Measurement of Raw Materials

The range of raw materials includes many different material types and forms such as pellets, pigment pastes and powders, from opaque to translucent or transparent. The requirements on color measurement and sample preparation are particularly challenging because of the extreme diversity. Lot-to-lot color consistency is an important indicator of quality and can only be achieved, if the measurement results are repeatable and reproducible.

Consistent Quality of Raw Materials

The ultimate manufacturing objective is to consistently and confidently sell their end product to a customer. Therefore, the product needs to be checked prior to shipping, to ensure it meets the agreed upon color and appearance tolerances. If the color is off specification, it will have to be reprocessed and potentially be sold at a lower price or even needs to be discarded. Therefore, incoming quality control of the raw materials is essential. Tight lot-to-lot variation is a pre-requisite for minimizing rejects.

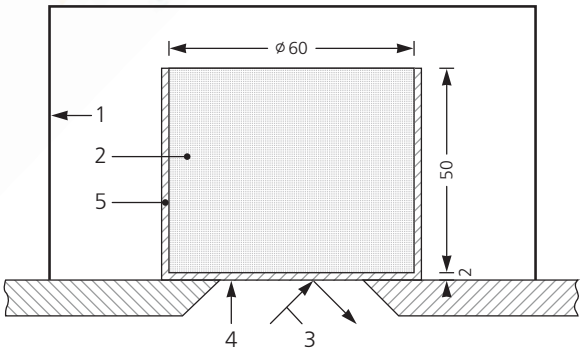
Resins

Plastic raw materials such as PP which is often used for colored end-use applications must be controlled for degree of yellowness. If the resin is not "white", the final color will be off specification. The degree of yellowness is influenced by contamination or impurities of the raw materials as well as process variations. For a very quick quality control, the pellets can be measured according to ISO 17223 using a glass sample cup and a light trap (see details in following schematic). To guarantee repeatable positioning, the spectro-guide can be placed on a mask which fits the aperture. Averaging several readings is essential for reproducible results.

BYK-Gardner Solution

Solid Color & Gloss
spectro-guide S

Objective Visual Evaluation
byko-spectra



1 = light trap
2 = specimen
3 = incident light
4 = measured surface
5 = specimen container

For stable quality control, creating reliable and repeatable results, it is necessary to mold the plastic pellets into plaques with a homogenous surface and defined thickness. The plaques can then be measured in reflection mode by the spectro-guide, a portable color spectrophotometer, which automatically calculates the yellowness index according to international standards.

As the yellowness index is just a one-dimensional number it sometimes does not completely describe the visual perception. Often samples show an additional significant difference in hue and lightness. Therefore, a three dimensional description of color using the CIELab color coordinates is recommended. Within this system, the b* value can be used as an indicator for yellowness. The molded plaques are usually not completely opaque. Thus, when taking color readings the background has a crucial impact on the measurement results. To achieve the best discrimination between different products a white backing material is recommended. The material should be long-term stable and agreed upon between the involved parties.

Granulate

Plastic pellets are typically translucent, non-uniform in size and inhomogeneous in color. The inhomogeneity in color of cylindrical pellets is due to different surface properties of the cut and the lateral surfaces or as a result of stress whitening. Thus, only under significantly increased efforts using special accessories and sample preparation techniques reproducible results can be achieved. Therefore, the process of pressing a color chip for the purpose of color measurement is common in plastic processing and is the recommended procedure to create reliable and repeatable measurement results.

Glass Sample Cup
Granulate

Template-C
Aperture mask for spectro-guide

Molded Color Chips

Molded color chips are thermoplastic materials that are compression molded from material suppliers into test specimens for the purpose of color measurement. These color chips often have areas with increased thicknesses and therefore range from opaque to translucent. Thus, they require different measurement techniques depending whether the color chip is opaque or translucent.

Opaque color chips are impermeable by light and are best measured using a 45°/0° or a d/8° reflectance instrument. A 45°/0° instrument is used in situations where we want to measure color the way our eyes see color. A practical use for a 45/0 color instrument is to check color consistency of consumer products when appearance is a deciding factor in a product purchase. A d/8° geometry eliminates the influence of gloss and surface texture on the object's color. A raw material supplier of pigments or resins would normally use the d/8° geometry to check lot-to-lot consistency.

Translucent color chips allow light to pass through, but only diffusely, so that objects on the other side cannot be clearly distinguished. The choice of instrumental measurement depends upon how a visual judgment is made. When measuring the diffuse reflection of these materials, the thickness of the specimen and the color of the material behind the specimen during the measurement process can significantly affect the measurement data. Therefore, thickness and backing must always be specified and held constant. To achieve the best discrimination between different products a white backing material is recommended. The use of byko-chart drawdown cards, as backing for the color chip guarantees consistent color and gloss ensuring that the measured color difference only comes from product variations.

A color chip provided by the material supplier poses a certain risk. Its material composition may slightly differ to the finally delivered material. The production processing parameters are usually unknown and it often does not have the exact same texture as the final product. To ensure comparable results the standard should be made from the same material and with the same grain as the final product.

BYK-Gardner Solution

Solid Color & Gloss
spectro-guide S

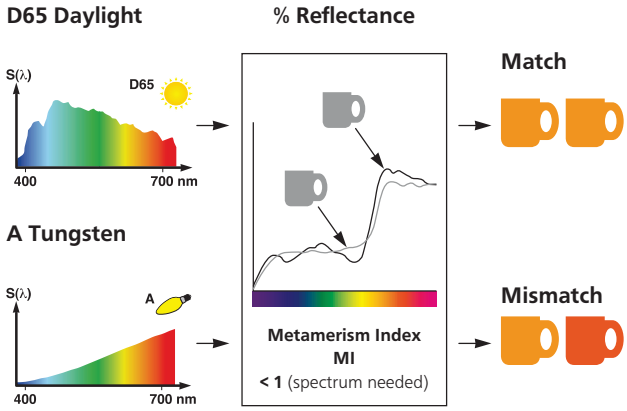
Gloss
micro-gloss S

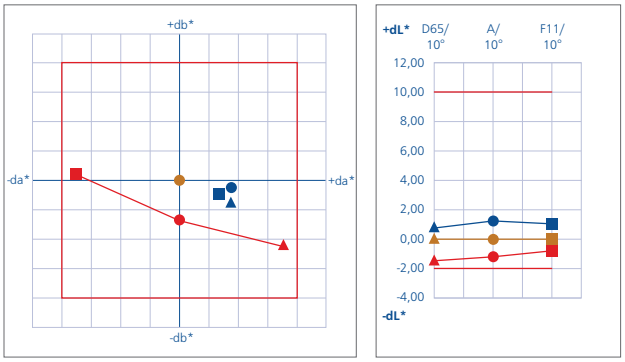
Color consistency under different illuminants
As multi-component products are utilized under different lighting conditions, color consistency needs to be controlled under multiple light sources. Otherwise parts molded from different batches have the potential risk to appear the same under daylight but show an apparent mismatch under indoor room lighting. This phenomenon is known as metamerism.

Visual test of metamerism
In a light booth standard and sample are viewed at the reference light source - most of the time D65. Then the light source is changed to at least one test light source which is significantly different from the reference light source. A common practice is to visually evaluate the sample pair under illuminant A and a fluorescent light source representing TL84 or CWF. This can be easily done using the byko-spectra lighting cabinet. The light booth supports commonly defined standard illuminants and an automatic sequencing of different light sources for standard testing procedures can be programmed.

Instrumental test of metamerism
The reason for metameric plastic pellet batches is that the pigments or colorants used in the formulation are different. This can occur when e.g. raw materials are no longer available because of environmental issues or more cost efficient solutions require raw material changes. In any case, the spectral curves of the metameric pair are different. Typically, the curves cross each other at least three times.

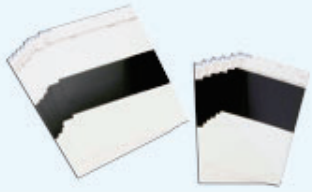
However L*a*b* values calculated for one illuminant are the same for both specimen, but are different for a second and third illuminant.The graph below shows measurements taken with the spectro-guide. The red line represents a metameric sample: the Da* and Db* values are significantly different for illuminant D65, A and F11 (TL84). In comparison the sample charted in blue has values that are very similar for all three illuminants. Therefore it is not metameric.





Color differences are charted for three illuminants
D65/10°▲ A/10°● F11/10° ■

Objective Visual Evaluation
byko-spectra



Test Chart
byko-charts