

Applications Note

$\Delta = 2t + \frac{\lambda}{2}$ (must equal a whole number of λ for a bright fringe or $\frac{\lambda}{2}$ for a dark fringe)

$$n\lambda = 2t + \frac{\lambda}{2}$$

$$t = \frac{n\lambda - \frac{\lambda}{2}}{2} = \frac{\lambda}{2} \left(n - \frac{1}{2} \right)$$

substituting

$$D^2 = 2s \left[\frac{\lambda}{2} \left(n - \frac{1}{2} \right) \right]$$

AN 1080



Measuring Opacity

Consistency of backing type is important for comparing Opacity measurements.

Abstract

The Opacity of a material a.k.a. Contrast Ratio is an indication of how much light passes through the material. The higher the opacity, the lower the amount of light that can pass through the material. Generally, opacity is calculated from reflectance measurements of the material with a black backing and the material with a white backing.

Conditions for Measurement

Instrumental: Most HunterLab color measurement instruments. Availability may depend on the software package.

Illuminant: Any

Standard Observer Function: 2 or 10 degree

Transmittance and/or Reflectance: Reflectance.

Formulas

$$\text{Opacity} = \frac{Y_{\text{black backing}}}{Y_{\text{white backing}}} \times 100\%$$

Where, Y is the CIE tristimulus value Y.

Typical Applications

Opacity measurements are done on a variety of materials to determine the amount of light that passes through the materials .

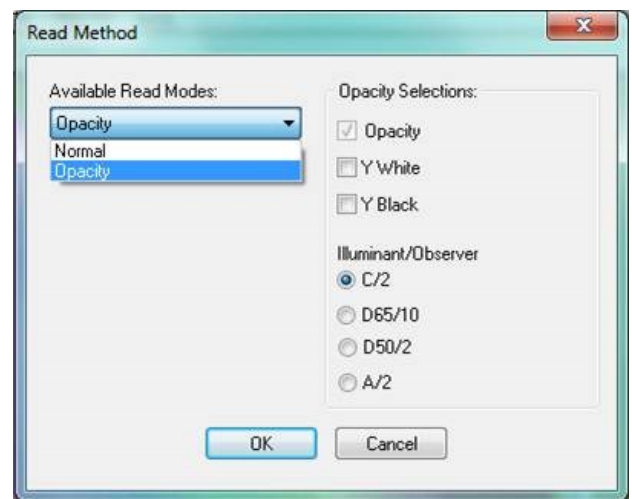
Measurements Using EasyMatch QC

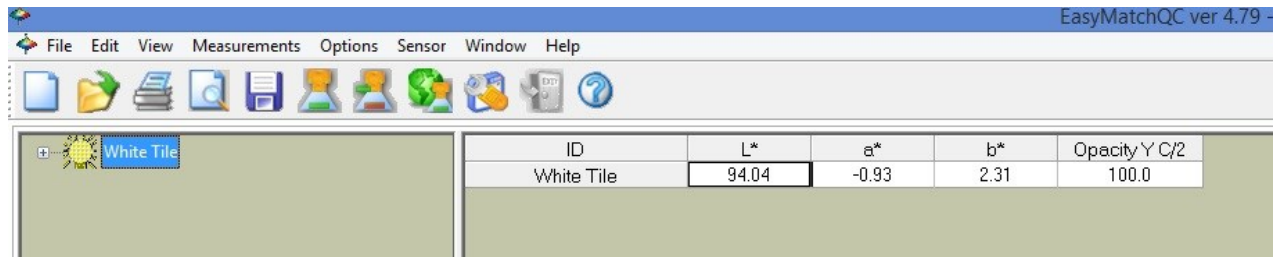
To perform opacity measurements in EasyMatch QC, first standardize the instrument in a reflectance mode. Once standardized in reflectance, select **OPACITY** to display in the Color Data View by going to **OPTIONS > READ METHOD**. A new window will open that allows you to choose Contrast Ratio Opacity as a read mode. Additional display options include the option to display:

- Y Brightness value of the sample backed with the white backing which can be used to indicate the overall reflectance or luminous brightness as additional optical information.
- Y Brightness value of the sample backed by black backing which is the second component of the Contrast Ratio Opacity calculation.
- A typical display is just Opacity with some users selecting the Opacity, Yw combination.

Another option is the choice of an illuminant and observer for opacity reporting. Choose C/2° if you have no prior conditions. Once all of your selections are made click **OK** to save and these metrics will be displayed in your Color Data View.

Standardize the instrument on its normal black and white standards. Then read the Opacity of the samples. When measuring opacity the color values displayed in the color data table represent the sample reading with the white backing as shown in the next figure.





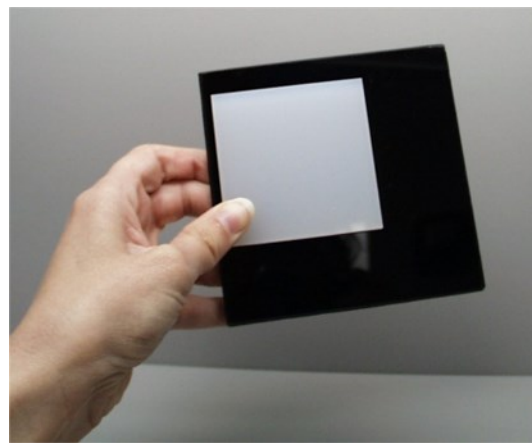
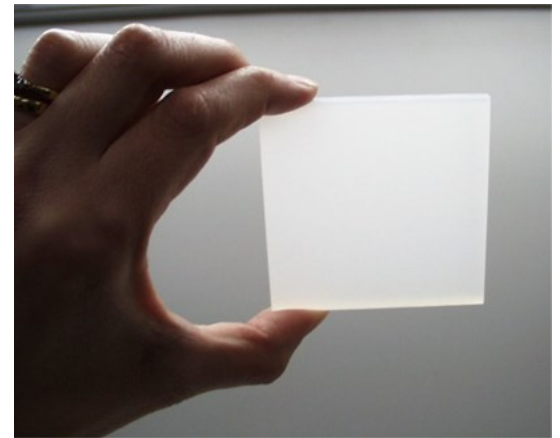
The screenshot shows the EasyMatchQC software interface. The title bar reads 'EasyMatchQC ver 4.79'. The menu bar includes 'File', 'Edit', 'View', 'Measurements', 'Options', 'Sensor', 'Window', and 'Help'. The toolbar contains various icons for file operations and measurements. The main window displays a 'White Tile' measurement with the following data:

ID	L*	a*	b*	Opacity Y C/2
White Tile	94.04	-0.93	2.31	100.0

Backings for Translucent Samples

Translucent samples (such as plastic plaques, citrus juices, and semi-solids like salad dressing) reflect enough light that their reflected color may be measured, but they also transmit light. In the picture below, you can see the reflected whiteness of the plaque (the color reflected back to you from the surface of the plaque), and you can also see some light shining at you from behind the plaque (the transmitted light).

When you're looking at the reflected color of a translucent sample, the light that is transmitted through the sample is lost to the reflectance assessment. One way to prevent this loss of light is to provide a backing for the sample to make it appear more opaque. The pictures below show a single plastic plaque backed by a white tile, and then by a black tile.

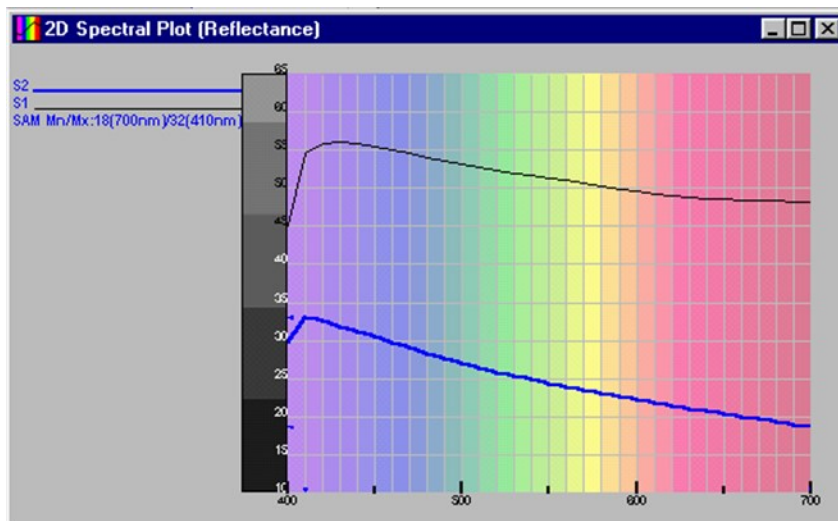


Do they look the same? No! Although the sample now appears opaque with both backings, the left sample looks whiter due to its white backing, and the right sample looks grayish due to its black backing. The samples look different to your eye with the different backings. Is the sample thing true when you measure with an instrument? You bet.

The sample above was measured on an Agera with a 1.75 inch area of view; first with the white backing and then with the black backing (D65/10°).

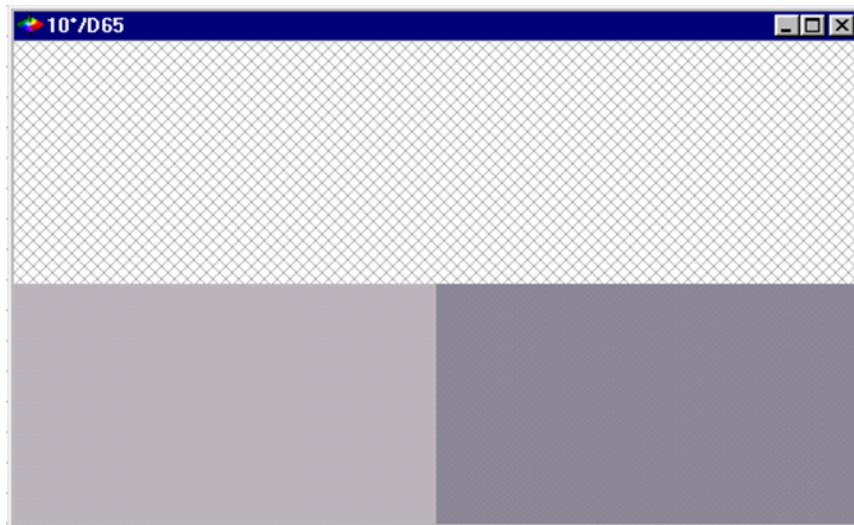
Backing	L*	a*	b*
White	76.89	-0.93	-3.77
Black	56.62	-1.50	-9.06

Just as we had noted visually, with the white backing the sample appears lighter (higher L*) than the sample backed by black. The spectral plot and color rendering view shown below also illustrate the differences detected instrumentally.



Top curve is the sample backed by white and the bottom curve shows the sample back by black.

This shows a color rendering of the sample back by white (left side) and the sample backed by black (right side). This is an approximation of the instrument measurement.



Color Rendering of the Sample Measurement

So, what does all this mean? It means that for each type of translucent sample you measure and compare, you need to choose one backing, record that backing as part of your measurement, and stick with it. If you measure some samples with a white backing and others with a black (or other colored) backing, you will not be able to compare the measurements. So, what is the proper type of backing for your samples? That depends.

In general, for solid samples HunterLab recommends use of an uncalibrated white porcelain enamel on steel tile (available through HunterLab using catalog number 11-0108-50) or the white disk on the sample clamp, if you have one. Occasionally your specification may require backing with black, in which case you can back the sample using your black glass or the dark insert for your sample clamp, if you have one. For liquids or semi-solids that are measured in a sample cup, the white ceramic disk of the ring and disk set (HunterLab Part Number 02-4579-00) should be used to provide a white background to direct light that has traveled through the sample back to the detector. All measurements of opacity will require measurement with both a white and black backing. Backing samples with colors other than white and black is not recommended.

References

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.

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