

Update on INORGANIC PIGMENTS

by Cynthia Challener
JCT COATINGS TECH
Contributing Writer

Producers of inorganic pigments face challenges similar to those being addressed by other sectors of the paint and coatings industry: high raw material, energy, and transportation costs; increasing environmental regulations; and growing customer demands for additional performance at lower cost. Suppliers of the many different types of inorganic pigments, extenders, and fillers have found that investing in innovation and enhanced customer relationships will be the key to success in the current climate.

The inorganic pigments market can be broken down in several different ways. The approach taken by market research firm Kusumgar, Nerlfi & Growney is to report market information based on pigment colors. The main categories are white, black, colored, anticorrosive, metallic, and pearlescent. Inorganic white pigments, which is largely represented by titanium dioxide (TiO_2), is by far the largest segment.

The global market for TiO_2 used in paints and coatings was nearly \$4.8 billion in 2004, according to Michael D. Brown, vice president of the ChemQuest Group, a management consulting firm located in Cincinnati, OH and an affiliate of TZ Minerals International of West Perth, Australia. The growth rate was an unusually high 7.7% over 2003 versus a long-term historical growth rate of 3%. The growth for 2005 should be closer to the historical rate. In North America, approximately 1.6 billion pounds of white pigments were used in paints and coatings, according to Steven Nerlfi, a consultant with Kusumgar, Nerlfi & Growney. Zinc oxide accounted for about 15 million pounds. Mr. Nerlfi puts the growth rate of white pigments in North America at around 2%. Major suppliers include DuPont, Millennium, Kerr-McGee, and Kronos.

Unpredictable changes in demand are affecting the TiO_2 market. "Producers have raised prices in an attempt to offset dramatic increases in the cost of ore and bulk shipping rates. Margins, however, remain squeezed, and demand growth is slowing in developed regions in response to the higher prices," notes Mr. Brown. Market trends for inorganic pigments are also driven by the TiO_2 supply and demand dynamics. "As TiO_2 prices continue to rise, more and more companies look to extenders to reduce that de-

mand and cut costs. Lower grade TiO_2 , extender pigments, and functional fillers become acceptable alternatives," says Tony Gichuhi, Ph.D., research and development manager, with HALOX. Paint companies are primarily focused on offsetting the rising cost of TiO_2 , adds Shaw Gilmer, business manager, Coatings, for Huber Engineered Materials, part of the J.M. Huber Corporation.

Capacity utilization is well over 90%, and TiO_2 producers face the difficult task of forecasting global demand accurately enough to properly plan new investment. "Chinese demand is especially difficult to forecast. China is a net importer of TiO_2 , particularly the high grades needed for coatings that they cannot produce domestically," Mr. Brown adds. About 60,000 tons of new capacity were added in 2004, largely through debottlenecking of existing plants. Prices are, however, closing in on the minimum for major reinvestment and should reach that point in 2005. New capacity is predominately the more efficient chloride process with the older sulfate process being moth-balled by many producers, according to Mr. Brown.

There are four main types of carbon black-based black pigments—furnace black, lamp black, channel black, and bone black, which are imported into the U.S. Together these four pigment types account for 92–93% of the approximately 30 million pounds of inorganic black pigments used in paints and coatings in North America, according to Mr. Nerlfi. He places the value of the market in 2004 at around \$33 million dollars and growing at 2% per year. Furnace black accounts for 80% of the total volume. Other black pigments include copper chromate spinel, iron titanium spinel, and synthetic iron oxide—none of which had sales of more than one million pounds. Major suppliers of furnace black include Cabot, Columbian Chemicals, and Degussa Engineered Carbon.

The North American market for pigments used to create colors other than black and white totaled approximately 115 million pounds in 2004 and was valued at about \$125 million, according to Kusumgar, Nerlfi & Growney. Yellow/orange pigments accounted for 42% of the total, followed by red pigments at 34%. Overall growth for this market is pegged at 1% per year by Mr. Nerlfi. The main compound used for the yellows/oranges and reds is synthetic iron oxide. Natural iron oxide is used for browns, and cobalt is typically used for blue pigments. Complex inorganic coloring pigments (CICPs), or mixed metal oxides, account for a small part of the coloring pigments market. Leading synthetic iron oxide suppliers include Bayer, Elementis, and Rockwood.

According to Ron Rapaport, managing director of Rockwood Pigments, deep tone colors are becoming more popular for interior architectural coatings than in

the past. Iron oxide pigments have also enjoyed strong growth in 2004, and Rockwood has been working closely with customers to develop new products that meet their needs. Rising raw material and freight costs, however, have outpaced price increases. "Paint companies are also seeing their margins squeezed. They are looking for multifunctional products that meet their stringent requirements including high dispersibility, tight color specs, and batch-to-batch consistency," adds Carlton Johnson, president of Rockwood Pigments NA, Inc.

Rockwood, along with BASF and Heubach, have introduced new yellow pigments for paints and coatings. Rockwood's Solaplex is a new class of inorganic pigments (Pigment Yellow 216) that provides unique colors in the yellow and orange color space. The company currently offers three products—Yellow, Mid Yellow and Orange. According to Michael Corcoran, vice president of coatings sales and specialties sales for Rockwood Pigments NA, Inc., the Solaplex products provide exceptional performance, excellent opacity and hiding power, and can be used in a wide range of applications. Bismuth vanadate from BASF is a yellow pigment with high brilliancy and good durability. The company has made advances in the areas of higher chroma and better chemical resistance.

Heubach's Heucodur Plus Yellow 150 nickel titanate products are manufactured through a proprietary process that enables this new product to have more opacity and gloss while being less abrasive than conventional rutile yellows. BiTan™ from Heubach are inorganic hybrid pigments based on bismuth vanadate and the new rutile yellow that provide high performance at economical cost in use ratios, according to Don McBride, COO of Heucotech Ltd., a member of the Heubach group. "BiTan can offer advantages in applications currently utilizing TiO_2 /organic blends, conventional bismuth vanadates, chromates, and cadmiums."

In the red range, Rockwood Pigments has also launched Ferroxide Orange 204M, the first iron oxide in the orange-red color space. It can be used as a single color or in combination with other pigments. "Ferroxide Orange 204M has a high chroma compared to other yellow-shade red iron oxides, so it can replace a portion of the organic pigments in selected applications," notes Mr. Rapaport.

Almost all anticorrosive pigments are inorganic in nature. In North America, the anticorrosive pigments market totaled approximately 33 million pounds and was valued at \$54–\$55 million in 2004, according to Mr. Nerlfi. Strontium chromate, barium phosphosilicates, barium borosilicates, modified phosphates, and zinc phosphate account for the majority of anticorrosive pigments. Leading suppliers include Elementis,

HALOX, Heubach, Rockwood, Sherwin-Williams, and Wayne Pigments.

Several companies have introduced new anticorrosive pigments. HuberGuard® barrier technology from Huber provides improved corrosion, chemical, and stain resistance by primarily focusing on improving the pigment/binder interface instead of the pigment morphology, according to Mr. Gilmer. HuberGuard technology is aimed at the industrial coatings market, but is also getting some attention from the architectural market for exterior paints.

Heubach's recently added Heucophos WSA products to its line of anticorrosive pigments have warranted an expanded commitment to this market segment. Heucotech, a member of the Heubach group, is expanding its technical service laboratory with additional features to be available to its customers in the Americas in early 2006.

The specialty effect pigments category includes both metallic pigments and pearlescent pigments. The North American market for metallic pigments in 2004 was valued at \$198 million based on a volume of 100 million pounds, according to Kusumgar, Nerlfi & Growney. Zinc dust accounts for about 70% of the volume, but only 12% of the dollar value. Aluminum paste, on the other hand, is much more costly, and accounts for 83% of the total dollars but only 25% of the poundage. Zinc dust suppliers include Purely Zinc and US Zinc and Gulf Reduction. Aluminum producers include Silberline, Eckart, U.S. Aluminum, and MD-Both. Pearlescent pigments are a very small volume, high value market.

In North America, in 2004, approximately 4 million pounds of pearlescent pigments sold for about \$75 million. The majority of pearlescent pigments are based on mica coated with titanium dioxide. Others include TiO₂ coated onto mica, fish-scale derived products, and silica-based products. Leading suppliers include Engelhard and EMD Chemicals.

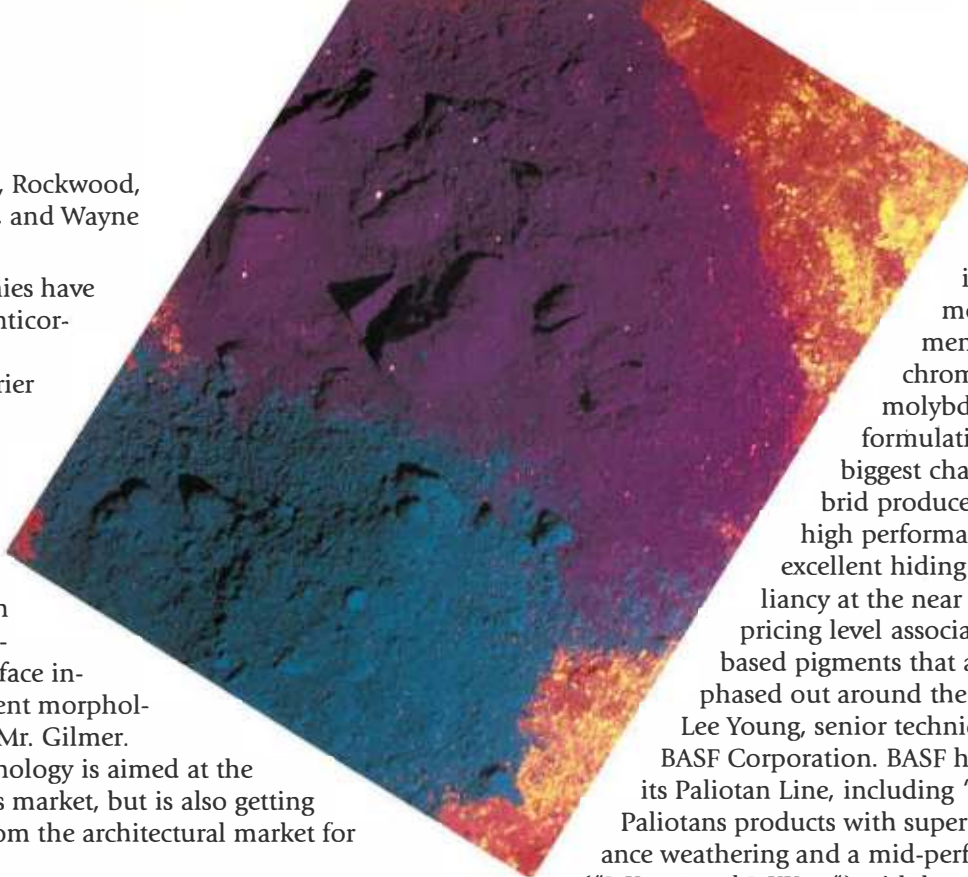
Hybrid pigments, which combine both inorganic and organic species, are also of growing interest to the paint and coatings market. While inorganic pigments offer better weathering properties, they also tend to provide lower chroma (saturation) compared to organ-

ics. Many companies are now offering hybrid pigments as replacements for lead chromate and lead molybdate-containing formulations. "The biggest challenge for hybrid producers is to bring high performance in terms of excellent hiding with high brilliancy at the near commodity pricing level associated with lead-based pigments that are being phased out around the globe," says Lee Young, senior technical director with BASF Corporation. BASF has re-launched its Paliotan Line, including "L XX45" Paliotans products with super high performance weathering and a mid-performance range ("L XX35 and L XX40") with better cost/performance ratio suitable for the industrial market.

Engelhard's Synergy™ line of color pigments resulted from combining the company's expertise in both organic and inorganic pigments to create pigments that optimize the best of each chemistry. This product line helps formulators reduce application costs while maintaining all the essential properties. Synergy pigments achieve the color spaces of bright orange, bright yellow, and bright red, offering the best-priced alternative for many heavy metal-free formulations. "We are able to give formulators a lower-priced alternative to a lead-free match, while maintaining the desired properties; or they can lower their costs significantly on many formulations based on high performance organic pigments," said Roland J. Valin, manager, sales and technical marketing of color pigments with Engelhard Corporation.

A secondary trend in the market is to develop inorganic pigments that can offer dark shades with low heat build-up, according to Mr. Young. Several suppliers are making advances in the lower Total Solar Reflectance (TSR) market. BASF has developed a tool that will predict the TSR based on pigment mixtures. "This tool will give formulators the opportunity to test colors on the computer before going to the lab for experiments, and works for multiple pigments in varying formulations with different film thickness, pigment loading, and substrate interaction," explains Mr. Young.

Engelhard has responded to the U.S. Government's Energy Star program, which challenges manufacturers of roof coatings and siding to offer products with high



infrared (IR) reflectance. "The biggest challenge is the development of new pigments in the black and brown color spaces. Because blacks and browns have the lowest IR reflectance, the challenge for R&D is to develop these color spaces with higher IR reflectance than ever before," notes Mr. Valin. He adds that the Energy Star program has provided opportunities for roofing applications either in the coil coatings or the applied roof coatings market, and could offer more opportunities in the siding market as well.

Research efforts at Engelhard have focused on the development of higher IR reflecting pigments as well as stronger, cleaner pigments in more color spaces. Recently, the company launched several new Meteor Plus® black and brown pigments for the paint and coatings market that have excellent IR reflectance properties and increased tint strength for camouflage and Energy Star applications.

Developing technology to assist paint and coatings formulators in meeting increasingly strict limits on volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and toxic chemicals such as lead and tin has also been a major focus of suppliers of all types of inorganic pigments. "As producers of inorganic pigments, we see a shift toward environmentally friendly pigments, a growing demand for lower cost alternatives to heavy metal-based products, and a rising interest in organic-based products that can maintain the same performance. In addition, more customers are inquiring about synergy of products to meet the performance standards set by environmentally toxic products," says HALOX's Dr. Gichuhi. "Stricter environmental regulations are forcing customers to re-evaluate their paints and reformulate with heavy metal-free products such as the newly developed multifunctional HALOX 430 anticorrosive pigment."

Other recent developments have centered around nanotechnology. Nanoparticles are being investigated for UV absorbance, scratch-

resistant coatings, functional fillers, nanofiller pigments, and hybrid corrosion inhibitors. Nano titanium dioxide and nano zinc oxide are two examples.

"Overall, research and development efforts related to inorganic pigments have focused on achieving high transparency, high opacity, ease of dispersion, increased toughness, ability to formulate corrosion resistant high gloss paints, lightweight coatings, improved thermal stability, and flame retardancy," says Dr. Gichuhi.



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Working closely with customers and maintaining an awareness of their future needs will be critical for suppliers of inorganic pigments to the paint and coatings market. "Global positioning, commitment to quality, and efficient manufacturing are strategic components for meeting the demands of our customers in today's tough business climate," stresses Mr. McBride.

Rockwood is also very customer-focused. "Delivering the products and services required by our customers, gaining proper value for our products in the market place, and making investments in our plants to have the ability to meet the growth in our customers' key product lines are the underpinnings of our approach," notes Mr. Johnson.

Innovation also lies at the heart of most company strategies. "The main focus of today is to provide new inorganic pigments with equal or superior quality and value to our customers," says Mr. McBride. "Heubach prefers to meet or exceed this challenge with innovation." According to Dr. Gichuhi, customers are willing to buy expensive additives that provide an added benefit and that can reduce the overall cost of their paint formulations, without sacrificing long-term performance. "We plan to continue offering newer, cost-effective, and environmentally friendly additives to meet customer demands. In order to do so, we must stay innovative and create products to meet future needs," he adds.

INORGANIC EXTENDERS AND FILLERS

Inorganic extenders and fillers, although they do not typically provide color, can impact other properties of paints and coatings such as rheology, permeability, and flattening. "The main reasons for using extenders and fillers in paints and coatings are to reduce cost and provide functional benefits such as improving barrier properties, reducing settling, preventing floating and flooding of pigments, extension of TiO_2 and color pigments, and control of gloss and sheen," adds Craig Stoneback, business director, Performance Additives, Engelhard Corporation.

Providers of extenders and fillers are focusing on providing lower cost materials that provide performance benefits for the final paint and coating formulation. "Environmental pressures on VOCs will continue to push the industry to enable higher solids and lower solvent usage, which increases the demand for added functionality in extenders and fillers," says Shaw Gilmer, business manager for coatings with Huber Engineered Materials, part of the J.M. Huber Corporation. Although the requirements for extenders and fillers differ across the globe, paint and coatings producers worldwide expect improved performance at lower cost, according to Mr. Stoneback.

The overall trend is development of lower cost alternatives that provide equal or better performance than those currently on the market. According to Mr. Gilmer, this trend can be viewed as a negative one in lower performance paints, but may provide opportunity for higher performance, higher priced systems. "As manufacturers of higher performance systems look for ways to reduce costs, producers of extenders and fillers should step up to meet this challenge," he notes. Paint companies are also looking for substitutes for TiO_2 and resin as the costs of these materials continue to climb. This situation also provides an opportunity for producers of functional extenders and fillers, according to Mr. Stoneback.

Both Huber and Engelhard are developing new extenders and fillers designed to take advantage of these opportunities. Huber's HuberGuard technology will be the platform for the company to build on for high performance systems, according to Mr. Gilmer. The company also markets kaolin clay, silica, alumina trihydrate, and barium sulfate for a wide variety of applications. Engelhard has developed engineered kaolins that provide high gloss in low VOC coatings that also have the capability of extending TiO_2 . ASP® G90 and ASP® G92 are ultrafine engineered hydrous kaolins that provide very high gloss for water and solventborne coatings. Newly engineered calcined kaolin grades, such as Engelhard Mattex® and Mattex MX®, are being developed to provide a balance between high opacity and low sheen for better touch-up properties. Other grades have been developed with high aspect ratio and platy morphology to provide improved barrier properties, washability, and stain resistance. **CT**



Industrial coatings require improved barrier technology. New pigments and improved pigment-binder interface within the formulation are at the forefront of Huber's inorganic development. Photo courtesy of Huber Engineered Materials.