

Dynamic Plastics Market Presents Challenges and Opportunities for Coatings Formulators and Their Suppliers

by Cynthia Challenger
JCT COATINGS TECH
Contributing Writer



Plastics are ubiquitous. From the time we rise in the morning until we turn off the lights at night, we come in contact with plastics. The floors we walk on, the bottles that hold our shampoo and lotion, the cars we drive, our office equipment, our cell phones, our refrigerators and ovens, and many more items we use every day are made of plastics. Much of these plastics are coated in order to provide a protective barrier, particular functionality, or specialized appearance to the plastic surface. Coatings formulators can not help but be attracted to this large and growing market. As with most applications, obstacles must be overcome before opportunities can be realized.

The automotive market is the largest consumer of coatings for plastics, with applications for both interior and exterior parts accounting for just under 50% of total sales, according to The ChemQuest Group, Inc. Resilient flooring is the second largest end user of coated plastics and accounts for about 20% of sales. Other applications include stamping foils, plastic signs and sheeting, office equipment, sporting goods, consumer electronics and appliances, and eyewear.

Coatings on plastic substrates serve several purposes. In many cases their function is to impart a desired appearance to the plastic part or container. They can also produce a softer touch or more leather-like feel that often is perceived as higher value and is often preferred by consumers. For plastics with exterior applications, coatings can increase the weatherability and scratch, mar, and abrasion resistance. For interior applications, the chemical resistance of plastic materials can also be significantly enhanced with the use of the appropriate coating. Coatings can also act as a barrier, preventing plasticizer migration. Coatings can even make it possible to use less expensive plastics yet achieve the desired performance, at an overall lower cost.

The desired properties of coatings for plastics depend on the end-use application of the plastic part or container. Coatings on exterior use plastics will need to be durable and have good mechanical stability, with excellent

elasticity and flexibility to respond to changes in temperature. Good chemical, mar, scratch, and abrasion resistance is desirable for many different coatings for plastics. Gloss levels and soft touch characteristics will vary according to the specific use of the plastic substrate. For all, good adhesion is crucial.

These properties are achieved through the use of a wide variety of resins and additives. As environmental regulations become increasingly restrictive regarding the allowable levels of Volatile Organic Compounds (VOCs) and Hazardous Air Pollutants (HAPs), resin producers continue to shift technologies to more water-based, high solids solvent-based, and energy cured 100% solids technologies. Growing most quickly are waterborne acrylics, epoxies, urethanes, and urethane-acrylics, although solventborne acrylics, epoxies, and one- and two-component urethanes are still widely used. Radiation-cured coatings find their greatest use in the vinyl flooring segment of the plastics market. Chlorinated polyolefins are often the basis of adhesion promoting primer coatings for thermoplastic polyolefin (TPO) plastics, which are finding increasing use in automotive interior applications. Polycarbonate is often the resin of choice for automotive headlamps and as an alloy in instrument panels.

The most important additive type for coatings used on plastics is the adhesion promoter, which aids in bonding of the coating to the plastic surface. Other additives include pigments, dispersants, UV absorbers, light stabilizers, biocides, fillers, rheology modifiers, and flow/leveling and slip agents.

RESPONSE TO ENVIRONMENTAL REGULATIONS

As with most other sectors of the coatings industry, the plastics segment must address the trend toward increasing regulation of VOCs and HAPs. As mentioned earlier, many coatings companies have responded with the development of waterborne, high solids, or 100% solids UV curable formulations. Resins and additive suppliers have also responded in kind, working to develop binders, adhesion promoters, biocides, and other important ingredients in water-based or low-VOC versions. "The loss of solvents as a tool to help coatings 'bite' into plastics creates formulating challenges that resin and additive suppliers will need to address," says Charles Cameron, industry manager, Transportation, for Cliba Specialty Chemicals' Coatings Business. Maintaining or improving the level of performance of

these new products without increasing the cost to the customer is a key issue.

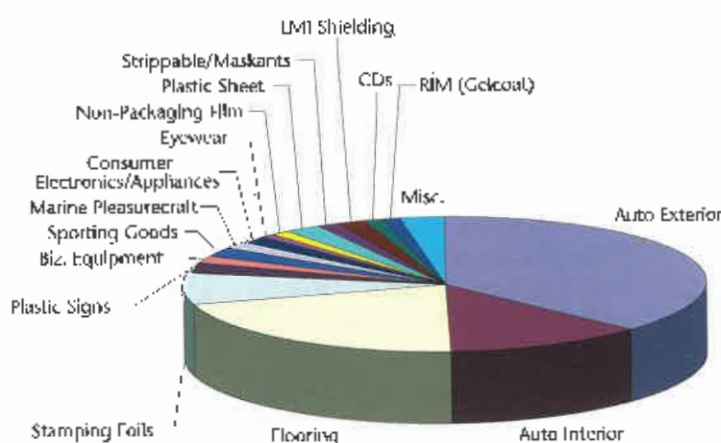
One example of a high solids formulation comes from Red Spot Paint and Varnish. 499S High Solids Adhesion Promoter/Primer for TPO and PP has about twice the solids both by weight and by volume as compared to conventional adhesion promoting primers. It is a one-component, high solids exterior universal primer that requires lower energy to cure than typical TPO primers. It is ideal for fascias, grilles, mirror housings, rub strips, and other miscellaneous trim pieces. "This coating is not only a more cost effective solution, it also reduces booth maintenance, which is a valuable added benefit," notes Red Spot's president and CEO Charles D. Storms.

New resin technology for plastics coatings includes waterborne acrylics and urethanes with improved adhesion and chemical resistance, waterborne UV resins, and self-crosslinking resins that provide enhanced chemical resistance in one-component systems, according to Gail Pollano, coatings market manager with DSM NeoResins. She also notes that waterborne isocyanates now allow for two-component acrylics and urethanes with very good resistances as well. "Plastic usage is growing, and the use of water-based resin technology will increase along with it because of its environmentally friendly nature," she says. "The key will be the continued improvement of the appearance and performance of these types of products. We have made a lot of progress to date and expect much more to come in the future," Pollano adds.

Cytec is also focused on developing greener technologies which help meet or exceed the demands for higher performance, lower total systems costs, and compliance with state and federal regulations for low-VOC and HAPs-free emissions, according to Jeff Rodrigues, market manager for RADCURE™ Industrial Coatings. "Continuous innovation in resin and additive technologies, coupled with worldwide manufacturing and technical support, can help formulators develop the robust coatings being called for in today's global plastics marketplace," he notes.

Ambient-cured and energy-cured coatings with improved scratch and abrasion resistance and UV-curable waterborne primers which promote better adhesion to plastics are examples of recent innovations at Cytec. RAYLOCK® 2221 UV-curable resin adheres directly to a variety of untreated plastics without the need for any surface pretreatments. It offers superior adhesion, high gloss, good cure response, and is ideal for automotive plastics and difficult-to-adhere-to plastic substrates, according to Rodrigues. UV/EB-cured products containing EBECRYL® 1290 UV-curable acrylate are characterized by excellent scratch and abrasion resistance, high gloss, high surface hardness, chemical resistance, and non-

North American Plastic Coatings—2001 \$934 MM/yr



yellowing. This resin is recommended for clear and pigmented coatings for rigid plastics.

At the European Coatings Show, May 8–10, Ciba launched new forms of several of its commercial ultraviolet light absorbers and hindered amine light stabilizers that are designed for easy incorporation into water borne coatings. At the show, the company will also introduced a new transparent high performance pigment that will fill a unique and exciting color space, according to Cameron.

The European Coatings Show will also be the forum where Eastman Chemical Company will showcase its new Advantis 510W waterborne, VOC-free, chlorine-free, and APEO-free (alkylphenol ethoxylates) high performing adhesion promoter for use in water-based formulations. Primarily for external applications, this product exhibits its strongest performance in hot spray resistance. "The shift to aqueous formulations has provided an opportunity for Eastman to bring its expertise to bear on a critical problem and provide solutions for our customers," says Jon Lawniczak, Americas market development manager for Eastman Transportation Coatings.

International Specialty Products (ISP) has focused on developing industrial biocides that do not negatively impact the environment, are safe to use, and are cost-competitive with existing products. The latest products from the company include Tungitol® 920 mildewcide (active, IPBC) and Nuosept® 498 bactericide (active, BIT). Both water-based products are designed to minimize impact on the environment during manufacture, during application, and after application.

The development of formulations that protect the environment is just the first step. "In the near term,

product reformulation will be focused on reduction of VOCs. In the long term, product formulations will go beyond this first step; they will be optimized using ingredients that both minimize toxicity and maximize safe handling in addition," asserts ISP's Industrial Biocides business development manager, Dr. William B. Woods.

In addition to driving the growth of water-based formulations, environmental regulations and general concerns are leading to a growing interest in radiation-cured technology, particularly for temperature-sensitive thermoset plastics. "Plastic part manufacturers in growing numbers choose UV-cured coatings to achieve very fast cured, scratch-resistant, tough finishes without the deformation that can accompany thermal curing," notes Cameron. Radiation curing also requires a much smaller footprint and consumes less energy than thermal curing processes.

One focus area of R&D efforts in this field has been to increase the flexibility of coatings designed specifically for plastic substrates. "Typically, radiation-cured coatings are very rigid, which can be a positive characteristic in many applications, but with plastics is not so desirable," explains Dr. Rose Rynitz, executive director, Materials Engineering and Processing, with Collins and Aikman Corporation, a leading supplier of automotive instrument panels, plastic-based trim, and convertible top systems. She is also the current president of the Federation of Societies for Coatings Technology (FSCCT).

Radiation-cured coatings for plastics have been an area of focus for PPC. "We are in the process of introducing higher scratch- and abrasion-resistant coatings for the consumer products market," explains Petra J'Abbe, global market manager for Industrial Coatings with PPC Industries and also president of RadTech. These UV-curable pigmented, and clear coatings are designed for the outside plastic coverings of televisions, cell phones, computers, etc. The company plans to launch these products in the second quarter of 2007.

UV-curable technology has been a core market for Red Spot for many years and accounts for roughly 20% of the company's annual sales revenue. Red Spot has long been a global supplier of UV-curable, scratch-resistant clearcoats for automotive head lamps and tail lamps and is rapidly expanding its offerings outside of the automotive sector. According to Storms, the company invests heavily in UV curable R&D and operates a state of the art UV applications laboratory at its world headquarters in Evansville, IN. He believes that the use of UV-curable technologies will expand dramatically as the plastics market further matures and companies

continue to seek new and innovative solutions to coatings needs with an eye on being highly efficient while minimizing the potential impact on the environment.

The way coatings impact the environment—and, in particular, the way volatiles are being measured—is currently under investigation and may result in the ability of formulators to return to solvent-based technology. The American Solvents Council is studying the reactivity of solvents with the atmosphere and has developed a new indicator—maximum incremental reactivity (MIR)—that gives an indication of the impact a particular solvent will have. The work has generated interest from California's South Coast Air Quality Management District (SCAQMD). "Using this measurement tool, different combinations of solvents can be used that could essentially replace waterborne coatings, but at a lower cost," notes Ryntz.

Environmental issues go beyond the ingredients used in formulating the coatings and the processes to produce them. The ability to recycle plastics will be a significant issue in the future. The "End of Life" (EL) recycling mandate affects all aspects of the automobile, and painted plastics are no exception. "We must be able to ensure that the whole plastic part, including the paint on the part, can be recycled in an environmentally safe way," states Pollano.

MANAGING THE CHANGING PLASTICS MARKET

While the plastics market is growing overall, there are varying trends and issues within different end-use sectors that pose challenges to producers of coatings for plastic products and their suppliers. A general trend that affects all segments of the industry relates to the rate at which plastic producers introduce new formulations.

"One of the key issues for the coatings supplier is keeping up with the plethora of new plastics being brought to market," notes L'Abbe. First, plastics of the same type can have different surface characteristics due to differences in formulations from various suppliers, according to Jawniczak. Second, plastics suppliers are constantly changing formulations. "Trying to stay out in front of these changes can be quite a challenge. Of course, it also offers a tremendous opportunity for coatings manufacturers that have the capability of developing coatings in a timely fashion that not only adhere to these new materials but also provide other desired performance characteristics," L'Abbe adds.

Along these lines, the growing use of more engineered plastics, typically thermosets containing various fillers, as replacements for metal-based structural parts is posing a challenge for coatings formulators. L'Abbe also predicts that the use of combinations of materials such as plastics and metals will be increasing in the future. Coatings will need to work equally well on all materials, providing the same look, feel, and performance on any substances used to create the part.

MANAGING THE DYNAMICS OF THE AUTO INDUSTRY

The dynamics of the automotive market also significantly influence the activities of coatings manufacturers. Some of these changes are occurring on the macro scale, while others are happening on a much smaller level.

Major trends in the automotive industry include the declining production levels of the big three U.S. auto makers. Transplant operations, particularly those of Toyota, Honda, and Hyundai will provide the most likely source of growth in plastic consumption in this sector, according to Ralph J. Wagner, director of marketing for NB Coatings. He also notes that at the moment there seems to be a decline in the use of decorative plastics on the exterior of cars, with chrome becoming a popular style choice today.

Coated plastics also face competition from alternative technologies such as mold-in-color and film laminations for interior uses. Mold-in-color parts have their own durability issues, however, and as a result Dr. Ryntz has noticed a shift again back to coatings, but with an emphasis placed on reducing the cost of the coating itself and the application process as well. At the same time, though, the relative cost of plastics compared to alternative materials is becoming increasingly higher, according to The ChemQuest Group.

Consequently, the consumption of plastics in auto interiors may be reaching a saturation point.

"Combined, these factors indicate that the overall use of plastics in the automotive sector will experience low growth or possibly even decline slightly," comments Dan Murad, president and CEO of The ChemQuest Group. He notes that while car weight has slightly increased in recent years, the plastics usage per vehicle has been flat. One positive note is that with higher energy prices, more emphasis may be placed on





Red Spot's UV Rotational Flowcoater.

achieving further weight reductions, a shift that could lead to more plastics being used.

Related to the constantly changing variety of plastics being supplied for the automotive industry is the substitution of certain types of traditionally used plastics with other lower-cost formulations. In exterior applications, high density plastics are being replaced with lower density plastics and thick-wall parts with thin-wall parts, according to Murad.

Interior automotive plastic parts are also changing composition. Hard trim is increasingly being made from polypropylene (PP) and thermoplastic polyolefin plastics (TPOs) instead of ABS. TPO is also replacing vinyl and thermoplastic elastomers (TPEs) in IP (instrument panel) skin and air bag covers. Instrument panels are increasingly produced from polycarbonate alloys that are prone to stress cracking. "Coating formulators have had to respond by replacing 'strong' solvents with milder ones, or even moving to waterborne technology as a result," says Ryntz.

There are also issues in the automotive sector not related to the plastics substrates, but to the industry structure. "The OEMs and Tier 1 suppliers are very effective at developing specifications and requirements that force coatings manufacturers to meet the lowest possible price," states Wagner. These specifications to some extent create a barrier to entry in the market, and once a coating supplier penetrates that barrier, the competition is fierce.

The supplier network for the automotive industry is also very extensive, with each supplier having different requirements. The landscape changes regularly, too, with companies entering and departing the network on a regular basis. "Meeting the needs of such a diverse and constantly evolving set of customers is a very big challenge," Wagner adds.

Regional changes come into play as well. In North America, coatings for plastics have historically been cured at higher bake temperatures than in most other parts of the world (100°C vs. 80°C). As globalization becomes a critical component of successful manufacturing operations, the drive to have consistent coating operations is leading many plastic coaters to seek paint formulations that can be cured at lower bake system temperatures.

"Coatings producers that supply this region have implemented active R&D programs to develop new paints that can cure at a lower temperature, yet still perform as desired," says Storms. Red Spot has developed 197S Conductive low bake adhesion promoter for TPO and PP

exterior trim parts. "The baking temperature for this product is 80°C. The lower temperature meets with global specifications, saves energy, and also eliminates the ramping up and down of oven temperature as different types of coatings are used," he comments.

Smaller level trends within the automotive sector can have just as big an impact on coatings suppliers as macro changes do. As with many other industries, reducing costs and increasing efficiency have become a focus of part suppliers and OEM manufacturers. Reducing and consolidating steps in the painting process is one means of improving efficiencies and lowering costs, according to Storms.

For many plastic substrates, an adhesion promoting primer coat is necessary to provide a surface on which the basecoat can adhere to. Often these primer layers are solvent-based formulations. Much effort these days is directed at developing basecoats that can adhere directly to the plastic surface, with the goal of reducing the cost of an additional layer, reducing environmental issues, and improving the efficiency of the coating process.

Eliminating the primer layer does cause one difficulty. The primer typically contains electrically conductive carbon black particles that dramatically improve the transfer efficiency for the basecoat application process. Without the primer layer, the transfer efficiency can be significantly lower, particularly for larger parts, resulting in greater product waste, the direct opposite of what is wanted. "The challenge for coatings formulators and their suppliers is to develop basecoats that have good adhesion to various plastics and provide high transfer efficiencies as well, while continuing to provide all of the desired performance characteristics demanded of a primer/basecoat system," states Lawniczak.

Suppliers of primer coatings like PPG, which is recognized for its ability to provide coatings for difficult substrates, will be affected by this trend to eliminate the primer layer. "We expect that for some of the newer grades of plastics designed for increased physical properties or lower cost, primers will remain a necessary step in the plastic coating process," notes L'Abbe.

"Beyond that, we look at the changing expectations of our customers as an opportunity to develop new basecoats that provide the adhesion and other properties they need." Primers are also challenged by alternative technologies for improving adhesion such as flame, corona, and plasma treatments.

Red Spot recently introduced 530S 1K Direct to TPO basecoat for exterior trim parts that is designed to be used without an adhesion promoting primer. It performs best when used with the company's 379S two-component urethane clearcoat. The coating not only eliminates the need for the primer layer, but also is baked at a low temperature (80°C), according to Storms.

For interior automotive applications, car companies are placing pressure on paint manufacturers to improve several properties of their coatings. The chemical resistance of paint formulations for interior plastic parts must be excellent against hair cream, beef tallow, and the ingredients in sunscreens and insect repellants. The growing use of metallic pigments in interior automotive coatings presents a challenge in this respect, because the metallic flakes are sensitive to alkali and are thus not as stable in waterborne formulations.

Odor in automotive interiors has recently developed as another issue for coatings producers. "New mandates for reduced odors from coatings on plastic parts designed for interior applications is leading coatings formulators to look at different additive and resin technologies," Ryntz states.

There is also demand for softer touch, lower gloss coatings (gloss < 2) that imitate the look and feel of leather yet retain ultra-good mar and scratch resistance. This has resulted in much work with flattening agents, which are needed to reduce the gloss but also typically reduce the mar and scratch resistance at the same time.

In addition, color harmony of parts from different suppliers with each other and with the body of the car has become an issue for both interior and exterior automotive applications. "The very large number of suppliers to the industry must be able to provide different parts that, when put together in or on the car, match in appearance seamlessly." Eastman is introducing Solus 2100 performance additive for clearcoats that provides a much smoother film, gives less sag, and dries more rapidly than traditional formulations. "With regard to color harmony, Solus 2100 helps improve coating per-

formance by making the metallic flakes more consistent," explains Lawniczak.

Color has in fact become a critical issue in many industrial applications. Coatings producers recognize the role that appearance can play in many products with painted plastic and other kinds of parts. PPG, for example, has responded with the development of its TrendCast® color styling tools and services. "We work with both OEMs and design firms, introducing new colors, textures, materials, and application technologies—basically addressing all aspects of the finish—to help them achieve the perfect appearance for their individual applications," says L'Abbe.

In automotive exterior applications, the use of materials such as sheet molding compound (SMC) for hoods, fenders, rear decks, and other parts is increasing because of the lowering tooling costs. These materials are expected to be painted just like metal in the assembly plant environment, according to Storms. "SMC absorbs water upon standing. This hygroscopic nature poses a problem, particularly for powder coatings, where bubbles appear as absorbed water evaporates during the curing process." Red Spot recently introduced a liquid primer that seals in the absorbed water and makes these plastic parts acceptable for powder coatings.

Reducing sag has become a major goal for exterior auto finishes. Clearcoats today tend to have more orange peel rather than sag. Paint manufacturers are working on technology that will reduce the orange peel while enabling the coating to flow and move smoothly with less sag.

Durability of exterior automotive coatings for plastic parts continues to be a focus issue for coatings producers. Ciba Specialty Chemicals has developed new additives to help formulators improve performance in this area. The hydroxy-functional Ciba TINUVIN® 400 UV Absorber and TINUVIN 152 HALS (hindered light amine stabilizer) provide state-of-the-art durability, because the additives crosslink into the clear topcoat instead of migrating into the semi-porous TPO plastic substrate during baking and weathering, according to Cameron.

Forward lighting on automobiles presents its own issues for paint manufacturers. "The geometry and position of headlights on cars have undergone significant change in the last few years," Storms notes. "Where





Ciba's Trendcast Styling Directions 2.

lights used to be exposed to the sun at a 45 degree angle, now they are exposed at a 90 degree angle. As a result, headlight covers tend to yellow." UV-curable clearcoats are now being introduced that have improved weathering properties that should address this issue. Later this year, Red Spot will be introducing its next generation UV-curable scratch resistant coating for the forward lighting market. The coating is expected to more than double the useful life of head lamp and tail lamp lenses.

MANAGING RELATIONSHIPS

The challenges and opportunities in the plastics market have led to the realization that strong relationships and communication are critical for commercial success. "The challenges inherent in the new end-use products require good coordination between the plastic fabrica-

tor, coatings suppliers, and resin suppliers to deliver a successful solution," asserts Bud Equi, market manager, Liquid Coating Resins, for Cytec. "Before we can decide on what chemical route to pursue—air-dry or energy-cure, PUD, acrylic or hybrid—we need to clearly understand the end-users' needs and the composition of the plastic."

Eastman's Lawniczak goes even further and includes plastics producers as well. "For technology development to be meaningful, it is very important that OEM, auto parts suppliers, paint manufacturers, and plastics formulators all be aware of what each group is doing. A new coating won't be of any value if it is developed for a plastic formulation that has been changed and no longer exists. All of these segments of the industry must work together so that the best paint formulation can be matched with the best plastic type and the most appropriate application."

His company has taken this philosophy to heart with the construction of a new state-of-the-art paint spray facility at Eastman's headquarters in Kingsport, TN. The facility will enable the company to take a holistic approach to determining the effect of specific additives on all aspects of a coating's performance. "With this multi-million dollar facility we are demonstrating our commitment to emulate the automotive OEM and supplier production environment so that we can much better understand the needs and performance preferences of our customers," Lawniczak says.

Coatings for plastics present many opportunities and challenges, and the road to success appears to be best navigated with innovation and collaboration. [G7](#)