Insight on Color   **Vol. 19, No. 11**

Averaging and Color Measurement

The ideal sample for yielding repeatable color measurements is completely opaque or completely transparent, flat, smooth, homogenous, non-directional, non-photochromic (not affected by light), non-thermochromic (not affected by heat), and non-hygrochromic (not affected by moisture). However, as few samples meet that ideal, a variety of sample devices and sample preparation and presentation techniques are employed to make measurements as repeatable as possible. One of these techniques is to make more than one reading of the same sample or to read multiple samples from the same batch and then average the readings for the final, reported result. Averaging helps to "even out" the mathematical highs and lows that are possible within a single sample or batch and to present a color measurement that is more representative of the sample or batch as a whole.

Here's an example:

Five readings from a bag of pretzel bites were made on a D25LT in a 5-inch glass sample cup. Between readings, the sample cup was emptied and refilled from the same bag.

The results were as follows:

Reading Number	L* (C/2°)	a* (C/2°)	b* (C/2°)
1	57.60	9.13	36.59
2	57.90	9.86	37.05
3	57.54	8.88	36.90

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Reading Number	L* (C/2°)	a* (C/2°)	b* (C/2°)
4	58.15	10.02	36.98
5	59.35	9.19	37.57

The average of these five readings is L* = 58.11, a* = 9.42, b* = 37.02. Suppose only one reading had been made and it was Reading Number 5. Number 5's values are quite different from the average values, aren't they? This reading by itself is misleading. The average of the five readings with different pretzel bites viewed and in different places in the area of view is better indicative of the color of the overall bag.

Directional Samples

Examples of directional samples are corduroy fabric, ruled paper, and yarn. These types of samples look different to both the instrument and the eye depending on which direction they are turned. Therefore, directional samples should be read two to four times, with the sample rotated 90° between the readings ("with rotation") so that each orientation is presented to the instrument. The readings should then be averaged for the final, reported result.

Non-Homogenous Samples

Non-homogeneous samples could include unshaken liquids with suspended particles, samples containing bubbles, scratches, or hazy areas, or ones with random color or texture distributions. In general, non-homogeneous liquids should be read several times and the readings averaged. In between the readings, the liquid should be dumped out of its container and the container refilled, so the sample readings are made "with replacement." Non-homogenous solids can either be rotated between readings like directional ones, or the sample can simply be moved so that a different area is read each time.
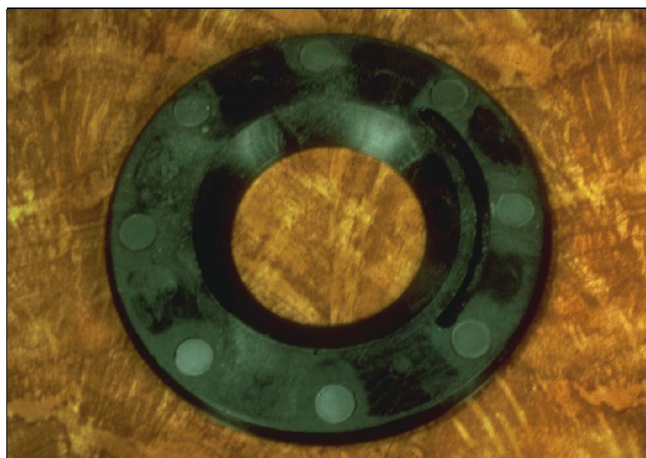
Batches of Samples Irregular in Size and/or Shape

These types of samples, where groups of individual pieces are measured together, include items like pieces of cereal, small plastic parts, and pretzels. You should read several containers full of this type of sample, emptying the container and refilling it with sample between readings.

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