Spectrophotometers have changed the way color is evaluated and are an integral part of product research, development, and manufacturing across industries and around the world. The advanced spectral analysis made possible by these instruments allows for unprecedented color quality control while simultaneously increasing efficiency and offering significant opportunities for cost-saving. However, the specific type of spectrophotometer you select can have a great impact on your color measurement abilities and results.[1] Choosing the correct instrument for your purposes requires an understanding of optical geometries and how they affect your ability to obtain the data you need.

Directional 45°/0° Spectrophotometers

With a directional 45°/0° geometry, the sample is illuminated at a 45° angle while reflected light is measured at a 0° angle to the surface of the sample. Spectrophotometers employing this method of measurement may be designed in one of two ways:

- **Bidirectional instruments**: Two light sources are placed on opposite sides of the sample and simultaneously illuminate the sample. Due to the effects of sample directionality, it is best to take an initial measurement, then rotate the sample 90° to measure it again and average the two readings.
- **Circumferential instruments**: Multiple lights are used to form a ring around the sample and evenly illuminate its surface to reduce the effects of sample directionality, eliminating the need for multiple measurements.

45°/0° spectrophotometers are designed to mimic human sight and perceive color in the same way the eye does.[2] Because they measure only diffuse reflectance and exclude specular information—also called reflectance-specular excluded (RSEX) mode—they automatically include the effects of geometric attributes, such as texture and gloss, to quantify sample appearance rather than color alone. As such, a glossy sample will appear darker than a matte sample even if the two are identically pigmented. This makes them the best choice for color matching samples with disparate geometric attributes to ensure a cohesive appearance. However, being confined to RSEX mode can be limiting and may prevent you from being able to obtain the data you need in certain situations. For example, if a single piece of plastic contains both glossy and matte surfaces, 45°/0° instruments will produce different readings for each surface type, leaving you unable to evaluate whether the plastic is consistently pigmented.

45°/0° spectrophotometers are also not considered suitable for measuring color in transparent samples because they are reflectance instruments and are not designed to operate in transmission mode. Although it is possible to measure transparent samples with careful sample preparation, it is not considered an optimal practice and is not a sustainable method for regular analysis of transparent samples. These instruments are also not able to produce the data needed for haze measurements.

Diffuse/8° Spherical Spectrophotometers

Diffuse/8° spectrophotometers, also known as spherical instruments, illuminate the sample equally from all angles while the reflected light is measured at an 8° angle from the sample surface. The diffuse nature of the illumination offers users several options not available in 45°/0° instrumentation.

- **Specular Reflectance Options**: d/8°spectrophotometers are typically used in reflectance-specular included (RSIN) mode to measure both specular and diffuse reflectance data and quantify the true color of samples regardless of geometric attributes. If objects of various textures and gloss levels must match in actual color rather than color appearance, RSIN is necessary to isolate chromatic information. Similarly, RSIN makes it possible to evaluate pigmentation consistency within a single

sample exhibiting texture variation. If desired, you can also obtain RSEX measurements, although in certain applications they may not be as reliable as those taken with a 45°/0° spectrophotometer.

- **Transmission Mode**: d/8° instruments can be operated in transmission mode to accurately measure the transmitted color of translucent or transparent samples.
- **Haze Measurement**: Measuring haze requires comparing the amount of diffuse light to the total transmitted light. Pairing your HunterLab d/8° spectrophotometer with EasyMatch QC softwareallows you to obtain highly accurate haze measurement in both solid and liquid samples.

The versatility and flexibility of d/8° instruments make them ideal for many applications in which 45°/0° geometry is unsuitable. These expanded measurement possibilities are critical for color formulation and quality control in many industries and have made d/8° spectrophotometers a very popular choice.

Full article with photos available here:

https://www.hunterlab.com/blog/color-measurement-2/understanding-optical-geometries-and-choosing-right-spectrophotometer-effective-data/