Challenges of Managing Color in White Goods

Introduction

The term white goods refer to large household appliances such as refrigerators, ovens, microwaves, washing machines, tumble dryers, and also air conditioners. White goods are given this name because traditionally they were manufactured with a white enamel finish.

Today, the predominance of white has now given way to colourful and more sophisticated finishes. While classic colors like white and black continue to attract the most attention, newer shades created by metallic and stainless steel, as well as, chrome are gaining popularity lately.

Combining those shades with different textures such as high gloss or matt finishes, add a hint of drama to its unique aesthetic.

Challenges Faced in Color Management

The wide variety of colors and finishes used in white goods or household appliances posed new challenges to appliances manufacturers when color and appearance management is concerned.

The use of different materials, coating methods and finishes within a product makes color control a difficult task, especially in view of emerging demand for color-coordinated household appliances.

To establish measurement data that correlates well with actual visual perception, the selection on the type of color measuring instrument and measuring method is critical.

Some of the common challenges faced are:

- Effects of texture on color perception
- Iluminant Metamerism
- Goniochromism

Effects of Texture on Color Perception

The difference in texture or gloss of two samples with similar material or color application may produce different color perception, especially in the lightness parameter. This is because an object's surface condition directly influences how light is reflected off that sample; thereafter, how our eyes perceive its color and appearance.

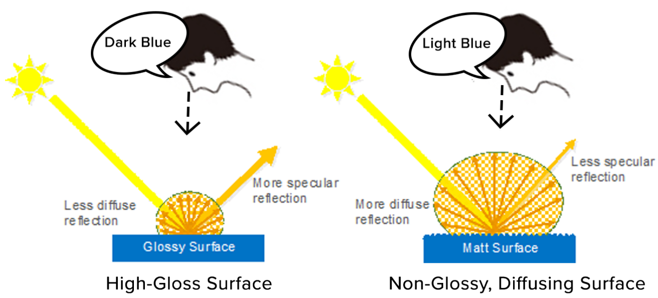


Figure 1 - Effects of texture on color perception

If the surface of the sample is smooth (high gloss), most of the light will be reflected from the surface like a mirror (specular reflection). When evaluating the lightness of glossy objects, human observers often ignore specular reflection; therefore, glossy objects are perceived as darker.

In contrast, matt surface reflects light in many directions (i.e., reflected diffusely). This phenomenon will make the sample appear lighter in shade or appearance.

Challenges of Managing Color in White Goods

To account for these variations in light distribution due to surface texture or glossiness changes, a sphere spectrophotometer, with d:8 geometry, that enables both SCI (Specular Component Included) and SCE (Specular Component Excluded) measurement mode can be utilised.

SCI vs. SCE

To measure the actual color of an object independent of surface conditions, SCI mode is typically used. This type of measurement includes both the specular and diffused reflected light; therefore, it is unaffected by any surface conditions (i.e., the total amount of reflected light is the same if the materials and color are the same).

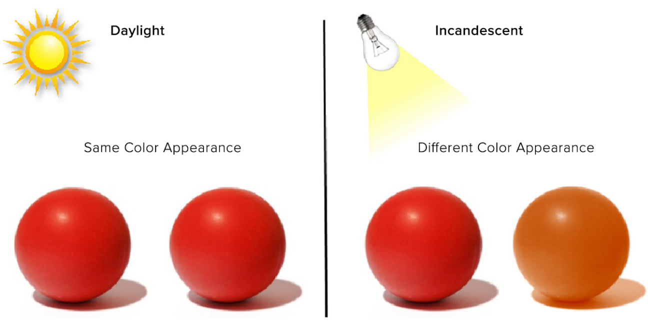
If we measure the two blue objects in *figure 1* in SCI mode, it would produce the same measurement result for both objects. This measurement mode is ideal when formulating recipes to match colors, for example computer color matching, or perform color strength evaluation to meet the color quality standards of the product.

To measure the color of an object which correlates to visual perception, SCE mode is typically used. This type of measurement excludes any specularly reflected light, making it more sensitive to surface conditions.

Again, if we measure the two blue objects in *figure 1*, a measurement in SCE mode would generate different color values for each object. Glossy object would fall in a darker and more saturated region of the defined color space while rough-surfaced object would fall in a lighter, less saturated region of the defined color space.

This mode is often used during quality control evaluations to ensure the product color and appearance consistency and meeting consumer visual quality demands. In another word, if we need to match the color and appearance of two different parts or products with different surface texture or gloss, SCE measurement mode should be applied.

Illuminant Metamerism



llluminant Metamerism, also known as Light Source Metamerism, is a phenomenon where two colored samples appear to identical under a specific light source but different under another lighting condition(s).

Illuminant Metamerism is a common challenge for household appliance manufacturers. Such phenomenon can occur during the product development stage when a plastic FA sample is compared against the visual color standard made of different material.

To reduce this effects, the same colorants should be used when formulating the color of a product. However, in most cases, it is not possible. For example, pigment is the common colorant used in plastic and paint but not for paper or colored ink, where dye is usually the preferred colorant due to its solubility.

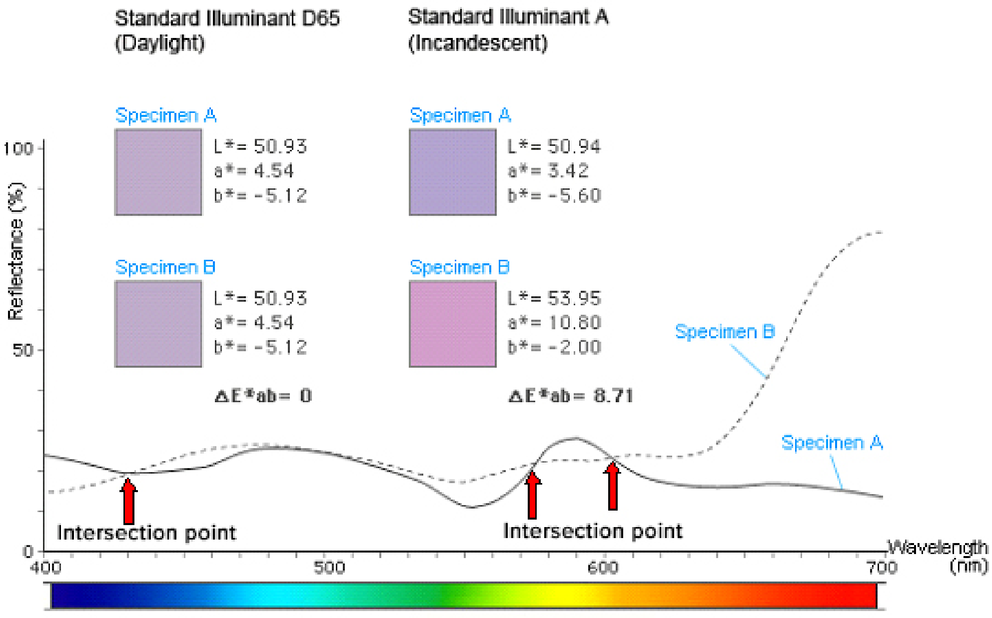
Hence, a [color formulation process](#) should be implemented to find the least metameric colorant combination for each color batch. This will minimize the metamerism effect and produce a good match.

A spectrophotometer can measure and evaluate the metameric properties of two specimens under two or more different illuminants, such as daylight (Standard Illuminant D65) and incandescent (Standard Illuminant A). Metamerism index (MI) can be calculated to indicate the relative color difference between two specimens under two different illuminants. A high MI value indicates the specimens is metameric.

A spectrophotometer also possesses the capability to display spectral reflectance curves of each color made by different color formulation or material independent of the lighting conditions.

When the colorant combination or material of two specimens is similar, the two spectral curves exhibited will be similar. This is known as a non-metameric match and the color of the two specimens will look the same in all lighting conditions.

Specimens are considered metameric when their spectral curves intersect each other at least three times.



Spectral Reflectance Graph

Figure 2 - Illuminant metamerism spectral reflectance curves

Goniochromism

Goniochromism is a phenomenon where surfaces that show metallic-looking color that change noticeably as the angle of view or illumination changes. This phenomenon is sometimes associated to geometric metamerism, where two colors appear to match at one angle of illumination and viewing but different when the geometry of illumination or viewing changed.

This phenomenon occurs when gonioapparent pigment such as metallic flake pigment, pearlescent pigment, or light interference pigment is used in the color formulation of the material or coating.

Challenges of Managing Color in White Goods

Special effect colors created by gonioapparent pigments provide a dynamic and appealing appearance and have gained popularity in the household appliance industry. The appearance of special effect colors depends strongly on the illumination and viewing geometries, hence, making the characterization of such colors a great challenge for appliance manufacturers.

Metallic coating contains lustre pigments like metal flakes that act as tiny mirrors. When the light illuminates the metallic coating from a single direction, in addition to specularly reflected light and diffusely reflected light, there is also light reflected from the surfaces of the metal flakes.

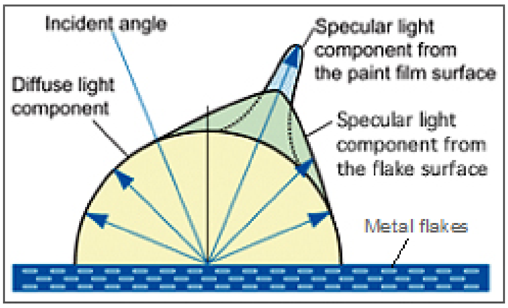


Figure 3 - Metallic coating reflection

Metallic and pearlescent paints use the variations in reflected light from the lustre pigment to provide an effect in which the paint appearance varies according to the angle from which it is viewed or illuminated.

Capturing and evaluating the effect of the lustre pigment using a color-measuring instrument with single geometry like d:8 or 45:0 geometry is not possible. Proper characterization of the goniochromatic effects of metallic and pearlescent coating requires a multi-angle spectral measurement at three critical aspecular angles (i.e., Highlight, 45:0, Shade) minimally.

Methods of characterizing and measuring metallic and pearlescent surfaces are being standardized by the standardization committee, such as the American Standard Test Method International.

Modern portable multi-angle spectrophotometer has been developed to provide controlled viewing conditions for judging these special effect colors.

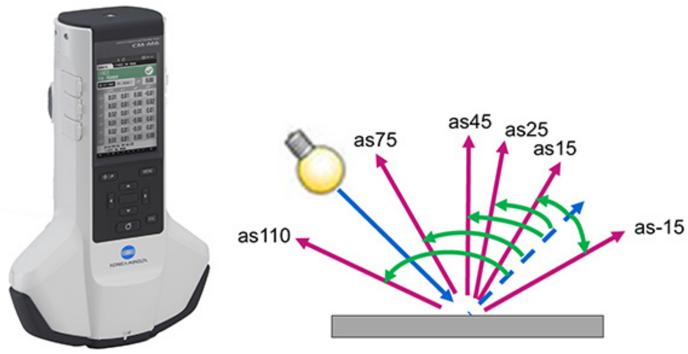


Figure 4 - Multi-angle Spectrophotometer CM-M6 with 6 angles

Derived from our state-of-the-art optical and image processing technologies, Konica Minolta color and appearance measuring instruments, consisting of benchtop to portable spectrophotometers and colorimeters, are widely used in the household appliance industry.

Download our educational booklets to learn more about the basic of color science. Alternatively, you can also check out our testing and measurement solutions for white goods applications to learn more.

Contact us for a free product demonstration or consultation on how you can improve your color management process, including selecting the right tools and methodology for your color measurement needs.