Datacolor Gloss Compensation

Gloss Compensation is a proprietary technology incorporated in Datacolor color control software for industries that use pigments. It offers Paint, Ink and Plastics users the ability to more accurately match, correct, and control color, even as the gloss of standards and products differ.

Color control systems employ spectrophotometers to measure light reflecting materials. These spectrophotometers usually use the Integrating-Sphere Specular–Component-Included (Sphere-SCI) optical geometry, though a few utilize 45/0, or Integrating-Sphere Specular–Component-Excluded (Sphere-SCE). Each geometry has advantages and disadvantages, but none can fully determine both the color and gloss of a sample. Thus, color difference calculations and formulations can be less accurate than desired, particularly when sample and product gloss are different.

Datacolor Gloss Compensation systems start by measuring a sample with specular included and excluded. Then, by applying calibration and mathematical models, the following information is yielded:

- A Specular-Included measurement
- A calculated Gloss measurement
- A calculated Visual (45/0) measurement

The first two of these outputs are determined from the SCI and SCE measurements, and the calculated Gloss is an estimate (not to be confused with a measurement by an ASTM-prescribed gloss meter). The third output is computed from the first two, and it is at this step that Gloss Compensation is accomplished. By knowing these functions, the Datacolor software can generate the best matches for, and most meaningful analysis of, all possible color and gloss combinations.

Surface Reflection

The reflection of light at the surface of a sample is the appearance effect that causes the gloss sensation. This surface reflection is also the effect that causes the failure of spectrophotometers to completely characterize both color and gloss.

In color applications, light travels through air and then is incident upon an object (sample). The index of refraction of air is 1.0, and the index of refraction of the sample might typically be about 1.5.

Whenever light travels from one medium to another (with different refraction indices), some light is reflected at the sample surface, thus never entering the sample. For most color applications, this surface reflection is about 4% of the incident light.

Spectrophotometer Optical Geometries

Color spectrophotometers typically have either integrating sphere or 45/0 optical geometries.

Integrating sphere models either illuminate samples at all angles, and view them at an angle 8 degrees from the normal to the sample, or illuminate at the 8 degree angle, and view at all angles. These two measurement conditions, d/8 and 8/d respectively, are considered equivalent. The integrating sphere models usually can measure with either the specular (gloss) included, or excluded.

45/0 models measure the same as 0/45, excluding the specular reflection. These spectrophotometers simulate typical industrial color viewing conditions. Sample surface reflection is sensed differently by the d/8 specular included, d/8 specular excluded and 45/0 optical geometries.

45/0 or 0/45

- Illuminates the sample at 45 degree angles.
- Excludes specular surface reflection.
- Includes diffuse surface reflection .
- Has poor repeatability and is sensitive to sample surface variability and imperfections.
- Simulates visual assessment.

Sphere-SCI

- Illuminates the sample equally at all angles.
- Includes all the surface reflection.
- Has good repeatability and is not sensitive to sample surface variability or imperfections.
- Does not sense sample gloss differences.
- Does not simulate visual assessment.

Sphere-SCE

- Illuminates sample equally at all angles, except no illumination at near-specular angles.
- Excludes specular surface reflection, though usually not completely.
- Includes diffuse surface reflection.
- Has medium repeatability, being somewhat sensitive to surface variability and imperfections.

Gloss Compensation: why and when. . .

Gloss Compensation is needed because the integrating sphere spectrophotometers used for most color work "see" the surface reflection of samples differently than how we view these samples. This can be described as follows:

1. Most color formulation and correction software programs utilize Sphere-SCI measurements. These measurements include the total surface reflection, irrespective of whether this reflection is all in one direction (gloss=100), diffuse (gloss=0), or at some gloss level in between the extremes.
2. When making visual color evaluations, samples are usually viewed under conditions where specular surface reflections are excluded. These optical conditions, standardized in light booths, are usually specified to be at 45/0 or 0/45 angles.
3. Spectrophotometer measurements made with 45/0 geometry will include that portion of the surface reflection that is reflected at the 0 degree angle. For typical paint, plastics, and ink high gloss samples, there will be little or no surface reflection included. For typical highly diffuse samples, the spectrophotometer will measure about 4% reflection. These measurements agree with visual assessments, but are also sensitive to gloss variations, and often not very repeatable.
4. If two samples of the same gloss are being compared, for formulation or quality control purposes, then there is no need for Gloss Compensation. The Sphere Specular-Included measurements are ideal in these situations, as they are immune to sample surface variations.
5. For production color correction, , Sphere-SCI measurements are usually used, as the standard will have the same gloss as the final product. Even if the sampled batch has slightly different gloss than the final product, Sphere-SCI measurements will ignore production gloss variability, thus correcting the color properly. Gloss Compensation is not used for production color corrections, unless the standard and product have different gloss levels.
6. For formulation and quality control purposes, if the batch and standard have different gloss, then the Sphere-SCI measurements will not agree with (45/0) viewed assessment. Gloss Compensation is used in these cases to adjust the sphere measurements as if they were made in visual space.

An example: matte and glossy black

As an example of Gloss Compensation, a black plastic material was molded into a sample with glossy, semigloss, and matte surfaces. These samples were measured and color differences calculated for the following conditions: Sphere-SCI - Visual (45/0) space, with Gloss Compensation. The samples were also evaluated using a light booth designed for industrial applications.

Results:

The Sphere-SCI measurements resulted in CIELAB color differences of nearly zero, between the gloss, semigloss, and matte sample surfaces. The visual space data resulted in CIELAB color differences agreeing very well with visual assessment. The semigloss surface measured about 3.0 ΔE (lighter) than the glossy surface. The matte surface measured about 13.0 ΔE (lighter) than the gloss surface.

Comment:

Gloss Compensation has proven to be an effective tool for all colors where gloss is different between standard and batch samples. The greatest effect is for darker colors (like the black example).