

# Color

## Color vs. Appearance

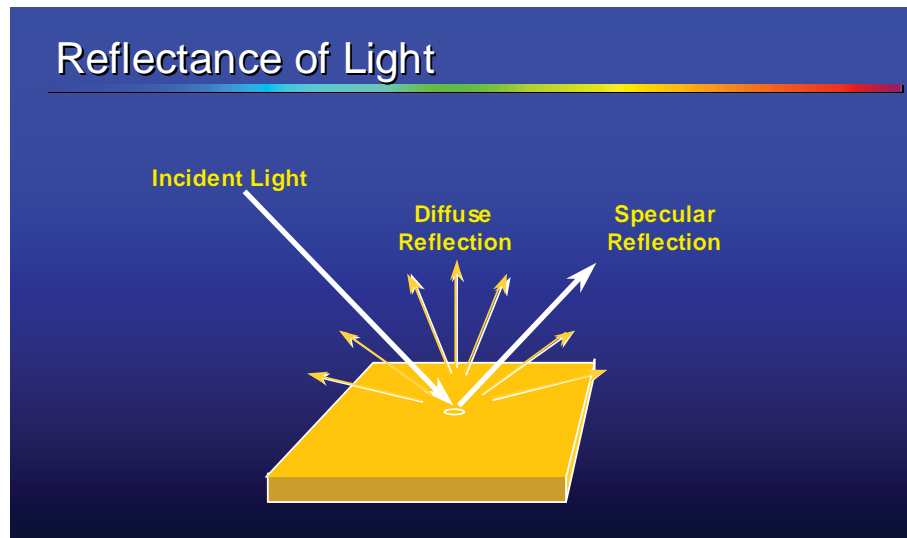


Choose the appropriate instrument geometry for your color measuring instrument.

*With the number of color measuring instruments on the market, how do you choose the most appropriate one? It helps to understand the difference between measuring color and measuring appearance.*

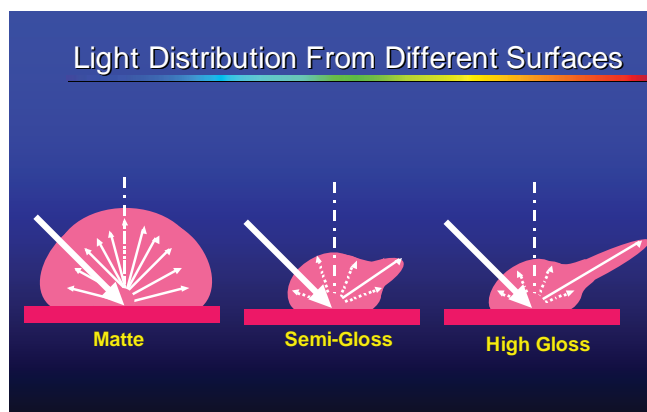
When light strikes an opaque object the total amount of reflected light is characterized as two distinctly different light reflections from the surface: specular reflection and diffuse reflection.

Specular reflection is light that is directed at an angle opposite to the incident light and is perceived by the observer to be glare caused by the shininess or glossiness of the sample. To see the apparent color of the sample, observers must move their eyes away



from the glare (specular) and concentrate on examining the diffuse (scattered) reflectance from the sample. These viewing conditions have led to standardized test methods such as ASTM D 1729, "Standard Practice for Evaluation of Color Differences of Opaque Materials." When the smoothness of a surface changes (lower gloss or increased texture, for example), the light-reflection characteristics from that surface become much more complicated. For a medium-gloss sample, the amount of specular reflectance decreases in one direction, then spreads out and

becomes mixed with the diffuse reflected light. A matte or heavily textured specimen scatters almost all the specular light that mixes with the normally scattered diffuse light, causing an apparent dilution of the perceived color. Since the specular light is normally white, the appearance is a lighter color with less chroma when it is mixed with the colored diffuse light. Therefore, the appearance of the color has been affected by the scatter of the specular light. To the average observer, a high-gloss specimen would appear to have more chroma and be a darker color than an identically pigmented specimen with lower gloss or increased surface texture.



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## Instrument Types

There are basically four geometries for color-measuring instruments:

- Sphere-based specular-included*
  - Sphere-based specular-excluded*
  - 0/45 - degree*
  - 45/0 - degree*
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## Sphere-Based Specular-Included

The integrating sphere type of geometry, which is most commonly the d/8 degree design, provides diffuse spherical illumination and 8-degree viewing conditions. When operated in the specular-include mode, the total reflectance (diffuse + specular) can be measured. Therefore, when comparing samples with different surface textures or gloss levels, the specular has been included in the overall measurement. This serves to negate the effect of the specular, which varies from sample to sample, from the overall measurement and permits the analysis of color composition, or pigment.

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## Sphere-Based Specular-Excluded

Some sphere instruments can also be operated in a specular-excluded mode. The measurement is accomplished by opening a port on the sphere wall that allows the specular component of light to exit and not be measured. Due to the nature of the design of sphere instruments, the size of the specular-excluded port is limited. When measuring very high-gloss (mirror-like) surfaces, the specular component can be properly excluded as all specular light passes through the port. However, when measuring medium-gloss, low-gloss or textured specimens, the specular has been spread over an angle greater than what can be properly excluded by the port opening. Thus, a small, variable portion of the specular will inevitably be included.

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## 0/45- and 45/0-degree

These instruments simulate the standardized methods for making visual evaluations. They avoid the specular component, like a person does when examining the appearance of color.



Two parameters affect the appearance of color:

- the basic pigment formulation*
- the surface characteristics*  
(*gloss, texture, pattern, etc.*)

Therefore, 0/45-or 45/0-degree instruments are most often used in quality-control applications where the overall appearance and batch-to-batch consistency of the product must be controlled. A 0/45-or 45/0-degree instrument is very sensitive to a change in any of the parameters of appearance and will alert the user that a problem exists.

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## Which geometry is best?

Although determining the most appropriate instrument really depends on the application, a few general rules apply. To negate the effects of surface characteristics, such as gloss, texture and pattern, and simply measure color, use a sphere - based instrument in the specular-included mode. To measure appearance –the basic color composition in combination with the surface characteristics of gloss, texture, pattern, etc.– use a 0/45-or 45/0-degree instrument.

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