Applications Note

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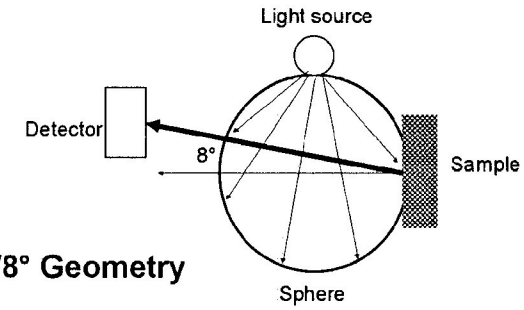
Instrument Geometries and Color Measurements Part II: Diffuse/8°

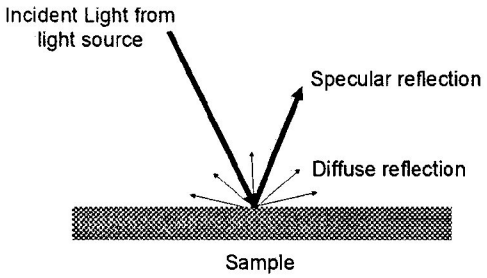
Description

In a description of instrument geometry, the first number is the angle or method of illumination and the second number is the angle or method of view. These are both relative to the perpendicular to the surface of the sample being measured. In an instrument with a diffuse/8° geometry, the sample is illuminated diffusely (from all directions), and the viewer (detector) receives the reflected light at a location 8° from the normal to the sample surface. See the diagram below. Diffuse/8° geometry is also known as "sphere" geometry because a white-lined diffuse-integrating sphere is used to project the light. Light is cast into the sphere and diffused by the sphere coating. The following HunterLab instruments are built using this geometry: ColorFlex Diffuse, ColorQuest XE, ColorQuest XT, MiniScan XE Plus Diffuse, UltraScan XE, UltraScan PRO, and UltraScan VIS.



Diffuse/8° Geometry

The 8° viewing variance from the normal allows some of the instruments (ColorQuest XE, UltraScan XE, UltraScan PRO, and UltraScan VIS) to measure reflectance in either specular included or specular excluded mode. The specular included mode measures *total* reflectance, including diffuse reflectance (color) and specular reflectance (direct reflectance of the light beam in an equal, but opposite, direction; mirror-like reflection or highlight). These two types of reflection are illustrated below. The specular excluded mode measures diffuse reflection only. The specular component is excluded by opening the section of the sphere from which light would ordinarily be specularly reflected from the sample to the detector. Note that specular exclusion is not complete in sphere instruments, so different models may yield different results in specular excluded mode. This difference is particularly noticeable for dark, glossy samples.



Sphere instruments used in the reflectance specular included mode minimize the effect of differences in gloss, texture, and directionality. For example, if two equally pigmented samples, one glossy and one matte, were measured on a sphere instrument, the readings would indicate that they are roughly equivalent in pigment color, even if they do not appear to be the same visually.

Applications

- Color formulation.
- Measurements for which choice of reflectance mode is important.
- Transmittance measurements of translucent and transparent materials, and for haze measurements (ColorQuest XE, UltraScan XE, UltraScan PRO, and UltraScan VIS only).
- Color of brightened bare metals by reflection with specular component included.
- Color matching to a standard of different surface texture.
- Color quality assurance of opaque specimens.

How the Numbers Look

In order to demonstrate that sphere instruments eliminate the effects of texture and gloss, readings of a single piece of plastic with a matte section and a glossy section were made. On visual assessment, the shiny part of the sample looked darker and more saturated that the matte section. Two measurements of each section were made using an UltraScan XE in RSIN mode.

Plastic ID	L (D65/10°)	a (D65/10°)	b (D65/10°)
Glossy 1	30.67	22.49	7.69
Glossy 2	30.70	22.54	7.72
Matte 1	30.12	22.93	7.98
Matte 2	30.10	22.85	7.95
Range	0.60	0.44	0.29

These numbers agree with our knowledge that the two sections of the plastic contain equal amounts of pigment. The L, a, and b values are very comparable for the two sections.

In order to demonstrate the difference between specular included mode and specular excluded mode, a single glossy tile was measured on the same ColorQuest XE in both modes. Two measurements in each mode were made and an average calculated.

RSIN ID	L (D65/10°)	a (D65/10°)	b (D65/10°)	RSEX ID	L (D65/10°)	a (D65/10°)	b (D65/10°)
Reading 1	48.98	-16.30	8.54	Reading 1	43.94	-17.94	9.38
Reading 2	48.98	-16.29	8.54	Reading 2	43.88	-17.90	9.39
Average	48.98	-16.30	8.54	Average	43.91	-17.92	9.39

As you can see, the numbers obtained using the two modes are indeed different.

References

Billmeyer, Fred W., Jr. and Saltzmann, Max, *Principles of Color Technology*, New York: John Wiley & Sons, Inc., 1981.

Hunter, Richard S. and Harold, Richard W., *The Measurement of Appearance*, New York: John Wiley & Sons, Inc., 1987.

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