

Applications Note

AN 1074

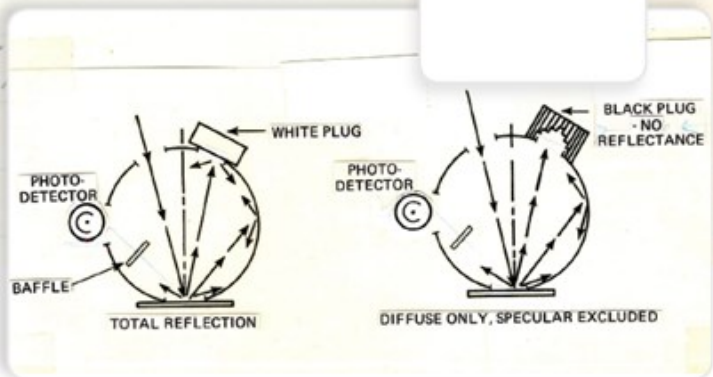
$\Delta = 2t + \frac{\lambda}{2}$ (must equal a whole number of λ for a bright fringe or

$$n\lambda = 2t + \frac{\lambda}{2}$$

$$t = \frac{n\lambda - \frac{\lambda}{2}}{2} = \frac{\lambda}{2} \left(n - \frac{1}{2} \right)$$

substituting

$$D^2 = 2s \left[\frac{\lambda}{2} \left(n - \frac{1}{2} \right) \right]$$



Measuring Appearance

All manufacturing industries are concerned with the appearance of their products. Measurements improve product quality, diminish rejects, decrease cost and reduce customer complaints.

Abstract

The overall appearance of any object is a combination of its chromatic attributes (color) and its geometric attributes (like gloss, shape, texture, shininess, haze, and translucency). Thus, both types of attributes should be measured and accounted for when making visual or instrumental assessments of appearance.

Chromatic Attributes

Chromatic attributes are those attributes associated with color. They are normally divided into three components:

- **Lightness**, whether the color is closer to black or white. Sometimes the term "value" is used rather than lightness.
- **Hue**, the perceived color of an object, such as red, green, blue, yellow, or orange.
- **Saturation**, the degree of departure from gray. This is the vividness or purity of a color. For example, bright candy apple red is more saturated than dull brick red.

In general, it is the chromatic attributes of appearance that are measured using HunterLab spectrophotometers and colorimeters, although the chromatic attributes of an object can never be completely separated from its geometric attributes.

Geometric Attributes

Geometric attributes are those attributes associated with distribution of light from an object. For instance, a flat cotton weave fabric is very different geometrically from a corduroy. A glossy photo print looks quite different than a matte one. There are many geometric attributes. Several examples are provided below.

- **Gloss**, the property of a surface responsible for shiny or lustrous appearance.
- **Haze**, the scattering of light within the surface of a nearly clear sample that is responsible for a cloudy appearance.
- **Directionality**, the characteristic of a sample which causes it to look differently depending on which direction it is turned.

Why is Product Appearance So Important?

All manufacturing industries are concerned with the appearance of their products. When consumers have a choice and all other factors are equal, they buy what looks best. Appearance is the foremost and most impressive product message.

Buyers also expect uniformity of appearance within any group of the same product. When consumers see a difference between several of the same product on display, that difference is associated with poor quality. Visual appeal and uniformity of appearance have such importance that quantitative identification of appearance is demanded in every marketplace.

Using HunterLab instruments and problem-solving approaches, the distinctive appearance attributes of a wide variety of products can be measured. These attributes include color, gloss, opacity, haze, whiteness and yellowness.

HunterLab manufactures a complete line of instruments for the measurement of appearance, including colorimeters and spectrophotometers for the physical analysis of color and various types of on-line continuous monitors. In addition, HunterLab provides technical advice through its help desk and can measure samples through its Technical Services Department using its color testing laboratory

Some of these types of products are outlined below.

Chemicals. The chemicals in paints, plastics, inks, ceramics, textiles, cosmetics, and foods are often responsible for their recognizable optical properties. Appearance measurements of these ingredients are used to predict the visual-optical qualities of the final product. The bonding materials, the light-scattering pigments used to reflect and diffuse incident light, the light-absorbing components which generate color and, in fact, the total surface composition, must be carefully controlled in order to achieve the desired final appearance.

Coatings. Many different paints, lacquers, varnishes, and other coatings, both pigmented and clear, are used to finish a wide variety of materials. Most protect the object while also providing desired appearance. Appearance tolerances must be tightly established and strictly maintained for coatings. For example, paint for a building cannot show dividing lines between the areas covered by paint from different batches, and the various components of automobiles or household appliances which are painted in different places with batches of paint made at different times, must still match.

For example, An appliance manufacturer was informed by his customer, a major retailer, that a shipment of color- coordinated appliances did not match visually. HunterLab was asked by the manufacturer to determine the accuracy of the color match of the appliances to the color standard.

HunterLab's investigation revealed that both the manufacturer and the retailer were making visual matches to a specified color standard. Since their visual assessments were subjective and could not be easily resolved, HunterLab obtained spectral reflectance curves of the product standard and a sample using a spectrophotometer. It was found that the product sample was actually within the specified tolerances when measured under the illuminant that simulates northern daylight (Illuminant C). However, the manufacturer was viewing the product under incandescent lighting (illuminant A) and the retailer was viewing it under fluorescent lighting (Illuminant F), so a difference was observed due to a phenomenon known as metamerism. That is, two colors which match under one light source may not match under another light source.

Food. Consumers have developed strong associations through appearance, and base their pre-purchase judgments of taste and quality on the appearance of the package or the product, possibly as seen through a transparent wrapper or counter window.

The food industry is also limited by governmental regulations in the correction of product color. Appearance measurement techniques, therefore, must be used upon the arrival of raw materials, at each production stage, during transportation and storage, and when the products are placed on the shelves of the retail stores.

A major producer of quality wines found through market testing that the clarity, or absence of haze, of wines was directly related to brand preference and that, in many cases, the slightest suggestion of haze, even though unrelated to taste or color, was unacceptable to consumers.

It was further found that the degree of haze was difficult to determine visually, yet strict specifications were to be enforced on haze tolerances. HunterLab was asked to study the feasibility of measuring both haze and color with a single instrument. After consultation, a benchtop sphere instrument replaced visual evaluations for both color and relative haze. The Vista and the UltraScan-series spectrophotometers were designed so that liquids, films, and any other products which transmit light can be feasibly measured.

The producer now maintains strict adherence to haze tolerances even though color may vary slightly from one bottling to the next. Now the instrument is also being used to measure the many varieties of grapes for blending purposes.

Metals. The high intensity of the specular refraction from metal products permits the eye to discriminate between small differences in surface texture.

In the metal manufacturing process, the raw material and metal-plating procedures are quite important and correlate closely with the amount of hand labor or machine buffing required before plating. Appearance measurement applied consistently most economically produces the product and assures the maintenance of the desired visual characteristics.

Paper. Most paper and packaging materials made from paper must be attractive and conform precisely to appearance specifications.

The use of optical measurements leads to substantial raw material cost reductions and decreased processing costs. Large, fast, computerized paper manufacturing machines now make it necessary to attain the specified quality rapidly and to have immediate warning of any departure from specifications. The use of continuous-monitoring on-line devices provides the reliable measurements required for almost instant decision-making and results in measurable cost reduction.

Example: A paper mill adjusted its production run of a high-gloss paper intended for the printing of half-tone photographs. However, the gloss then decreased and the color began to change. Since these problems were not detected immediately, much of the paper had to be recycled at great cost.

A HunterLab colorimeter to measure color and a glossmeter to measure gloss were placed in operation. The mill now consistently produces the desired quality paper. Thus, the instruments directly helped to increase profits. Variations of these instrument systems have also proven to be valuable in the coatings and plastics industries.

Plastics. Finished plastic products range from thin, flexible films to thick cast sheets and molded, extruded, or otherwise formed objects. They may be transparent, translucent, or opaque, and have textured, smooth or metallized surfaces.

Since plastics are used in a great number of products, appearance measurement assumes major importance. Such measurements must be used in assessing raw materials (such as pellets, powders or flakes), formulating specified colors, and predicting and achieving the desired final product appearance.

Example: A large plastics company makes white, opaque plastic pellets. On occasion, they must switch the production line from making the opaque pellets to making the clear plastic product. To determine if the opacifier had been sufficiently purged from the product, they would press a plaque from the pellets and determine opacity visually. Meanwhile, the production line was still turning out pellets that had to be recycled while they were making the plaque and the visual assessment.

The manufacturer purchased a HunterLab spectrophotometer, and now they quickly measure the L* value of raw pellets to determine whether the opacifier has been sufficiently removed. The quicker decision means that less product must be recycled.

Textiles. Clothing enhances the appearance of people, and rugs, draperies, upholstered furniture, and other textiles beautify the interiors of buildings. In cars, vans, campers, and mobile homes, fabrics create comfortable, noise-absorbing atmospheres.

Color measurements conducted on incoming raw materials, during fabric coloring, and on final textiles products, are imperative. They provide insurance against customer rejection of products and allow identification of the least expensive ingredients and processing required. Instrumental measurements allow reproducible product to be made and guide in the development of new and improved products.

Shade sorting has become essential for garment and textiles producers. The shade sort measurement system enables mills to inventory and coordinate goods by shade numbers. They are therefore assured of a proper visual match between all the pieces in a set.

Example: A major garment manufacturer discovered that pieces of cloth cut from different bolts, but from the same lot, did not appear to match when the pieces were sewn together to make suits. The textile mill was informed of the problem and had to accept the material returned by the clothing manufacturer.

The mill purchased a HunterLab spectrophotometer and software system that has the capability of rapidly accepting, memorizing, comparing, and arranging thousands of bits of data to define the shade of a specimen. The mill was then able to determine which of the various shades within certain tolerances could be sewn together without noticeable differences.

About HunterLab

HunterLab is the technology leader in color measurement solutions, providing instruments, software, knowledge and service to a wide variety of industries.

With over 5 decades of experience in more than 65 countries, HunterLab applies our leading edge technology to your products helping you measure and communicate color simply and effectively.

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