Color Matching Plastic Parts

In last month's article, we reviewed how color is controlled by three components; an observer, a light source and an object[1]. Attempting a color match of two different parts requires the balance of these three components. This article presents topics to consider regarding proper color matching and some thoughts on color matching specifications.

Light Source

Different light sources affect color. For example, an object viewed at your desk under fluorescent lights compared to the same object in the sunlight will likely appear to be a different color. For this reason, it's important to specify the light source to be used when determining the color match. If a color match under more than one light source is required, this should also be specified. High tolerance color matching under varying light sources can add expense due to the higher cost of the necessary colorants. For this reason, consider different tolerances for the color match under varying light sources.

Observer

It is also important to note that perceived color will vary from one observer to the next. Thus, the observer of a color match must be specified. In today's industry, it's likely a spectrophotometer or colorimeter is the observer. Utilizing this technology will give precise results, yet the measurements can vary between instruments. This variation between spectrophotometers is documented by the manufacturer as "inter instrument agreement." It's important to be specific about the type of spectrophotometer that will be used for the color match.

Object - Shape

Another consideration when color matching is the shape of the object. How the object is shaped will affect how the light is reflected back to the observer. This, in turn, creates a difference in perceived color. The object's shape can also present a challenge for color measurement. It's probable the part does not have a wide, flat area for the spectrophotometer apparatus to be placed perfectly. If this is the case, consider a fixture that places the part and spectrophotometer in the same position. This will fix their relative positions and improve color measurement consistency.

Object - Gloss

Object gloss will also affect color. Color can be defined by values of L* (lightness), a* (redness-greenness) and b* (yellowness-blueness). Higher part gloss tends to result in a lower L* value yet a higher a* and b* (e.g. a darker, more red and yellow part)[2]. Depending on the allowed color variation, part gloss may need to be specified to ensure a proper color match.

Object - Environment

Other parameters to consider are the thermochromic and hydrochromic properties of color, color shifts due to a change in temperature and humidity, respectively. It is not unusual for a given color to vary 0.04 in L*, a* or b* for every one degree Fahrenheit shift in temperature[3]. For this reason, specifying the temperature and humidity conditions during color reading may be important.

Object – Plastic Type

Coloring certain plastic parts poses other challenges. Alloyed plastics can be difficult to color due to the varying additives, mix ratios and base resins used. ABS (acrylonitrile butadiene

styrene) exhibits significant variations in yellowness (b*) because of different polymerization techniques and additives used by the resin manufacturers[4]. PC (polycarbonate) exhibits variation from supplier to supplier in tint (ranging from blue to gray tones). When working with these plastics, a proper color match usually requires the exact same grade of resin to be used every time.

Keep in mind that fillers also affect color[4]. Talc, calcium carbonate and other mineral fillers can vary in color from a light tan to a dark gray. This color variation and the amount used in the plastic can cause significant color differences.

Object - Cost

A final consideration should be cost. Detailing and specifying part color will help ensure a proper color match, yet increasing quality specifications can also increase part cost. It may be cost prohibitive to have a tight tolerance color match under all lighting and environmental conditions. Final cost will likely have a large role in the level of color matching.

Conclusion

To obtain a proper color match, one must evaluate the necessary and sufficient conditions for acceptability. This means understanding how changes to the light source, object and observer will affect part color and, ultimately, what cost the color match is worth.

References

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[3] Mouw, Timothy A. "Principles and techniques of color measurement." SPE Conference 2000

[4] Hargett, Tom. "The basics of coloring plastics." Appliance buyers' guide to plastic materials, equipment and services 56.4 (1999): 101-102.