New Advances in Powder

The powder coatings market in 2020 is estimated to be about $12 billion and represents about 12.5% of the industrial coatings market. After a trying 2020 for both business and operations the global powder market is forecast to grow 4.5% in 2021 with the Asia Pacific region leading the way at about 6% and North America at a more modest 3.4%.[1]

Growth is expected to be fueled by recovery in the gross domestic product, a rebound in the automotive market, and increased housing starts and construction. An environmental regulatory push for lower volatile organic compounds (VOCs) will also cause a modest incentive to transition from solventborne paints to powder coatings.

Overall, 2020 was a slow year for powder coating innovations, but many development programs were in the works before the COVID-19 pandemic and are now emerging as the market landscape has stabilized somewhat.

Advances in low-temperature cure were introduced recently as well as powders capable of meeting high durability standards such as American Architectural Manufacturers Association (AAMA) 2605 and Qualicoat Class 3 (both require 10 years Florida durability).

To meet these specifications the coating must pass the following tests: dry adhesion, wet adhesion, boiling water adhesion, impact resistance, abrasion resistance, muriatic acid resistance, mortar resistance, nitric acid resistance, detergent resistance, window cleaner resistance, 4000 h humidity resistance, 4000 h salt spray resistance and 10 years South Florida durability with a maximum ΔE color change of 5.0 units and 50% gloss retention.

Coating Technology

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These architectural specifications represent the most demanding coating requirements for commercial buildings such as skyscrapers and stadiums. In addition, sustainable technologies are emerging based on either recycled plastic feedstocks or biobased raw materials. Moreover, binders exhibiting enhanced corrosion resistance and edge coverage have been recently debuted. Corresponding new developments have occurred in testing and application technology.

SUSTAINABILITY

A number of strides have been made in sustainable raw materials developed specifically for powder coatings. Defining sustainability can be elusive and concrete examples are sometimes difficult to pinpoint.

Investopedia offers this succinct definition: "Sustainability focuses on meeting the needs of the present without compromising the ability of future generations to meet their needs. The concept of sustainability is composed of three pillars: economic, environmental, and social—also known informally as profits, planet, and people."[2]

Sustainability can be represented in different ways. Renewable resources such as plant-based feedstocks are obvious, but other less obvious materials and processes can be found under the sustainability umbrella. For example, low-temperature cure products use less energy and therefore create a smaller carbon footprint.

Coatings with greater durability (corrosion resistance and UV durability) save materials, energy and labor. The following captures some of the latest sustainable developments in powder coatings.

BIOBASED AND RECYCLED

The coating resins company allnex has committed to sustainability with the development of polyester resins based on C5 and C6 sugars, which have been derived from plants.[3] This product portfolio includes carboxyl polyesters designed for hybrids (epoxy cure), HAA (hydroxy alkyl amide) and TGIC (triglycidyl isocyanurate) cure powders.

In another sustainable initiative they have developed a series of polyester resins that utilize up to 25% pre-consumer recycled PET (polyethylene terephthalate). PET is commonly used to make the popular two-liter beverage bottles. Interestingly the feedstock is *pre-consumer* waste. This significantly decreases plant-generated waste streams.

Mirroring allnex's recent developments, Sherwin Williams debuted its Powdura® ECO Hybrid Coatings line.[4] The company notes that the polyester resin used in these coatings contains 25% pre-consumer recycled plastic (rPET). On average one pound of powder coatings contains the rPET equivalent of seven to 10 single-use water bottles depending upon final product formulation.

Sherwin Williams touts these coatings as being easy to apply (better first pass transfer efficiency), having wide cure capability over a significant temperature range, and aligning with certain third-party certifications that define and measure sustainability standards, such as Leadership in Energy and Environmental Design (LEED), GreenGuard and the Business and Institutional Furniture Manufacturers Association (BIFMA), a not-for-profit organization that was formed with the purpose of creating voluntary standards that would promote safe working environments).

Battelle Memorial Institute has developed a biobased powder resin that checks two boxes of sustainability—renewable plant-based feedstocks and low-temperature cure. This polyester-amide resin boasts an 85% biobased content and is capable of cure as low as 130 °C.[5]

In addition, its aliphatic chemistry affords excellent ultraviolet (UV) resistance as evidenced in laboratory testing (less than 50% gloss loss at 4,000 h in QUV-B accelerated indoor weather testing). Prototypes have been submitted to a limited number of powder manufacturers for their evaluation with hopes for eventual commercialization.

Most powder coatings are thermoset, accounting for nearly 95% of the market. However, it is important to note that a sustainable, very high-performance polymer accounts for approximately 22% of the thermoplastic powder industry.

Polyamide 11, a member of the nylon family of polymers, is produced by the polymerization of 11-amino-undecanoic acid. The source of this organic acid is castor beans. Arkema produces this polymer and markets it under the trade name Rilsan®. PA-11 is used for a variety of products requiring high performance including dishwasher racks, auto parts, potable water pipelines, outdoor furniture, medical instruments, and commercial grade outdoor lighting.[6]


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LOW-TEMPERATURE CURE

Low-temperature cure is another subgenre of sustainable products. Reducing the energy requirements to cure coatings reduces carbon footprint and saves operating costs. Major resin companies offer products that reduce the typical powder-cure requirement of 15 to 20 minutes at 190 to 200 °C to a more energy efficient 10 to 15 minutes at 150 to 160 °C.

AkzoNobel recently introduced its Interpon Low-E (low-emissivity) collection of polyester powder coatings, which are designed to reduce the curing temperature and/or curing time without sacrificing the quality and properties of the coating.[7]

AkzoNobel's Interpon Low-E polyester powder coatings have a recommended bake temperature of between 150 and 170°C and cure in 8 to 40 minutes. By using this range, coaters can reduce their energy consumption and/or increase the productivity of their application process. This contributes to lower costs and improves its ecological footprint. Axalta debuted a similar line based on TGIC-free polyester technology called Alesta BE+ in Mexico in 2020.

IFS Coatings debuted a new product line for FBE (fusion-bonded epoxy) applications mainly for the functional markets including gas and oil pipelines and rebar (concrete reinforcement bar).[8] IFS Pureflex Fastcure is a flexible, corrosion-resistant, single coat, thermosetting FBE powder with built-in rapid reactivity, which allows coaters increased line speeds along with energy savings from lower oven temperatures. This FBE powder will gel in 2-3 seconds and cure in only 12-15 seconds, depending on the temperature of the incoming bar.

HYPER-DURABILITY

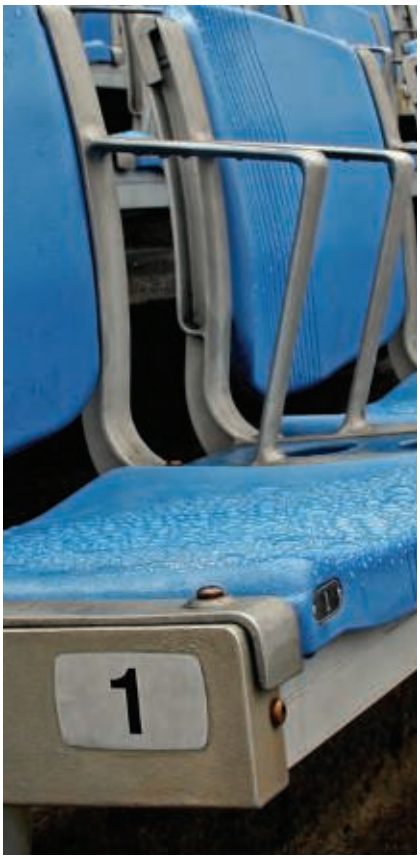
Longevity of a coating and hence the durability of the coated item is another aspect of sustainability. The need to refresh or repaint products is costly, labor intensive and can involve field applied coatings possessing high VOC content.

Furthermore, if coating failure (e.g., severe corrosion) renders an item inoperable, the cost of replacement and disposal is antithetical to environmental stewardship. The powder coating industry recognizes this and has developed technology that significantly enhances the longevity of a coated asset.

The two most common powder approaches to coating longevity are UV durability and corrosion resistance. Hyper-durable powder coating technology is well positioned to take on the high-performance architectural market for skyscrapers and other monumental building products.

The North American architectural market abides by the AAMA specifications: 2603 (one year Florida durability), 2604 (five years Florida durability) and 2605 (10-plus years Florida durability).

Powder coatings meeting the AAMA 2604 specification have existed for decades and have a sterling track record of performance in the field. These are typically based on "superdurable" polyester binders combined with high performance pigments, fillers and additives. Superdurable solid polyester resins are based on isophthalic acid and corresponding aliphatic glycols and maintain greater than 50% gloss with minimal color change after five years of exposure in south Florida.[9]



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Powder coatings meeting the more stringent AAMA 2605 requirements have recently been commercialized and are gaining momentum in the architectural market. These powders are based of fluoropolymer binders and can last up to 20 years in UV-intense environments such as south Florida.

Leaders in this arena include IFS Coatings, PPG, Axalta, ProTech and AkzoNobel. Prominent building projects have touted the use of AAMA 2605 powder coatings including the PNC Plaza in Pittsburgh (PPG Coraflon), and 55 Hudson Yards (PPG Coraflon) and 10 & 30 Hudson Yards (AkzoNobel Fluoromax) in Manhattan.

AAMA 2605 compliant powder coating technology is based on proprietary FEVE (fluoro-ethylene vinyl ether) resin technology that comes from AGC Chemicals America. These resins, dubbed Lumiflon® are hydroxyl functional fluoropolymers and typically cure with aliphatic blocked isocyanate crosslinkers commonly used in polyurethane powder coatings.

A myriad of coating colors, gloss and surface profiles can be produced with this fluoropolymer binder system including satins, gloss and textures to meet the discerning eyes of architectural design engineers.

OTHER TECHNOLOGY TRENDS IN POWDER COATINGS

Several new developments are emerging across the powder coating technology spectrum. An unexpected shift in the use of curing agents has occurred largely due to supply chain difficulties. New approaches to antimicrobial performance continue to develop as companies try to help manufacturers stay ahead of the concerns for infectious viral spread.

Novel techniques for bonding special-effect pigments to powder coatings have been identified in university research laboratories. Instrumentation techniques continue to evolve with the development of surface profile characterization innovations. Control technology for powder application equipment has advanced with more sophisticated software to fine-tune application parameters.

SHIFT IN POLYESTER CURING AGENT TECHNOLOGY

An ongoing technical trend in the industry involves a transition of crosslinkers used to cure polyester powder coatings. TGIC has been the predominate curing agent for polyester powder coatings since the 1970s.

Primid® XL-552 was introduced by Rohm & Haas in the 1980s as an alternative to TGIC. Chemically this material is a beta hydroxyl alkyl amide and hence is referred to generically as HAA. Powders using this crosslinker are also described as "TGIC-Free Polyesters."

HAA took a while to gain acceptance in the powder industry. However, a watershed moment occurred in the early 1990s when the nascent European Union identified TGIC as a potential mutagen and required new labeling for products containing it. This strict labeling requirement, including a skull-and-crossbones image, motivated European powder manufacturers to shift polyester curing systems from TGIC to HAA.

It was a different story in North America. Neither the EPA nor OSHA required such labeling, nor did the state of California. Consequently, TGIC continued to hold the lion's share of the market in the United States.

HAA-based polyester powders crept into the market mainly through multinational producers of powder coatings, oftentimes as part of their global powder coating platforms. In other cases, the improved first pass transfer efficiency observed with HAA polyesters prompted the change. In a few isolated cases it was related to food contact requirements.

Recently the pace of transition from TGIC to HAA has increased. Some of this is due to shortages of supply of TGIC, most of which is produced in China. Two TGIC production sites recently suspended production because of state inspections regarding environment compliance.

This tightened the supply of TGIC which, in turn, encouraged powder producers to make a switch to HAA-based polyester powders. PCR Group's 2019 market analysis pegged the North American share of HAA powders at a paltry 3.2% compared to TGIC's robust 43.5% share of the powder market.[10]

The current North American market share for HAA powders is now estimated to be 5.7% and climbing at the expense of TGIC polyesters. This trend is expected to continue throughout 2021.

ANTIMICROBIAL COATINGS

The COVID-19 pandemic has brought an increased focus on materials technology capable of creating hygienic surfaces. Multiple organizations have been feverishly pursuing a solution to stem the spread of the novel coronavirus.

Industrial Engineering Chemical Research Journal reports that scientists in China and from Western Ontario University have developed an improved technique to use silver ions to kill infectious microbes including the novel coronavirus.[11]

Their technique involves chemically bonding silver nanoparticles to Ag, Cu, and Zn ternary zeolites using alpha lipoic acid then encapsulated by hydrophilic polymers. They claim that this combination controls the release of silver ions and thereby significantly increases the longevity of efficacy provided by the silver ions. They offer test data that shows a 99.99% of kill rate of

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various bacteria after being wiped 1,200 times with cleaning solution.

Raising the bar even higher, Keyland Polymer has developed a special antimicrobial coating that is not only a powder coating but also can be cured within minutes at 100 to 125°C because it is based on UV cure powder technology.[12]

Unlike thermosetting powders, UV curable powder coating technology separates the melt phase from the curing phase, allowing for consistent, even film formation before the crosslinking reaction kicks in.

This technology, dubbed UVMax® Defender, provides added antimicrobial protection for Keyland Polymer's entire line of UV-cured powder coatings. These products use silver ion technology and third-party testing showed reproduction of *E. coli* and *Staphylococcus* microbes were reduced by more than 99.99% with these coatings.

UVMax Defender can be used on plastic, composite, medium density fiberboard (MDF), wood, and metal substrates and is ideal for healthcare, public transportation, hospitality, education, food service, consumer goods, or other coated products where harmful bacteria can be prevalent.

BONDED METALLIC POWDERS

Progress in Organic Coatings journal published a paper in 2020 that detailed a new technique to bond metallic particles such as aluminum flake to powder coatings.[13] The concept of bonded metallics is nothing new, but these researchers from China and Western Ontario offer a new twist.

They developed a technique using microwave energy instead of the heat generated from high-intensity mechanical mixing to fuse the metallic particles to the organic powder coating.

They claim that the microwave process gets the job done at a significantly lower temperature (<80°C) than the conventional method which can approach the Tg (transition temperature) of a powder coating binder, typically ranging from 85 to 90°C.

In addition, they purport that a higher degree of bonding occurs with their method. It will be interesting to see how these pioneers approach commercializing this type of process on a production scale.

INSTRUMENTATION AND TESTING

AkzoNobel and BYK-Gardner collaborated to address a complex issue plaguing the powder coating industry—how to quantify surface texture. This partnership spawned the development of the spectro2profiler, which concisely and consistently measures the textured surface of a powder coating.[14]

Until now, this aesthetic property could only be described qualitatively through visual inspection. The spectro2profiler can measure color, gloss, and three-dimensional topography of surface texture.

BYK-Gardner explains that the spectro2profiler uses a circumferential illumination at 45° with 0° viewing. The circumferential illumination is essential to achieve repeatable measurement results on textured surfaces.

The extra-large measurement spot with homogeneous illumination guarantees highly reliable and representative readings. This sounds like a game changer for characterizing the appearance of textured powder coatings.

Defelsko developed a new generation PosiTector Gage Body. This major innovation has a plethora of new features such as a larger 2.8-inch impact-resistant color touchscreen with redesigned

keypad for quick menu navigation which can include touchscreen keyboard for quickly renaming batches, adding notes, and more.

This new-generation product is more user friendly with a help feature in the software that explains menu items at the touch of a button and an updated, stylized user interface retains the same familiar menu structure for easy one-handed menu navigation with or without gloves.

Furthermore, durability has been upgraded with a weatherproof, dustproof, and water-resistant IP65-rated enclosure and shock-absorbing rubber holster ideal for the toughest environmental conditions including an unexpected rainstorm.

APPLICATION EQUIPMENT SOFTWARE

Powder coating equipment makers have introduced more sophisticated coating-application control software in the form of user-friendly apps. GEMA's OptiStar® 4.0 controls crucial coating parameters such as pneumatic and electrostatic parameters.

These relevant coating data can be then accessed on a mobile device with the company's Electrostatic App. Moreover, its DVC technology ensures precise and reproducible powder output and ensures consistent film thickness. Finally, GEMA's PCC and SuperCorona software improves penetration, reduces back ionization, orange peel, and picture framing.

Nordson recently introduced new application control software dubbed Encore® Engage. It features an easy-to-understand, 15-inch touchscreen with modern graphics and intuitive symbol-driven navigation.

In addition, a guided recipe feature provides step-by-step navigation with preset options to help operators confidently create new recipes. Video tutorials and guided instructions provide greater visibility to key information and give additional support for critical tasks. For operators around the world, Encore Engage® includes several screen language options and its controller interface delivers easy navigation and enables industrial internet of things (IIoT)/Industry 4.0 functionality for powder coating application.

Parker Ionics has focused on improving its exclusive Pulse-Power gun control technology. Its new GX8500A powder application system features a 3G patented Super Pulse Power corona-charging technology that provides superior first pass transfer efficiencies on all shapes and substrates.

In addition, it is fully digital with simple controls featuring 250-recipe capacity. Parker explains that the GX8500A is excellent for coating boxes, wheels, piping, MDF and extrusions and that it possesses the highest transfer efficiency in the industry, resulting in lower operating costs.

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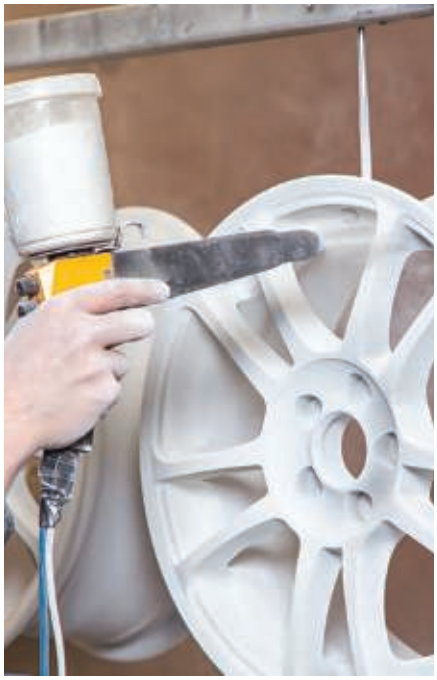

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