Pigments for plastics

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INTRODUCTION

Pigments and dyes are distinctly different types of colourants. A pigment is a finely-divided solid which is essentially insoluble in its polymeric application medium. Pigments are incorporated by a dispersion process into the polymer while it is in a liquid phase and, after the polymer solidifies, the dispersed pigment particles are retained physically within the solid polymer matrix. In contrast, a dye dissolves in the polymeric application medium and is usually retained as a result of an affinity between individual dye molecules and molecules of the polymer. Pigments are generally preferred to dyes for the coloration of plastics mainly because of their superior fastness properties, especially migration resistance.

The main reason for incorporating pigments into plastics is to introduce colour (including black and white), either for aesthetic reasons and market appeal or because of functional demands. However, the optical role of a pigment can extend wider than simply providing colour, because it plays a decisive part in determining whether the medium is opaque or transparent.

Pigments may often perform useful functions that are more wide-ranging than their optical role, for example mechanical reinforcement or the inhibition of polymer degradation. On occasions, the incorporation of pigments can produce problems in plastics, such as the warping of polyolefins as a result of uncontrolled nucleation.

Pigments may be introduced into plastics by a variety of methods. Direct dry colouring, in which the pigment is incorporated into the molten polymer often along with other additives using high-shear dispersing
equipment, may be used. However, many manufacturers of plastic articles find it more convenient to make use of pre-dispersed concentrates or masterbatches of pigment in a liquid additive such as a plasticizer or in a compatible resin. Such concentrates are then easily incorporated by mixing into the final polymer composition at an appropriate stage of the processing sequence.

Pigments are conveniently classified as either inorganic or organic types. The properties of a pigment are primarily dependent on its chemical constitution. However, other factors influence the properties as a result of the fact that pigments are used as solid crystalline particles. One of these is the crystal structure, i.e., the way in which the molecules pack in their crystal lattice. Certain pigments, notably titanium dioxide and copper phthalocyanine, exist in different polymorphic forms with significantly different optical and stability properties. Further important factors, especially in influencing the strength or intensity of colour of pigments, are particle size and shape. Organic pigments generally show an increase in colour strength as the particle size is reduced, while with many inorganic pigments there is an optimum particle size at which the colour strength reaches a maximum. Other important factors which influence the dispersion properties in particular are the degree of aggregation of pigment particles and the nature of the particle surfaces.

REQUIREMENTS OF PIGMENTS FOR PLASTICS APPLICATION
The ability to produce the desired optical effect in the plastic product is obviously a prime requirement. However, the pigments must also be capable of withstanding the effects of the environment in which they are placed, both in processing and in their anticipated useful lifetimes. A pigment will be selected for a particular application on the basis of its technical performance but with due regard also to toxicological considerations and, inevitably, cost.

Optical properties: colour and opacity
The optical properties of materials are a result of a combination of two effects arising from the way they interact with visible light: absorption and scattering. An object appears coloured when it selectively absorbs certain wavelengths of visible light. The brightest, most intense colours are in general provided by the use of organic pigments. The colours of inorganic pigments are as a rule weaker and duller. High transparency in a plastic material requires the absence of light scattering centres either within the structure of the polymer itself or as a result of additives present. To produce a coloured transparent article, an inherently transparent polymer is coloured either with dyes which dissolve in the