Reflectance of Light

- For opaque materials most of the incident light is reflected.

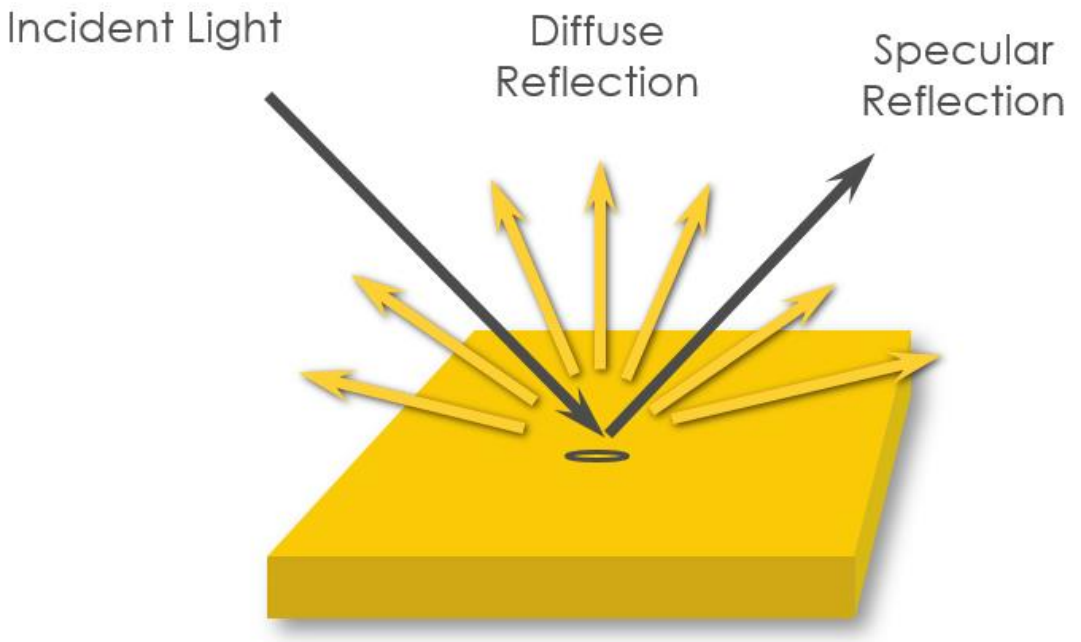
Color is seen in the diffuse reflection and gloss is seen in the specular reflection.

The reflection at the specular angle is generally the greatest amount of light reflected at any single angle.

However, specular reflection represents less than 4% of total reflected light.

The remaining reflection is diffuse reflection.

Reflectance of Light



Effect of Surface Texture on Perceived Color

- Samples that are exactly the same color, but have different surface textures, will appear different.
- Glossy surfaces appear darker and more saturated.
- Matte and textured surfaces appear lighter and less saturated.

Effect of Surface Texture on Perceived Color

Rough

Glossy

Matte

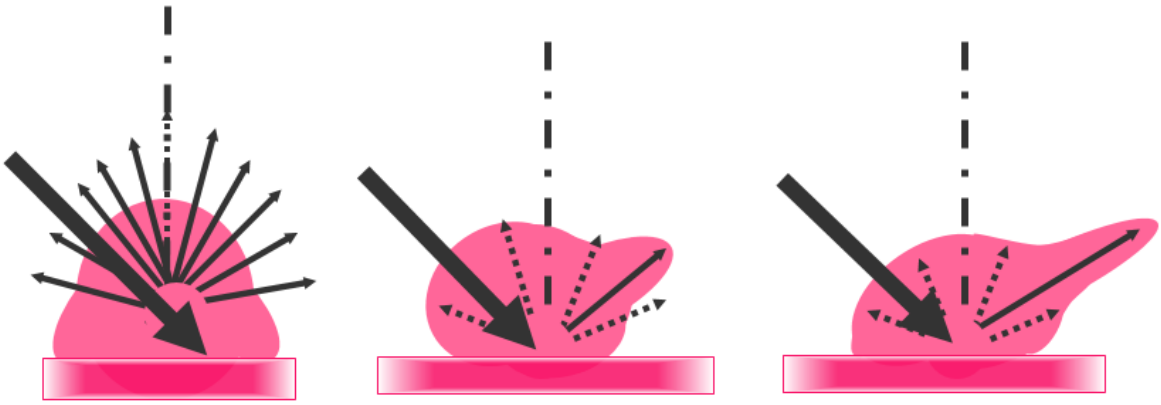
Effect of Surface Texture on Perceived Color

- Increased surface roughness affects perceived color such that it appears lighter and less saturated.

  This is caused by mixing diffuse reflectance (where we see pigment color) with increased scatter from specular reflectance (white).

  The rougher the surface, the greater the scatter of the specular reflectance.

Light Distribution From Different Surfaces



Matte **Semi-Gloss** **High Gloss**

Instrument Geometry

- Instrument geometry defines the arrangement of light source, sample plane and detector.

There are two general categories of instrument geometries:

Directional (45°/0° or 0°/45°) and **diffuse** (d/8° sphere).

Directional Geometry

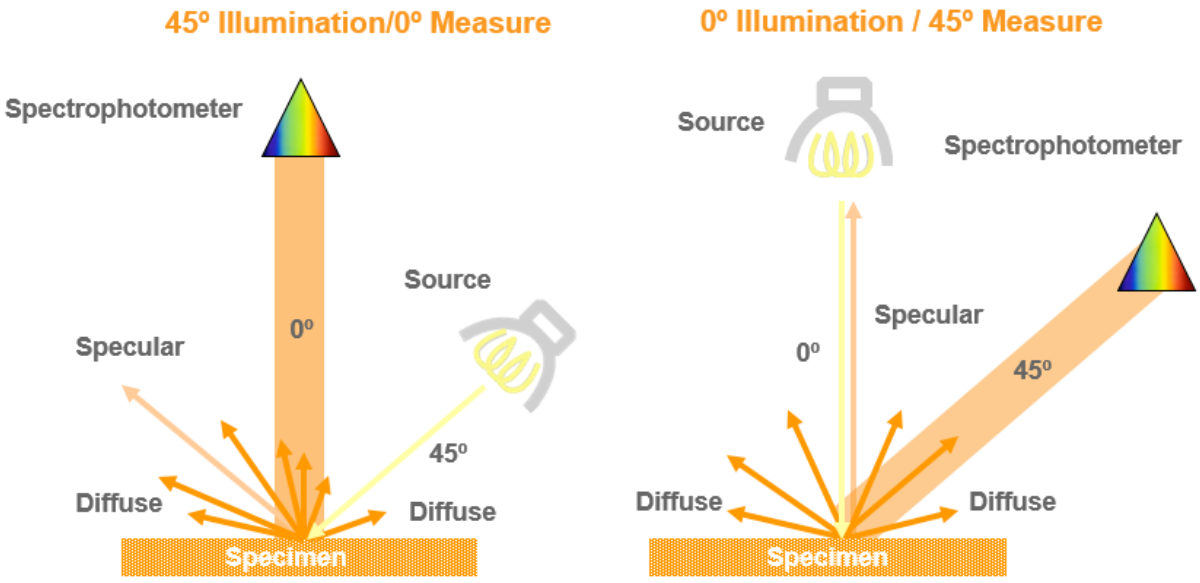
- **Directional 45°/0°** geometry has illumination at a 45° angle and measurement at 0°.

The inverse **0°/45°** geometry has illumination at 0° and measurement at 45°.

Both exclude the specular reflection in the measurement (specular excluded).

This provides measurements that correspond to visual changes in sample appearance due to either changes in pigment color or surface texture.

Directional 45º/0º and 0º/45º Geometry



Gloss Effect on Color Difference Measurement

On the following slide the paint on the card is the same color across the entire card. The right side has a matte surface finish and the left side has a high gloss finish.

The color difference measurement, made using a directional instrument, indicates a color difference that agrees with visual evaluation (the matte side is lighter and less red).

Directional instruments measure both the effect of the pigment and the effect of the surface finish. They are appropriate for quality control applications where agreement with what you see is important.

Gloss Effect on Color Difference Measurement

Directional 0°/45° Geometry

	ΔL*	Δa*	Δb*
Specular Excluded	**1.4**	**-1.5**	**-1.2**

Diffuse Geometry

Diffuse (**sphere**) geometry instruments use a white coated sphere to diffusely illuminate the sample with 8° (**d/8°**) viewing.

Measurements on a diffuse sphere instrument can be taken with the **specular included** or **excluded**.

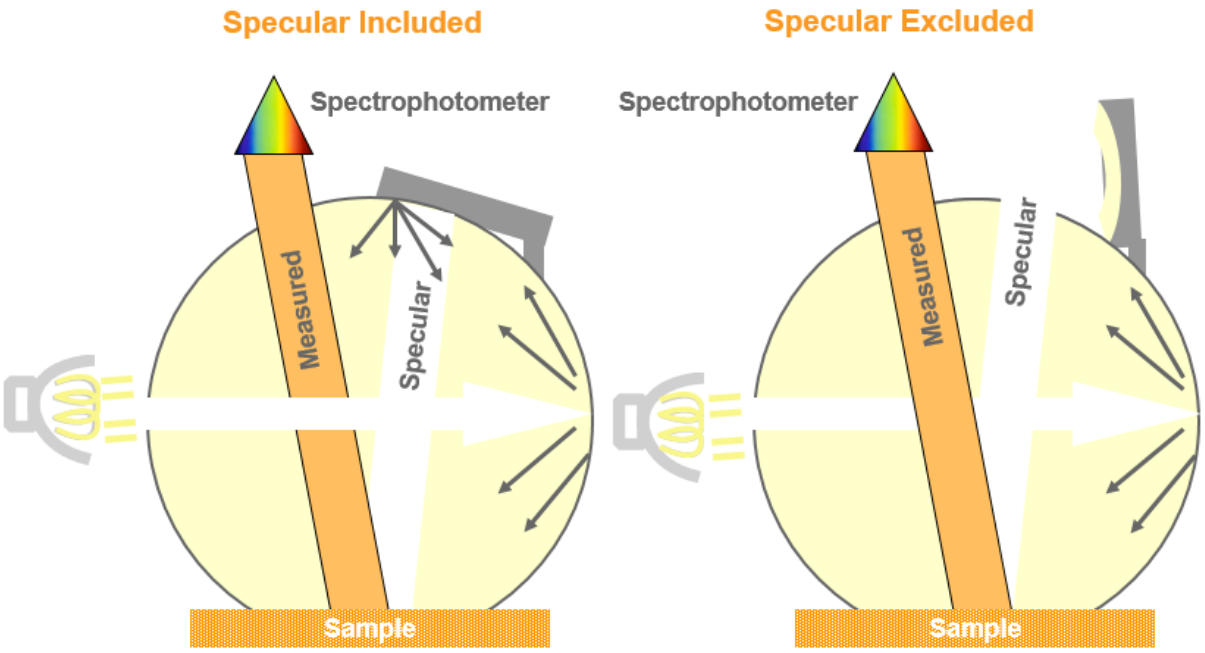
Diffuse Geometry

Specular Included measurements negate surface differences and provide values which correspond to changes in color.

Specular Excluded measurements negate specular reflectance on very smooth surfaces, measuring only diffuse reflectance.

Most measurements are taken in the specular included mode.

Sphere Geometry d/8º



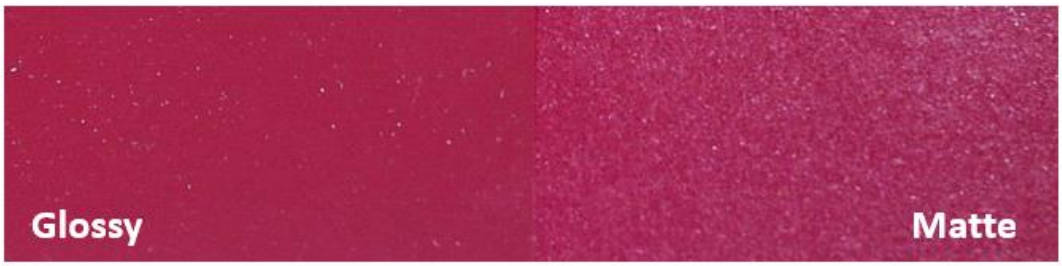
Gloss Effect on Color Difference Measurement

On the next slide measurements were taken on the same card, using a diffuse d/8° sphere instrument.

The specular included measurement indicates no color difference. It quantifies only colorant differences and negates differences in surface finishes.

In the specular excluded mode, the readings quantify appearance differences, similar to those from the 0°/45° instrument.

Gloss Effect on Color Difference Measurement



Sphere Geometry

	ΔL*	Δa*	Δb*
Specular Included	0.0	0.1	-0.0
Specular Excluded	1.8	-1.6	-0.9

Texture Effect on Color Difference Measurement

Sphere Geometry

	ΔL*	Δa*	Δb*
Specular Included	0.1	-0.1	0.1
Specular Excluded	2.0	0.5	1.0

0º/45º Geometry

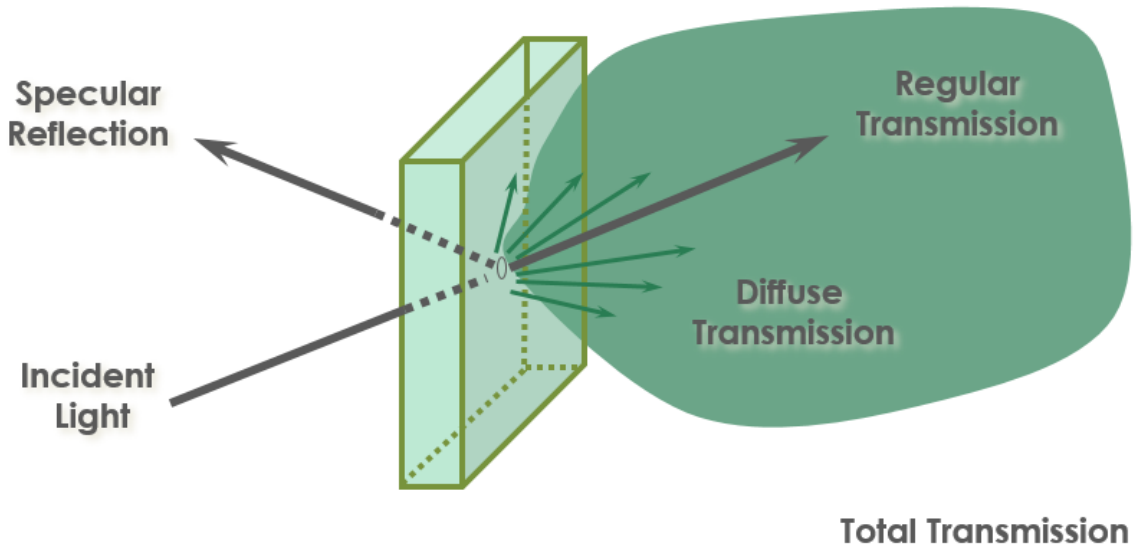
	ΔL*	Δa*	Δb*
Specular Excluded	5.2	1.8	2.5

Sphere Geometry for Transmission

Sphere geometry instruments also have the ability to measure the color of transmitted light.

- Color is seen primarily in **Regular Transmission** which transmits straight through transparent solids and liquids.
- Surface texture or internal scattering within the material can cause the light to scatter or diffuse.
- **Diffuse Transmission** also contains color of the material.
- **Total Transmission** is a combination of regular plus diffuse transmission.

Transmission of Light



Sphere Instrument Measuring in Transmission

HunterLab

UltraScan® VIS