime Organization fall 2021 meetings, a proposal entitled, "Microplastics from Antifouling Paints—An Overlooked Source of Marine

Plastic Litter,” was submitted by several environmental non-governmental organizations (NGOs). The proposal asked the Marine Environment Protection Committee to note the impact of microplastics from paints and antifouling coatings on ships, urged it to prioritize the need for further investigation and noted the need to take action to reduce the inputs of microplastics from paints and antifouling coatings into the marine environment. Although this proposal was not adopted, the issue of microplastics in the ocean environment will continue to generate debate and discussion.

A draft resolution, proposed by Japan, was offered at the United Nations (UN) Environment Assembly in early December 2021, requesting the executive director of the UN Environment Programme to convene an inter-governmental negotiating committee with the mandate to prepare an international legally binding instrument to address marine plastic pollution. The resolution proposes that an intergovernmental negotiating committee develop an international legally binding instrument in 2022 based on a comprehensive approach to address marine plastic pollution covering the entire marine life cycle and promoting resource efficiency and a circular economy.

FORCED LABOR RESTRICTIONS ON RAW MATERIALS SOURCED FROM CHINA

In June 2021, the Biden administration announced actions in response to labor practices of companies operating in China’s Xinjiang Uyghur Autonomous Region. Most significantly, the U.S. Customs and Border Protection (CBP) issued a Withhold Release Order (WRO) on silica-based products manufactured by Xinjiang-based Hoshine Silicon Industry Co., Ltd. (Hoshine)

and its subsidiaries. The WRO authorized CBP personnel at all U.S. ports of entry to immediately begin detaining shipments containing silica-based products made by Hoshine and its subsidiaries.

The scope of the WRO applies to finished goods such as photovoltaic cells, solar generators, solar panels, electronics, adhesives, and lubricants, and CBP has indicated that if silica is an insignificant or unessential additive to a product, it may be out of the scope of the order.

More recently, President Biden signed the Uyghur Forced Labor Prevention Act into law in December 2021, which will go into effect on June 21, 2022. The act will create a rebuttable presumption that goods produced in whole or part in the Xinjiang region of China were produced with forced labor and thus banned from U.S. importation unless the importer can provide clear and convincing evidence that the goods were not produced with forced labor. Additional information on the scope of this law will be forthcoming and will surely have an impact on the supply of silica.

WCC DEVELOPING SUSTAINABILITY REPORT

The WCC is currently developing a “Sustainability Report for the Global Coatings Industry.” The framework of the report is consistent with the United Nations Sustainable Development Goals most relevant to the coatings industry. It contains key sustainability performance indicators and sustainability case studies from the global industry. The report is anticipated to be final in mid-2022.

ESTABLISHING LEAD PAINT LEGISLATION

The WCC is a contributing member of the Lead Paint Alliance (LPA)—formerly the Global Alliance to Eliminate Lead Paint—an organization established under

The WCC is currently developing a “Sustainability Report for the Global Coatings Industry.”

the United Nations Environment Programme and the World Health Organization.

The LPA has been working to engage national governments, industry, and non-governmental organizations in establishing restrictions on lead use in paints that pose public health and environmental risks, especially to children.

The current focus of the LPA is to assist in the expansion of the number of regions or countries in restricting lead use in paint by virtue of a universal, consistent model regulation. The WCC contributes to the LPA highlighting the widespread existing restrictions on lead use in paints, encouraging the adoption of similar restrictions by governments that currently have none, and providing industry expertise on technical issues raised by reformulation challenges. Recent legislative campaigns have been conducted in Benin, Ecuador, Peru, Columbia, Mexico, Morocco, Nigeria, Congo-Brazzaville, Laos, Guyana, Malaysia, and Suriname.

CONCLUSION

For more than two decades, the WCC has worked to improve communication and coordinate policy on matters of international concern to the paint and coatings industry. As common issues facing the industry on a global level increase, the council will continue to provide a forum for exchange and cooperation on major issues and priorities, as well as serving as a global voice for the industry. For more information, visit www.worldcoatingscouncil.org. ✨

HEIDI MCAULIFFE is ACA vice president of Government Affairs.



Red Pigment Designed for Coatings Systems

DCL's QUINDO Magenta 202 228-6725 is designed to be the opaquest Pigment Red 202 for coating applications and has value in many types of coatings systems, including automotive, industrial, and powder. According to the company, its unique, large crystals provide solid blue-shade reds with the best hiding power and excellent weather and light fastness, as well as exceptional chemical resistance compared to conventional Red 202s. To learn more, visit www.pigments.com.

HEPA-FILTERED ENCLOSURES FOR PACKAGING/HANDLING POWDERS

HEMCO has introduced enclosures designed to isolate powder handling, sample weighing, high throughput screening, and other lab-automated processes. Enclosures can feature HEPA-filtered exhaust or HEPA-filtered systems to protect users or product—depending on the process. They are available in unitized or modular models and are offered in standard sizes or can be built to meet exact size and design specifications. For more informatoin, visit www.hemcocorp.com.

CONCRETE CORROSION INHIBITOR BACKUP PLAN

Cortec MCI® introduced MCI® Grenades, prepackaged water-soluble pouches of MCI®-2006 NS that can replace MCI®-2005/MCI®-2005 NS liquid admixtures if needed. The grenades are predozed to treat one cubic yard of concrete per bag (one cubic meter per Metric MCI® Grenade™). While unexpected MCI® supply and dosing equipment problems can happen, they do not have to be added to the already-stressful task of achieving a good concrete pour. To learn more, visit www.cortecmci.com.

HIGH-SPEED INTELLIGENT MIXER FOR COATINGS

Covestro Hauschild Engineering developed a series of intelligent DAC (Dual Asymmetric Centrifugal) laboratory mixers that it will display at the 2022

American Coatings Show. The Hauschild SpeedMixer® SMART DAC series offers innovations such as real-time temperature control, vacuum-robotics, sensor integration, variable counter-rotation, internet-of-things compliance, QR-code readers, remote control and automatic pot cooling systems. Many companies in the coating industry already mix with the predecessor models of Hauschild's bladeless system. Hauschild has increased the capacity of its new SMART DAC series, which now allows mixing from 250 g up to 1.5 kg and 2 kg, and offers mixing volumes from 310 ml up to 2.8 liters. Visit www.hauschild-speed-mixer.com for more information.

GRAPHENE NANOTUBE PRODUCT TO INCREASE COST EFFICIENCY

OCSiAl launched the new TUBALL™ MATRIX 822 graphene nanotube concentrate. The new product provides targeted conductivity in thermoplastics produced by injection molding at working loadings starting from 0.1 wt.% of nanotubes in the final system. This approach allows makers to optimize the painting process and reduce the final production cost. Graphene nanotube concentrate now enables in-line e-painting of plastic exterior parts together with metal components using electrophoresis, where previously, separate production lines were required. Manufacturers of polymer injection molded parts for automotive, industrial, construction, mining, and other

applications now have opportunity to reduce production costs and the number of rejected final parts without changing standard operating processes by using high-performance graphene nanotubes. To learn more, visit www.ocsial.com.

IMMERSION MILL DESIGNED FOR EFFICIENCY, PRODUCTIVITY

The Hockmeyer HCP Immersion Mill is designed for milling efficiency and productivity. In immersion milling, the feedstock is circulated through a powerful and turbulent shear zone at very high velocity. This produces very narrow particle size distributions, decreases the bead to product ratio necessary for efficient milling, and increases productivity and throughput. Hockmeyer says it has continued to improve on the original design by increasing impact points, adding flow boosters, developing a high-viscosity model, and introducing nano-milling features. For more information, visit www.hockmeyer.com.



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April



05–07 American Coatings Show and Conference

Indiana Convention Center
Indianapolis, IN
www.american-coatings-show.com

14 New ACA Sustainability Standard for Architectural Coatings ✳️

(1:00 p.m.-2:00 p.m. ET)
ACA Members-only Webinar

19 State Affairs Network Update—Illinois, Kentucky, Minnesota, and Ohio ✳️

(2:00 p.m.-3:30 p.m. ET)
ACA Members-only Webinar

21 Getting out of the Lab—Advantages of Evaluating Coatings in a Real-World Manufacturing Environment ✳️

(1:00 p.m.-2:00 p.m. ET)
ACA Members-only Webinar

May

02–05 TRFA Annual Meeting

Thermoset Resin Formulators Association
The Fairmont Dallas
Dallas, TX
www.trfa.org/2022-annual-meeting

05 FOCUS

The Detroit Society for Coatings Technology
The Inn at St. John's
Plymouth, MI
www.dsctfocus.org

09–12 RadTech UV+EB Technology Expo and Conference 2022

Hyatt Regency Orlando
Orlando, FL
www.radtech2022.com

11 What You Should Know about TSCA in 2022 ✳️

(1:00 p.m.-2:00 p.m. ET)
ACA Members-only Webinar

17–18 Windy City Coatings Course

The Chicago Society for Coatings Technology;
The Chicago Paint and Coatings Association
The Westin Chicago Northwest Hotel
Itasca, IL
www.windycitycoatings.com

23 Making 'Zero VOC' Claims: A Legal Perspective ✳️

(1:00 p.m.-2:00 p.m. ET)
ACA Members-only Webinar

June

05–08 2022 SSCT Annual Meeting and Technology Conference

Hyatt Regency Jacksonville Riverfront
Jacksonville, FL
www.southerncoatings.org

05–10 Coatings Science Short Course

Dept. of Coatings and Polymeric Materials
North Dakota State University
Fargo, ND
www.ndsu.edu/cpm/shortcourse

07–09 UTECH Middle East/Africa Foam & Polyurethane Expo

Dubai World Trade Centre
Dubai, United Arab Emirates
www.mefpu.com

13–15 Corrosion Protection by Coatings Short Course

Dept. of Coatings and Polymeric Materials
North Dakota State University
Fargo, ND
www.ndsu.edu/cpm/shortcourse

21–23 Abrafati Show—17th International Coatings Congress and International Exhibition of Coatings Industry Suppliers

São Paulo Expo
São Paulo, Brazil
www.abrafatishow.com.br

Information in this calendar was correct at the time of publication but is subject to change. Check the websites listed for the latest information and updates.

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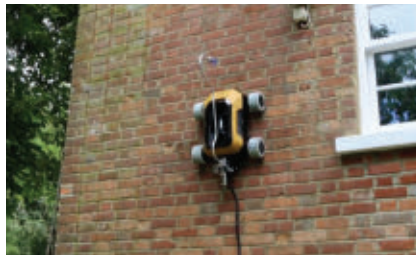
New Ways to Spray

By Victoria Scarborough, Ph.D., The ChemQuest Group

For decades, original equipment manufacturers (OEM) have used specially designed robots to paint automobiles, all types of parts, and heavy equipment in a factory environment. To accommodate customer needs, coating chemists have created multiple coating formulas and techniques for each robot and the corresponding substrate. This helps address robotic painting problems on the OEM factory floor. As software expertise has grown, so too have robotic capabilities that expand to painting outside the factory environment. Now, paint bots and drones are currently at the cutting edge of paint application technology.

In 2019, AkzoNobel held its annual Paint the Future contest, seeking new technologies to fund for collaborative development. The contest was won by Apellix LLC, a startup company in Jacksonville, FL, whose patented tethered drone technology was developed not only for painting structures, but also for measuring dry film thickness on the substrate. The technology has sophisticated algorithms that allow it to build a surface “heat map” to tell the asset owner where paint is too thin and may fail prematurely. In addition, the drone can also be used for cleaning surfaces prior to painting.

Another robotic painting tool is being developed by HausBots Ltd, in the United Kingdom. Here, the HB1 robot is



The HausBots climbing robot. Source: Hausbots.com

shown climbing rough surfaces and can overcome obstacles such as wires and bolts. The robot is used for painting and doing visual inspections of a building. It sticks to the surface using suction and can climb up to about 100 feet. In 2021, the HausBots staff was recognized by *BuildWorld* as some of the best new talent designing robotics for the built environment. In addition, HausBots has been selected to conduct a trial of its innovative wall climbing robot for the removal and prevention of graffiti on highway roads by Highways England.

Transforma Robotics Pte. Ltd. is located in Singapore and sells a line of robotic painting devices. The PictoBot is an autonomous system developed for industrial applications. It can paint large wall sections using a typical spray nozzle to apply paint to building interiors. According to Transforma, there is a 25% time savings over using two painters for the same job. It reaches

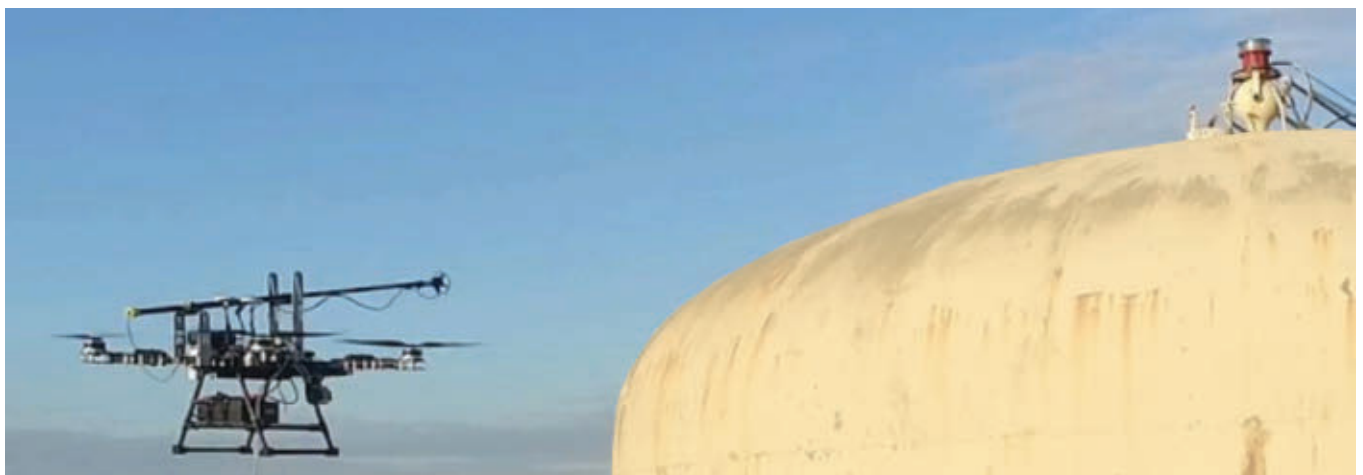
up to 30 feet inside and can easily paint high walls and ceilings using its extendable and retractable spray nozzle arm. It stores about 10 gallons of paint. Transforma also sells a line of robots for exterior use and one that uses electrostatic spray to dispense disinfectants.



The PictoBot robotic painting device. Source: Transformarobotics.com

While some of these technologies are in the early stages of development, the benefits of using drones and paint bots are evident, especially when it comes to improving worker safety. Commercial painting often involves the use of scaffolding and ladders in elevated positions that puts workers at greater risk. If painters can stay on the ground and monitor the drone’s performance, they face fewer hazards.

Drones could apply paint in enclosed spaces such as mixing tanks that usually require special breathing equipment due to exposure to hazardous fumes. In a time when skilled labor is scarce, robots can perform repetitive tasks, which allows experienced workers to focus on more complicated painting duties. Making painters more efficient at their work will reduce the overall cost of jobs and optimize the painting process. ❖



The Apellix tethered drone. Source: Apellix.com

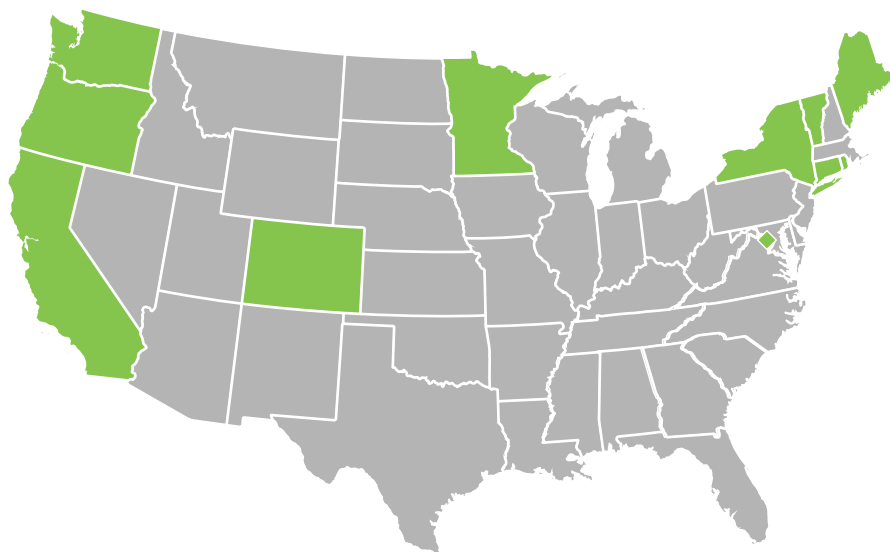
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