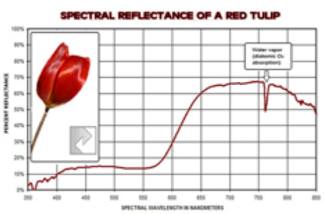
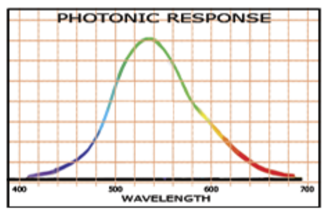
COLOR COMMUNICATION

Color space tends to be somewhat different from most physical measurements because color is a human perception. That is, color is a physiological perception based upon human vision. Although color is related to physical measurements of reflectance and transmittance of an object, color also needs to be considered in terms how a human will see that object. Thus, full consideration of color depends not only on physical properties of an object but also upon human vision of seeing it and the lighting under which the color is viewed. To provide standardization of color measurements, a standard (human) observer has been mathematically created and several illumination sources have been designated as standard illuminates

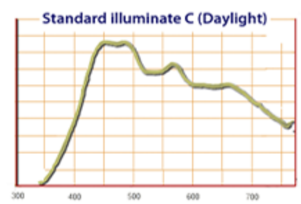
As can be noted in the chart below, a corrected spectrum which is a measurement of an object's physical characteristics needs to be multiplied by the photometric response in order to obtain a human vision response. Then, the result needs to be related to the illumination because illumination is needed so a human observer can see the object. With these two modifications made, color space can be calculated. Such calculations are readily implemented by use of color calculation software in Ocean Optics' SpectraSuite or in C-Spec.



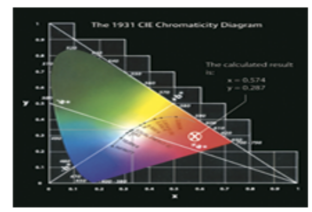
First, acquire a valid corrected spectrum of the sample



Then, multiply it by the response of the standard observer to obtain human vision.



Relate the spectrum to the light which illuminates the sample



The spectrum is now adjusted to human vision; color space may be correctly calculated

Set-up for color measurements

USB4000-VIS-NIR Spectrometer	$ 2,887.00
P400-2-VIS-NIR Fiber optic line	138.00
ISP-REF Illuminated integrating sphere	1,679.00
WS-1 Standard white	314.00
SpectraSuite software	199.00
Total price	$5,217.00
(or if bought together from Ancal, pack is	$4,999.00)

There are several fiber optic spectrometer systems which can be used for color measurements. The same basic spectrometer can be used for both reflective and transmissive measurements.

A system which is easy to use and which provides very good results is an Ocean Optics' USB4000 spectrometer coupled to a small illuminated integrating sphere. The system set-up is shown (left). For reflectance measurements, a sample (an object) is placed upon the integrating sphere. Light is then focused from the sphere onto the surface of the sample. Light reflected from the sample is collected by the sphere and transmitted to the spectrometer. Typically, such data can produces corrected reflectance spectra. Those spectra can then be related to color space as by appropriate color calculations.

For transmittance measurements, a similar measurement can be made. This measurement will entail having an external sources of illumination. With the internal sphere light off, a sample may be placed on the sphere orifice so that external light goes through the sample, into the sphere. For films, a sample can be placed directly on the sphere. For liquids, such as paint, a microscope slide or other transmitting medium may be coated with the sample and placed upon the sphere. For liquids which have very little absorbance, a cuvette may be used to provide a fixed path length (10 mm, etc.). In the case of samples in cuvettes, it is often better to use cuvette holders (i.e. CUV-UV or CUV-UV-10, etc.) for transmittance measurements. Once the entering light is collected in the sphere, it's sent to the spectrometer where it can be used to calculate CIE, L*a*b*, ΔE*, etc., color spaces.

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