Advances in aluminium pigment technology to meet the demands of the coatings industry

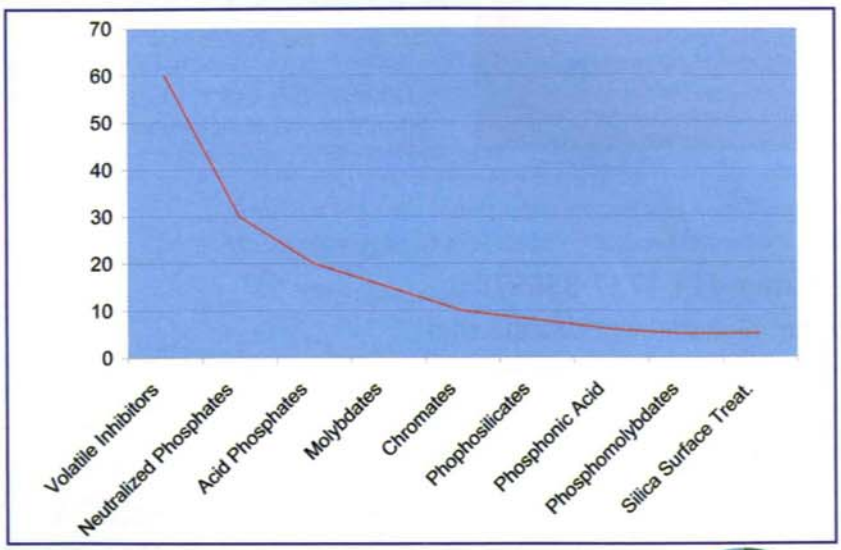
Russell Ferguson looks at silver's popularity and compares the latest aluminium pigment technologies available on the market

Colour sells consumer goods – and metallic colours have never been more popular. Silver, king of all metallic colours, has been riding a popularity boom for the past five years. While silver's popularity will not continue forever, our love affair with a metallic appearance will continue. From bright, sparkling, chromatic colours to smoother, subtler effects, the demand for metallic colours on a global basis has never been greater.

While today's 'techno-silver' may begin to lose its appeal, grey, blue, and brown metallic, utilising high levels of aluminum pigments, will begin to take its place. This popularity and the demand for new effect colours has heightened and underscored the need for continuing research and development in the areas of appearance and performance.

Hidden from most consumers are the efforts and 'behind-the-scenes' challenges that face coatings formulators and manufacturers of aluminum pigments alike, in their quest to provide the new effects so desirable today. Faced with an amazing array of regulations and various other hurdles, however, we continue to deliver new products to support styling and consumer demands.

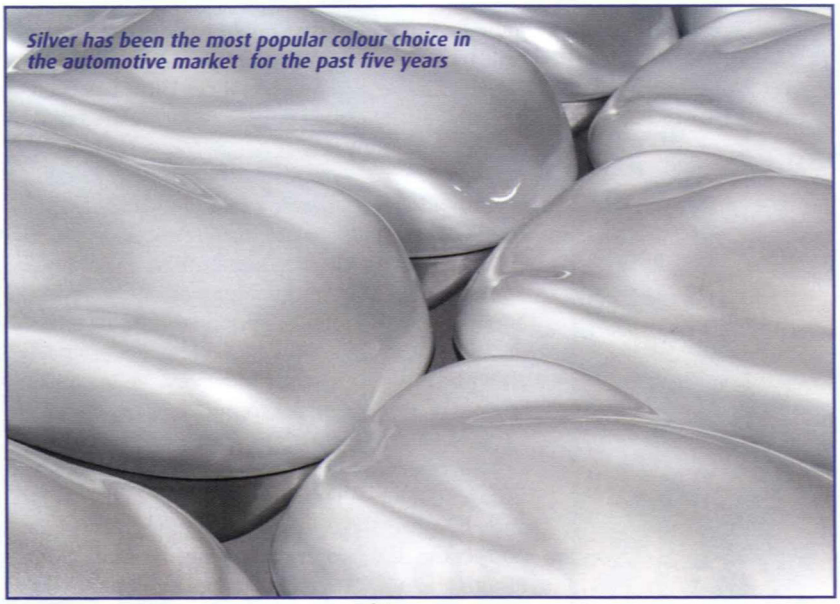
Figure 1. (below)



New advances in aluminum flake technology continue to reflect the needs of our industry and requirements of our customers. Our industry is in a state of change and successful raw material suppliers are those capable of keeping up with these needs. Several areas have created the highest hurdles for new aluminum flake development: Environmental Compliance; Styling Requirements. The days of low solids lacquers, exhausting nearly 80% of their volume to the air, are numbered. And not only are we seeing the demise of low solids systems, but also the introduction of application methods that are so efficient that nearly of the paint is attracted to the substrate, resulting in little overspray. Although these changes have been very beneficial to the environment, they have proven to be challenging to metallic coating appearance.

The drive toward environmentally friendly coatings is certainly not a recent initiative, and is well advanced in terms of VOC reduction. Increasing vehicle solids or utilising compliant waterborne coatings continues to effectively address VOC issues, although efforts continue for future improvement.

In fact, today there is a higher degree of emphasis being placed on 100% solids coatings (powder coatings) for many ancillary automotive components. Each of these two directions, high solids and waterborne, have challenged aluminum pigment manufacturers to develop improvements and modifications in the pigment to overcome



Silver has been the most popular colour choice in the automotive market for the past five years

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several issues.

Millions of dollars have been spent by aluminum pigment manufacturers on developing technologies for the passivation of aluminum pigments in waterborne coatings. Some of the early technologies, while being very effective, created other concerns especially from a health standpoint.

Heavy metals and chemical toxicity are issues that cannot be tolerated in the coatings we make and use today. Without question, the most effective and safest inhibiting agents currently in use are based on organic or inorganic phosphate, molybdate, or polymer surface treatment chemistries. Unfortunately many of these inhibiting chemistries are system dependent, working better in some resin systems than others, giving rise to the many options available from aluminum pigment manufacturers.

The primary issue in choosing a 'best chemistry' is to minimise the gassing reaction. It is well known that aluminum reacts with water to generate hydrogen gas. If severe enough this reaction can cause drums of paint to swell and potentially explode (from the pressure); and even a minimal reaction can detrimentally affect the hiding, colour and orientation of aluminum flake in the coating. Several years ago, a stochiometric calculation was made indicating the potential for one gram of aluminum to generate over 1000 ml of hydrogen gas. Imagine how much gas can be generated from a gallon of silver metallic paint formulated at a standard P/B!

Although it is difficult to characterise and compare the gassing effectiveness of different inhibitors, the chart below offers a reasonable generalisation ***(Figure 1).***

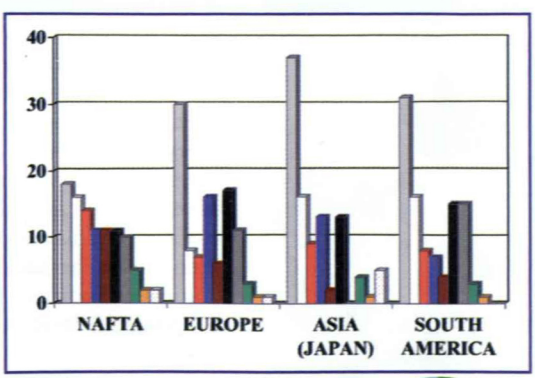

Figure 2. (right) Global Colour Popularity for Automobile Industry

Supplying a suitable technology for waterborne applications has been important, but of even greater importance and interest is coupling the inhibition properties with other tangible performance enhancements. One of the recent innovations at Silberline is the development of a stable, VOC free aluminum pellet that is dispersible in water. Utilising technology adopted from the plastics industry, aluminum flake is combined with a proprietary water miscible resin, and through a unique process delivered in a pellet form. This product is completely free of solvents allowing the paint formulator more latitude in solvent selection and minimising VOC content.

The pellet, trade named 'Aquavet' is packaged in bags within drums, which allows for clean easy use without the labour normally associated with scooping paste from the drum. The pellets pour easily out of the bag, leaving little residue behind thus providing a much cleaner workplace environment and easier disposal of containers. However, probably the most important feature of this technology is the performance. Inhibited with one of the most effective chemistries available on the market today, Aquavet technology has proven effective in many general industrial and trade and maintenance systems.

A second technology finding a strengthened interest in today's industrial waterborne systems is based on silica chemistry. Developed almost a decade ago, '4 All' technology is finding renewed interest because of enhancements it offers to coatings. Originally designed for good gassing stability, this technology is produced through a polymerisation process resulting in a surface treatment that is very effective in waterborne coating systems. One of the performance enhancements that are creating renewed interest is circulation stability. Aluminum flakes, like the base metal, are malleable, and easily bend, break or deform under shearing conditions. Aggressive dispersion practices or long-term circulation in paint systems can readily change metallic coating appearance due to flake degradation. This is a well-known challenge that all formulators face when producing metallic coating systems.

One solution to this challenge was the development of circulation stable grades known as Tufflake. However unless inhibited separately, they cannot be used in waterborne applications. The '4 All' technology however provides a solution for waterborne coatings. The silica coating on the flake enables the flake to better resist deformation offering improved performance characteristics.

In addition to the challenges of meeting environmental regulations, styling trends and requirements have driven the need for improvements in appearance. Today's aluminum flake technology has changed dramatically over the years, progressively sophisticating and offering new effects. Globally silver continues to be a very popular colour ***(See Figure 2).***

This colour popularity is very similar for many other consumer goods. The demands for brighter, whiter, smoother aluminum flakes with more metallic travel have not been ignored, and the

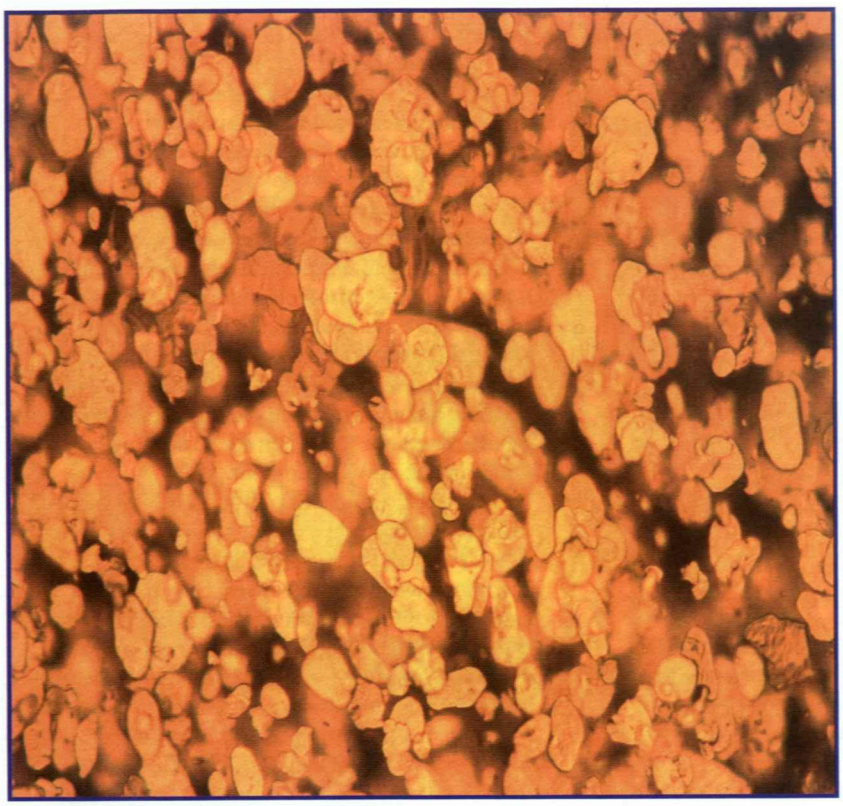

Figure 3. (above) Sparkle Silver Ultra 600X

newest developments are designed with these needs in mind.

The general trend in milled aluminum flakes (milled flakes are those produced by ball milling atomised aluminum powder into flakes) has been to a flake geometry commonly called 'lenticular' or 'silver dollar.' Unlike the older aluminum flake shape, which was irregular in geometry, lenticular flakes have smooth contours and a regular oval or round shape.

This technology has been perfected and improved to a level that now provides exceptional brilliance. A new family of grades, manufactured by Silberline, called Sparkle Silver Ultra has been recently introduced, and already formulated into a number of automotive coatings ***(Figure 3).***

High brilliance coupled with excellent metallic travel, and very smooth patinas are achieved through a unique manufacturing process that narrows the particle size distribution. Probably one of the big keys to the improvement in appearance is the exceptionally smooth surface of these flakes. Flake topography measurements using Atomic Force Microscopy indicate a significant advancement over earlier technologies.

This technology measures the topographical delta between the hills and valleys on the flake surface; the measurement is recorded in nanometers. Irregular flake surfaces result in greater light diffraction, and poorer alignment in a coating film resulting in a darker metallic appearance and lower metallic travel ***(Figure 4).***

Although Sparkle Silver Ultra technology epitomizes the 'best' today, stylists worldwide in all market areas are continually looking for the next generation for appearance improvements. Development is currently underway to expand the Ultra Lenticular product line to provide some of these improvements.

Utilising an entirely different technology, opportunities for improved appearance over the Ultra Lenticular product line are also possible using a vacuum metallised flake (VMF). This technology is quite unlike traditional milled flake technology, involving the vapour deposition of aluminum metal onto a very smooth plastic substrate. The resulting metal film is not only very smooth and highly reflective, but also very thin.

Production of the metal flakes is possible by stripping the metal film from the plastic substrate, and then breaking the metal into small flakes using vibration energy. The resulting flakes possess all of the qualities of the vapour deposited metal, with an exceptionally smooth surface, and very thin geometry. In fact, the aspect ratio (D 50: Thickness) of these flakes is several magnitudes greater than standard milled flakes due to the reduction in flake thickness.

Silberline produces VMF flakes under the trade name 'StarBrite.' These flakes, as mentioned earlier have exceptional brightness, and because of their aesthetics have many applications in both ink and coatings markets. They are supplied in a variety of solvents including glycol ethers, and when inhibited find applications in waterborne systems. Advances in StarBrite technology have already allowed the introduction of newer VMF flakes that provide even brighter, more desirable effects.

Our industry will continue to be challenged to meet environmental, health, safety and other regulatory issue, however through continued innovation not only can we rise to meet and overcome these hurdles, but at the same time provide improved product performance and new exciting aesthetics. Silberline is a leader in this field and continues to advance technology through innovative research, development and design of new products. APCJ

Figure 4. (right)

FLAKE TYPE	MEAN ROUGHNESS
Standard Cornflake	28.8nm
Advanced Cornflake	26.2nm
Lenticular Flake	17.4nm
Ultra Lenticular Flake	10.1nm
Vacuum Metalised Flake	3.6nm

Figure 5. (below) StarBrite Vacuum Metallised Flake 600X