Color and Appearance Measurement in Plastic Industry

Introduction

Plastic can generally be classified into 2 groups, thermoplastics or thermosetting plastics, based on how they respond to heat. Thermoplastic such as acrylics, nylon and polystyrene, is the most sought-after material due to its ability to be heated and shaped multiple times. For thermosetting plastic like polyester resin and epoxy resin, once they are cast into a particular shape or form it becomes permanent.

Measurement of color and appearance in the plastic industry is governed by the American Society for Testing Materials (ASTM)[2]. Some specific test methods covered under the ASTM standards include instruments for measurement of color, yellowness, gloss and applications of methods of appearance measurement.

Typically, 3 groups are involved in the manufacturing process of plastic product, namely raw material manufacturer, processor like masterbatch or compounder, and converter. Within each manufacturing phase, the use of color instrumentation and computer color matching (CCM) is essential in ensuring the success of the final plastic product.

Color

There are many factors affecting color in the plastic manufacturing process, namely colorant selection, processing temperature and dispersion method. Variation between lot-to-lot is highly possible due to the nature of colorant manufacturing.

Ensuring consistent lots or batches quality requires manufacturers to qualify the inherent color characteristics with standard material. The use of color QC instrumentation provides manufacturers the ability to set-up tolerances for color control.

Colorant selection is probably one of the most important activities in the color process. There are 2 types of colorants, namely dyes and pigments. Dyes are transparent, soluble and has good heat stability. It is generally used to shade or tint a resin and its solubility only allows it to be used in selected type of resins.

Pigments, can be divided into organic pigments or inorganic pigments. It also has good heat stability, but are insoluble and must be dispersed within a resin matrix. Pigments are more sought after because of their wide chroma range and opacifying ability. Selecting the right colorant depends on the type of resin, processing conditions and the end-use application requirements.

2 problems concerning colorants are the dispersion and heat stability. Generally, organic pigments are more difficult to disperse than inorganic. A good dispersion is required to characterize the inherent color and a large majority of the industry uses pre-dispersed colorants for their operation.

Exceeding the thermal limitations of colorants can cause colorants degradation. Organic pigments exhibit color fading while inorganic pigments turn dark and dull.

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The standard rule of thumb here is higher temperature, higher yield and hence, a basic QC measurement allows user to calculate pigment degradation as a function of temperature.

With growing demand in custom color matching, the use of CCM reduces the time it takes to make a match and display to customer for approval. Most colorants have opacifying abilities like inorganic pigments. For those that are translucent and transparent like some organic pigments or dyes, it is difficult to characterize within the same software as opaque colorants. Different let-down methods are often necessary to characterize those types of colorants.

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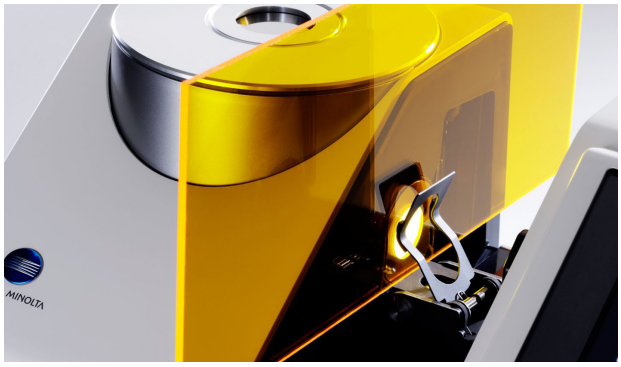
Pigments should be dispersed in the resin before color evaluation. A single or blended pigment should be evaluated with a known standard. Colorant is prepared either as a tint or masstone to determine its strength or inherent color respectively. For color measurement that correlates with visual, spectrophotometer with 45/0 geometry is recommended.



Plastic resins are also evaluated for yellowness and haze. Resins can vary from clear to cloudy or colorless to light yellow, amber and brown. During servicing, many resins turn yellow due to heat or the result of chemical degradation. For clear plastics, transmittance measurement of haze and yellowness are the two attributes commonly measured. For such measurement, a sphere-based spectrophotometer is recommended.

For white pigments like titanium dioxide (TiO2), they are commonly tested for whiteness and opacity. Sphere-based and 45/0 spectrophotometers are recommended for both measurements. Gloss is another attribute commonly measured on flexible plastic films or molded parts.

CCM is used for matching concentrates, film, molded parts and fiber. It typically consists of 3 modules, namely QC, formulation and batch correction. The QC module allows user to compare and calculate difference between samples while also the ability to evaluate and monitor the strength of incoming pigments. The formulation module predicts and provides single or multiple color recipe that best matches the object's color or standard as defined by user. These predictions can be sorted by various criteria like metamerism and cost.

Batch correction module allows user to calculate the deviation in colorants being used today as compared to the originally characterized colorant file. This data can then be applied to the correction based on the tintorial and colorimetric differences.

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Below are some color formulation conditions and procedures best practices

- To ensure consistency, monitor the strength of incoming pigments or dyes
- Based on the weight of the objects being colored, establish appropriate weighing methods for pigments or dyes
- Calibration of color measurement instruments and weighing scales at scheduled times for accuracy and optimum performance
- Specify a fixed room temperature to avoid causing a drift in the color of your samples
- Standardize procedures from the start to end, which includes the creation of samples for measurement, mixing samples, the flash time after mixture and oven temperature and time for drying

Derived from our advanced optical and image processing technologies, Konica Minolta color and appearance measuring instruments, from benchtop to portable spectrophotometers and colorimeters, are widely used in the plastic industry.

Download our free educational booklets to learn more about the basic of color science. Alternatively, contact us for a free product demonstration or consultation on how you can improve your color management process or select the right tools and methodology for your measurement needs.