smoother film approaching that of liquid paints.

At this time of the year when there is a dearth of technical papers and articles dealing with new advances in powder coatings technology, it is interesting to consider some other aspects of the industry and, in particular, the problems that can arise in end-use applications. The case history detailing a problem that arose in the coating of metallic components at a US applicator illustrates the importance of maintaining records of all aspects of production, including changes in metal suppliers, daily checks on cleaning processes, assessing oven performance and the actual metal temperatures and powder curing times on different metal gauges. While this end-user eventually resolved the problem with the aid of his suppliers, he may have avoided this costly and time consuming investigation by carrying out some simple tests in his own facility. It cannot be assumed that all new items added to the production schedule will conform to a standard set of cleaning, coating, and curing operations. While in most cases he will encounter no obvious departures from the usual performance associated with his approved powder coatings, he should confirm this at the time he first introduces a new high volume product to his already heavily committed production schedules. I have lost track of the countless times I have been involved in detective work at end users when time has obscured most of the clues. One thing I have learned is that it seldom is the fault of the powder coating!

There may be a shortage of technical papers but market surveys are at a premium when trade is slack. According to the forecasters, there is still a tremendous potential for growth, even in the most mature of powder coating applications. In the Markets section, the abstracted article taken from Coatings World reviews a survey from Freedonia and complements this with comments from respected persons associated with the major global powder producers. The article confirms the belief that most major producers have in the growth potential for powder coatings, and their actions in this field during the past two lean years, substantiate that belief.

Sid Harris

TECHNICAL

Colour metallics in powder coatings

Metallic pigment flakes can cause problems in powder coatings for a number of reasons, including their poor electrical charging characteristics. A recent article explains the fundamental differences between the way metallic pigments perform in solvent borne systems and powder coatings. The article discusses particle size, resin mixing, surface orientation, and other aspects that a formulator needs to know when working with metallic flake pigments in powder coatings. It then explains a new formulating technique that overcomes the obstacles to the successful formulation of powder coating systems with metallic flakes.

The initial approach was focused on determining the rheology and curing mechanism of metallics in conventional solvent borne systems, compared with powder coating systems. They then sought to modify metallic flake pigments so that they would behave in powder coatings just as they do in liquid solvent borne systems. This development effort resulted in commercial aluminium flake pigments that offer a number of benefits to powder coating formulators who prefer to use coloured and non-coloured metallics. These pigments are based on a silica coated aluminium flake encapsulated with either an organic layer or an inorganic layer. The flake is then grafted with suitable organic functionalities enabling it to be easily linked to the particular resin in a powder coating system. Thus, it renders aluminium flakes to achieve a similar environment as those of the resins, which has a direct effect in acquiring similar electrical transfer properties to that of the resin system during application by electrostatic spray equipment.

When producing powder coatings, the formulator mixes or disperses pigment, additives, and resin into a variety of powder coating systems. The final intermixing of pigment and resin occurs during the melt and film forming curing stage. Mixing difficulties can be eliminated with good powder blending equipment. While spraying the powder, however, it is important that the resin powder and the pigment particles flow evenly to coat the substrate, which is vital to ensuring colour stability. This problem is less severe with organic pigments than with metallic pigments, especially aluminium. Any colour inconsistency with organic pigments is probably less significant due to the nature of the pigment particles. Organic pigments are small in particle size and spherical in shape, while metallic pigments are larger and have platelet structure. It is particularly important that the metallic flake particles align on the substrate, as they do with liquid solvent borne systems, for maximum optical properties.

Other methods used for blending metallic flakes into powder coatings include: dry blending of the metallic flake that results in a physical mixture of particles with very different material characteristics. This method produces colour differences because of difficulties with pigment agglomeration, poor electrical charging qualities, and particle size. Extrusion of all components is another technique but the primary difficulty is that shear forces during extrusion will mechanically break down the metallic flake resulting in dark and dull colours. Bonding was introduced in the 1990s, and this process mixes pigments and resin at a temperature that enables the metallic flake particles to adhere to the powder resin particles. The metallic flake is bonded to the powder coating, and the particles will possess more uniform characteristics. This process improves electrostatic and air flow behaviour because the pigment adheres sufficiently to avoid separation during application. The process is normally factored to companies specializing in bonding and can be a costly procedure with the additional problem of delayed production.

The novel technology described in this article involves grafting functional link moieties by chemical means to the outer core of the silica or resin encapsulated pigment molecules so that they can react with the resin molecules of the powder coating system. Functional linking groups are selected for their capability to react or combine with the resin systems. Functional linkages completely participate with the resin in the crosslinking process during curing to form a tight, integrated network of cured film. The technology focuses on the appropriate chemical link for a specific powder coating resin system. The chemical linking groups could involve amine, isocyanate, carboxylic acid, or hydroxyl radicals and, depending upon the resin used in a powder coating formulation, the functionalities of the coated flakes could be designed accordingly.

This technology elevates the conventional method of silica coated or resin encapsulated metallic flakes to a level of higher compatibility because it focuses on enhancing the pigment–resin relationship. The objective of the process is to improve optical properties, better film integrity, and increased colour stability. It is anticipated that this technology could be broadened to enhance the performance of mica, iron oxides, and titanium dioxide used in powder coating systems.

The recently introduced line of organo functionalized silica and resin coated products includes a variety of coloured and silver aluminium flakes. These coloured and silver aluminium flakes are coated with either silica or proprietary resins, or their combinations to meet the requirements of specific powder coating applications.

The line of products is suitable for use in a range of conventional resins that includes, epoxy, TGIC, polyester, polyurethane and acrylics. Products in the line are available in medium to fine non-leafing aluminium grades. Particle sizes range from 15 to 60 microns, depending upon the individual product.

"A New Development in Colour Metallics for Powder Coatings" by Dr Arun K Chattopadhyay of US Aluminium, published in Powder Coating, Sep 2003, 11-17. Powder Coating is published ten times a year by CSC Publishing Inc, 1155 Northland Drive, St. Paul, MN 55120, USA

Problems with adhesion failure on powder coated parts

Powder coatings are generally accepted for their high levels of adhesion to metal components. There are some occasions when problems of poor adhesion are reported and the applicator is obliged to reassess his production process. A case history illustrates a typical production problem encountered at Eclipse Manufacturing in Sheboygan, Wisconsin. The company designs and makes complex metal components and assemblies and powder coats these items to meet the finishing demands of their customers. A year ago, a customer complained that during assembly the polyester powder coating was flaking off tank brackets, made of 12-gauge cold-rolled steel. It was assumed that this order comprising some 50,000 pieces exhibited a widespread failure of adhesion, but they later learned that only a small number of items were affected. Evaluation of the pre-treatment documentation and subsequent assessment of the failed parts did not show any surface contamination on the exposed metal. Attention was then turned to the stoving oven and tests indicated that the parts were getting a marginal cure because of the short cure time, since the parts were at temperature for only 8-9 minutes instead of the recommended 15 minutes required for a full cure cycle on 12-gauge metal. After raising the temperature to compensate for the short stoving schedule, it was still found that some parts showed adhesion problems. Examination of the underside of the flaked film revealed traces of carbon, possibly hydrocarbon oil, present on the substrate underneath the coating. It seemed that complete removal of oil traces from the metal was not being achieved during the cleansing process. The faulty parts were then vibratory deburred and the problem appeared to be resolved. Further investigation into the records of purchased materials showed that some steel was purchased from an alternate supplier at the time the problem arose. Reverting to steel supplied by the original supplier was the main factor in resolving this time-consuming and costly investigation.

Case history described in Powder Coating, Sep 2003, 36-39. Powder Coating is published ten times a year by CSC Publishing Inc, 1155 Northland Drive, St Paul, MN 55120, USA