11 Applications of Mass Pigmented Systems

This chapter describes the most common colouristic applications of metal pigments in mass pigmented polymers. Non-colouristic applications are described in Chapter 15.

11.1 Household goods

Metal pigments, principally aluminium, are very effective in breaking up the uniform appearance of large areas of solid colour, especially dark colours. There is increasing interest in this technique in the teletronics market. Traditional black TV and video cabinets are being subtly pigmented by metal pigments to give renewed customer appeal. Most recently, the technique has spread to shavers and mobile telephones. Aluminium flakes in the 20-60 μm range predominate. Many of these appliances require cut-outs for switch and cable attachment, which are a source of flow and weld lines. These challenges are being met by combinations of flake and spherical pigments and by SCORIM (see Chapter 8).

Larger flakes are used in footwear, especially in thermoplastic elastomers for soles and in trims for trainer shoes. Glitter flakes appear in transparent or tinted children’s sandals. Their sparkling appearance increases the appeal of toys.

Pigmentation by coarser aluminium flake is also feature of larger articles, such as vacuum cleaners, coffee makers, toasters, suitcases and the like. To mitigate the reduced opacity of coarser pigments, they are generally formulated with organic and inorganic colours. A selection of metal flake pigmented articles is shown in Figures 11.1.

Although more often surface printed, floor coverings are also pigmented by extrusion coating over a foamed polymer substrate. The main advantage is uniform coloration throughout a layer of increased thickness and therefore increased wear resistance [1].

For the garden, lawnmower and hedge trimmer housings, patio sets and hand tools are produced with metallic finishes. Some are painted, the others pigmented. Many traditional white patio sets are now coloured with low concentrations of black glitter flakes to give a good contrast with the white.
11.2 Sports goods

This is very definitely a fashion driven market. Styles therefore come and go in cycles. A particularly prominent application for aluminium flake pigments in the mid 1990s was ski boots. Coarse flakes in the 70-230 μm range were used with solid colours to provide sparkle and avoid weld lines.

Bicycle parts and accessories, such as chain guards, mud guards, brake mechanisms and cycle helmets are also mass pigmented by metal pigments. A key consideration for functional parts is the effect of such pigmentation on mechanical properties. Chip resistance is also important. Bicycle frames continue to be made from steel or lightweight alloys and are increasingly painted with effect pigments.
11.3 Agricultural film

The light reflecting and opacifying properties of aluminium flake pigments offer several potential advantages in agricultural film applications. These include crop ripening, silage wrapping and weed suppression.

Black, grey and white and pigmented plastic sheets were some of the first to be patented for their plant mulching properties [2, 3]. Mica flakes for this application are claimed in US Patent 3,099,897 [4]. An early use of aluminium flakes is disclosed in US Patent 3,382,610 [5], in which the flakes are combined with an asphalt binder.

PE film, mass pigmented by around 1% of a particularly fine particle size aluminium flake pigment, has been spread on the ground under soft fruits. The reflection of sunlight and heat by the metal flakes is believed to retard the rate of plant root development. This has the effect of delaying the onset of ripening by a few weeks, providing a significant commercial advantage. The more diffuse reflective properties of this type of film are said to be an advantage over vacuum metallised film, which can concentrate the sun’s rays, causing scorching of the plants. Although metal pigment offers some inherent UV protection, UV inhibited polymer should be used to ensure maximum film life.

In a modification of this process, Fawcett [6] of Transmet Corporation patented a mulch sheet to be placed on the soil around the stalk of a plant. The mulch comprises a woven mesh with aluminium flakes which will reflect the sun’s rays up onto the underside of the leaves. The mesh retains moisture that has seeped into the ground through the porous mat. The aluminium flakes are applied to the upper tacky surface of thermoplastic woven mat and pressed into position. They are fixed there when the polymer cools. A pod containing a seed may be secured to the underside of the matting in the open hole. A layer on the underside of the mat could include a layer of fertiliser.

In weed suppression film, fine grades of aluminium flake exclude light, but unlike black pigmented films, which absorb heat and stimulate growth, aluminium flake pigmented films appear to discourage weeds more effectively by reducing soil temperature. The use of such film for wrapping silage for temperature modification to control storage properties is a related potential application.

The main parameters affecting the service life of PE agricultural films are discussed by Henninger [7].

11.4 Sacks and bags

This application area comprises rubbish bags, carrier bags and general flexible packaging. Cost is the main factor in determining the products used. Both aluminium and gold
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bronze are employed, generally relatively low quality, wide particle size distribution ‘cornflake’ grades, in particle size in the range 5-12 μm diameter for maximum opacity. Even the finest grades of metal flake do not compete on price with carbon black for garbage bags. Applications tend to be restricted to the relatively up-market areas of carrier bags, or where the non-pigmentary attributes of metal pigments are needed, i.e., light exclusion to hide the contents or light reflection to keep the contents cool.

11.5 Containers

Containers of all types are a major target for ‘effect’ pigments, particularly where their use has a fashion component. Thus injection and blow moulded cosmetic and toiletry containers, extruded toothpaste tubes and the like are frequently styled with metal pigments. Containers for car engine oils are another major, though less fashion driven outlet in this sector. Even PET beverage bottles have been launched which contain a low concentration of a coarse, food contact grade aluminium flake.

Toiletry bottles are a popular application. This is at least partly due to reduced opacity requirements. A rich, deep metallic effect can be obtained from a relatively low pigment concentration, yet there is sufficient opacity to obscure the bottle’s contents.

Plant pots, tubs and containers are a consumer of ‘effect’ pigments, especially coloured glitter flakes. These are formulated with white, cream, beige, pink and grey to provide simulations of stoneware and marble (see section 11.8).

11.6 Automotive

It has been estimated that up to a quarter of the roughly 1,150 kg weight of a modern mid-range car is made from synthetic polymers [8]. The largest element of this is the 125 kg comprising body parts, interior trim, instrument panels and headlights; all applications in which visual quality is important.

Metal automotive components are increasingly being replaced by polymer, especially where mechanical properties are not critical. Corrosion resistance and weight saving are the two main driving forces for the use of polymers in general.

In addition, the need for a prestige appearance and the perceived strength attributes of metals demand that polymers be made to look like metal. This applies not just to internal and exterior trim components, but also to engine compartment parts such as air filter housings and battery mountings. Thus, for example, Fritzsche describes metal pigments for polyamide engine components, without surface marks, stable to 300 °C and required to look like diecast aluminium [9].
A recent example of the replacement of a cast metal accelerator pedal by a metallic pigmented polymer equivalent is shown in Figure 11.2. Skilful design allowed the necessary mechanical properties to be retained with a considerable weight reduction.

Extension of metallic pigmentation to larger and more visible components is frequently hampered by flow and weld lines and by the difficulty of colour matching to painted body panels. One solution is to move to mass coloured body panels. This has already occurred with the launch of a mass market automobile in China [10]. The so-called ‘Smart’ car, a joint venture between Mercedes Benz AG and the Swiss SMH AG company, will feature easily replaceable, mass coloured body panels and bumpers [11].

The very new technique of paint-less film moulding, described in section 10.5, provides the high quality of finish demanded by the automotive industry. The all-polymer panels have high surface uniformity and brilliance, toughness, good long-term durability and an attractive price/performance ratio to add to the obvious weight-saving advantage.

11.7 Pearl simulants

By reducing the concentration of very high quality, fine particle size, surface polished aluminium flakes to very low levels in optically transparent polymers, it is possible to achieve light reflection from deep within the polymer. This is a characteristic of pearlescent (mica) pigments, which have much less inherent opacity than metal pigments.
Thus the visual effect of using 2-6% of pearl pigment may be reproduced from as little as 0.01 to 0.2% w/w aluminium flake. This ensures extremely cost-effective formulations. It must be emphasised however, that because of the inherent colour of aluminium metal, this approach is limited to silver and deeper coloured pearl effects. Aluminium flake pigments are available that have been specially designed for this application. They will typically have much lower metal contents than general purpose metallic pigment masterbatch. This is to ensure the high degree of dispersion required at the very low concentrations required. Toiletry and cosmetics containers are typical applications of this approach.

11.8 Mineral simulants

The aim in this group of effects is to simulate in a mass pigmented polymer, the visual effect of such minerals as granite and marble.

These formulations generally consist of two or more coarse metal flake pigments of contrasting colour in a white or coloured background. Thus the black and white particulate appearance of granite is simulated by a 200-600 μm diameter aluminium flake, mixed with a black surfaced flake of similar dimensions. Chopped foil glitters can be used, but the visual effect can look overly uniform. Milled flakes, with their irregular geometry can often provide a more natural appearance. Lightly pigmented white, cream, ochre and pink polymers with good surface gloss give the best results as hosts for the metals. PMMA and PP are the popular choices. Because the hiding power of large flakes is so low, a 1-2% loading of each may be required.

The technique can also be extended to the simulation of man-made products such as stoneware. Together with the mineral simulations, these effects are found in resin bonded laminate sheets for kitchen and bathroom work surfaces and in plastic flower pots, tubs and other garden applications [12, 13].

11.9 Fibres and textiles

Due to their very much larger size compared to organic and inorganic pigments, metal pigments have limited application in fibres. Indeed the diameter of a fibre strand can be less than that of many flake pigments. At the very least, mechanical strength is lost. Brightness and metallic effect are also compromised because only the smallest and therefore darkest flakes can be used. Nevertheless, Blechschmidt [14] has described the preparation and properties of polyolefin tape yarns, coloured by metallic coloured masterbatches during extrusion.
A more common application involving textiles is coating onto a textile substrate for the manufacture of synthetic leather, or lethercloth. The coating is generally a PVC plastisol, applied by knife coating and thermally cured.

References


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