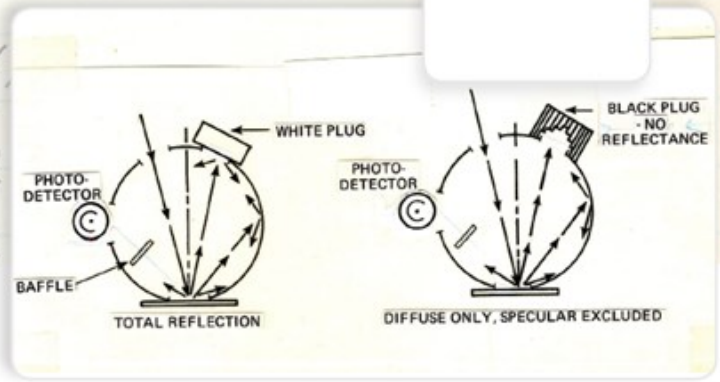
Applications Note

AN 1088



Measuring Reflectance: Specular-Included vs. Specular-Excluded

. . . to measure appearance and appearance difference , . . . you would want to measure in RSEX mode.

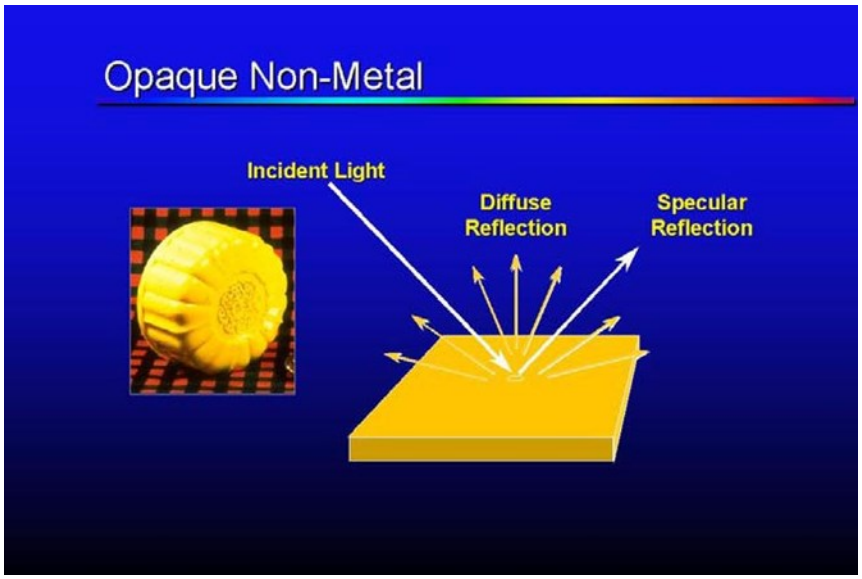
Abstract

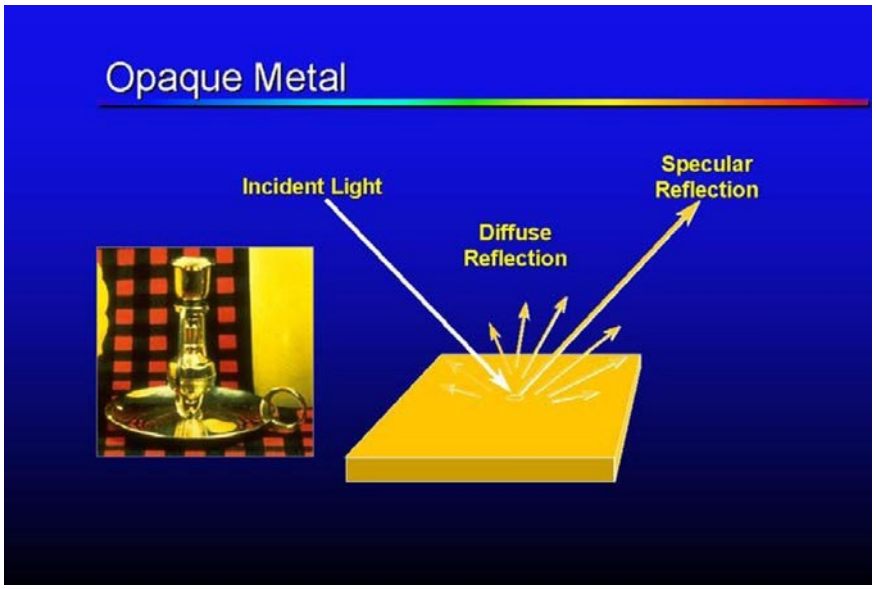
HunterLab benchtop sphere (diffuse/8°) instruments, can measure reflectance in two different modes:

Reflectance-specular included (RSIN), which includes diffuse reflectance (color) and specular reflectance **Reflectance-specular excluded (RSEX)**, which measures diffuse reflectance only.

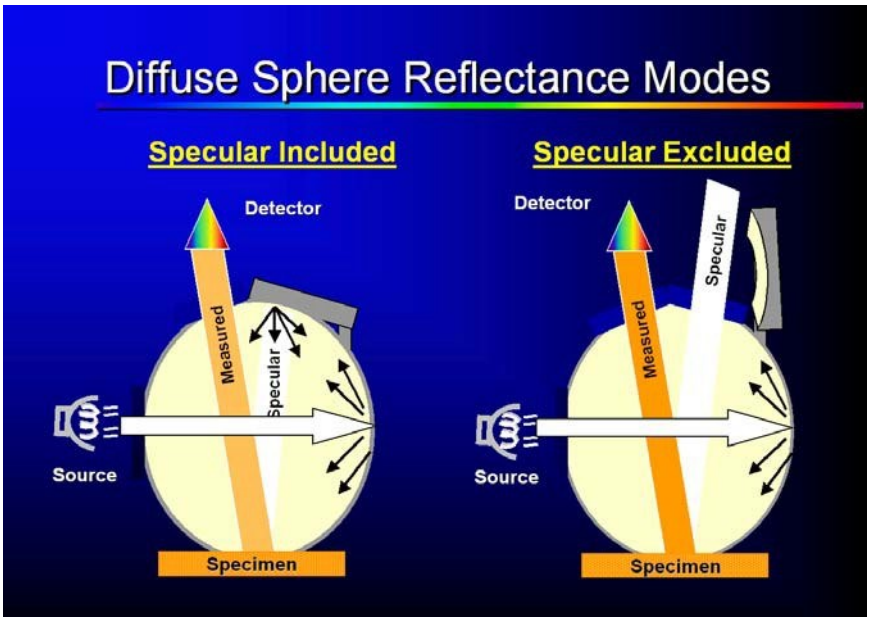
The world's true measure of color
HunterLab

Diffuse and specular reflectance are illustrated in the images below for the two types of samples normally measured in reflectance.





When RSEX mode is being used, the specular component of the reflected light is excluded from the measurement by opening the section of the sphere where light would ordinarily reflect specularly from the sample to the detector. For the UltraScan VIS and UltraScan PRO this is done using a motorized specular-included/excluded port door that opens or closes the appropriate section of sphere as needed. The instrument configurations for a sphere instrument with the sphere port door closed and open are shown in the next figure.



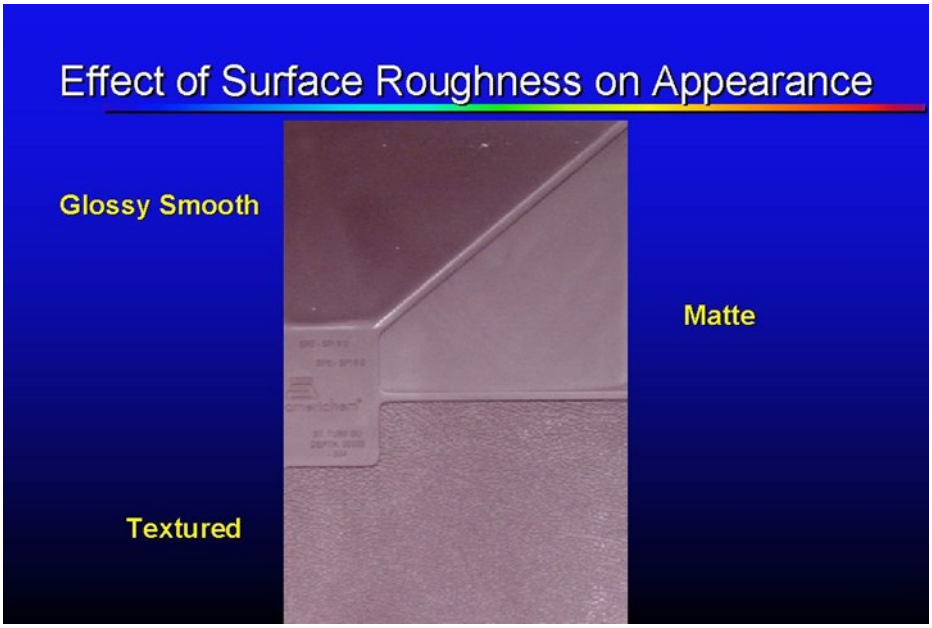
These images show what the two modes look like inside the transmittancecompartment of an UltraScan VIS or UltraScan PRO.

Specular port closed

Specular Port Open

So, when should RSIN mode be used and when should RSEX mode be used?

In general, brightened bare metals should be measured in RSIN mode, since their color is seen primarily in the specular reflection. If your sample is not a shiny metal, though, the answer to the RSIN versus RSEX question depends on the answer to another question: *Do you want your measurements to measure color as an actual physical property (as if to determine the exact amount of pigment used), or do you want to measure specimen appearance (that is, what it looks like to a human being)?* Consider a sample of a single color of plastic or paint with areas that differ only in surface texture, as in the picture below.



The color is constant throughout the three areas, as previously mentioned. However, the surface texture makes them *appear* differently to the eye. The glossy smooth area appears darker and more saturated than the matte and textured areas.

If the three areas were measured on a sphere instrument in RSEX mode, which approximates the way the glossy surface would ordinarily be viewed visually, the appearance difference would be shown by the instrumental measurements. If, on the other hand, the areas were measured in RSIN mode, measuring all the light the sample reflects, the values would indicate that the color is indeed the same across the three areas.

As an illustration, a single paint chip with both a glossy surface and a matte surface was measured in RSIN and RSEX modes on an UltraScan. As you can see from the table below, in RSEX mode, the difference between the two surfaces was readily apparent (DEcmc is 2.75), but not significant in RSIN mode (DEcmc of 0.21).

RSIN					**RSEX**				
	L*	**a***	**b***			**L***	**a***	**b***	
Glossy standard	32.97	19.24	5.17		Glossy standard	25.00	25.84	7.68	
	DL*	**Da***	**Db***	**DEcmc**		**DL***	**Da***	**Db***	**DEcmc**
Matte sample	0.24	-0.01	-0.16	0.21	Matte sample	3.08	-2.76	-1.44	2.75

Therefore, if you want your instrument to measure **appearance** and **appearance difference** as seen by the eye, taking into account the effects of texture and finish, you would want to measure in **RSEX** mode. If you were concerned with the **actual color content** or doing **color formulation**, you would want to use **RSIN** mode.

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.

© Hunterlab 11/2023

The world's true measure of color
HunterLab