A Brief Guide to Gloss Measurements In Weathering

Introduction

Gloss is one of the parameters most often measured in weathering tests of materials and products. In weathering, this particularly includes paints and coatings for architectural, transportation, and consumer products as well as other high gloss finishes. The perception of gloss can relate to a product's finish, texture and how a sample is illuminated and viewed. This guide will serve as a brief introduction to specifying and understanding basic gloss measurements used in weathering. While we are generally concerned with a loss of gloss during degradation, an increase in gloss can also be important, such as for an automotive instrument panel where glare can present a safety hazard.

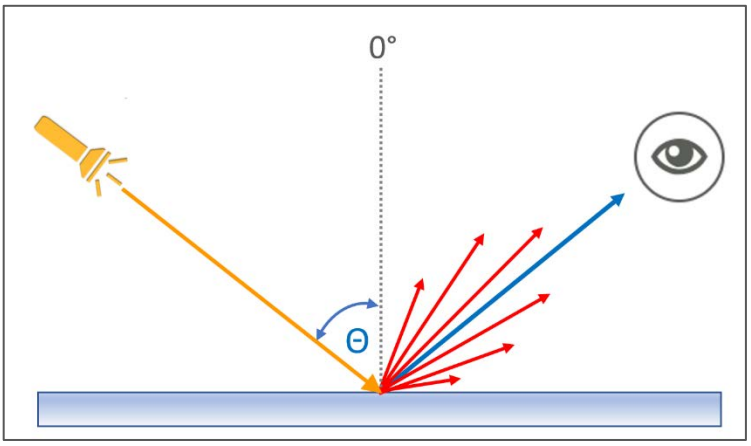

Figure 1. Gloss consists of incident light of known intensity (yellow line) at angle Theta (Θ), specular reflection at the same angle but lower intensity (blue) and scattered light (red). Typical angles are 20°, 60° and 85°.

Gloss

In the simplest terms gloss is specular reflection. In Figure 1 we have an incoming light beam impinging on a surface. If it were a perfect mirror, 100% of the light beam would be reflected forward, at the same angle as the incident beam. However, if the surface becomes irregular from weathering some light is diffusely scattered. This light can be scattered in all directions, although only forward-scattered angles are shown in the figure for simplicity. Further, some of the incident beam can be absorbed by or transmitted into the material.

As the gloss level decreases, the amount of specular reflection decreases while the scattered light increases. The reflected image becomes duller and may also lose its sharpness.

With non-metallic materials, such as plastics and coatings, the amount of specular reflection increases as the incidence angle (Θ*, theta*) increases. Metals have a higher reflectivity and gloss is less angle dependent than are other materials. Therefore, the measurement angle must be standardized for a gloss measurement value to be meaningful.

Gloss Units (GU)

In modern gloss meters the measurement results are related to the amount of light reflected from a black glass reference standard rather than to the incident and specularly reflected light beams, and the value of this calibration is set at 100. Materials posessing a high refractive index can have values >100 GU due to multiple internal

reflections. Note that this is an arbitrary unit and 100 GU is not equal to "100%" of anything. For example, transparent and reflective metals can be as high as 2000 GU, relative to the 100 GU black glass reference standard.

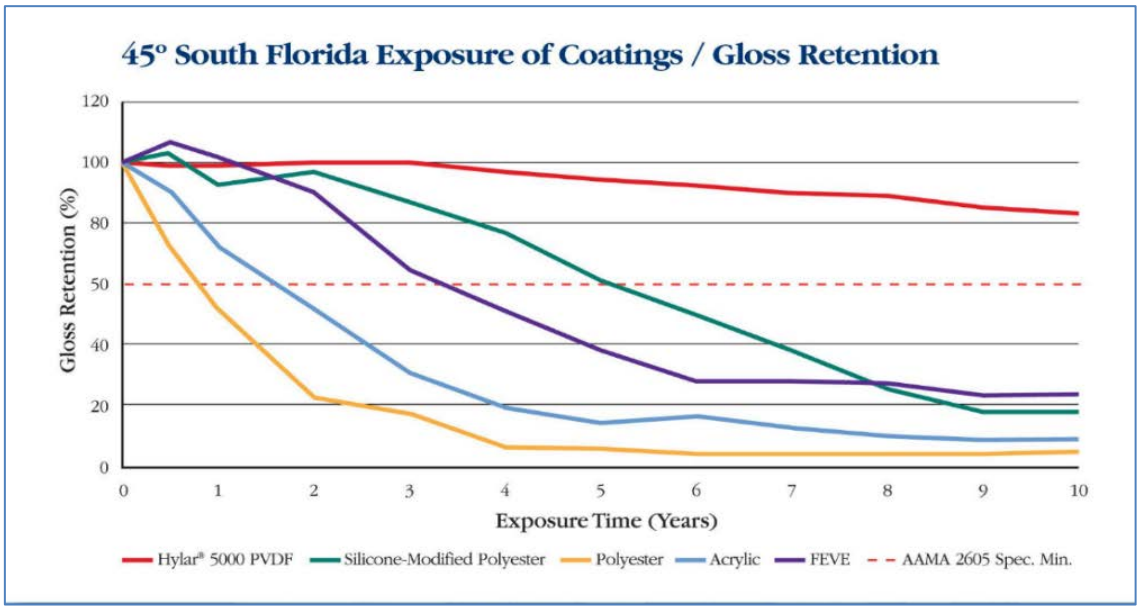

Figure 2. Plot of gloss retention (%) of architectural coatings during weathering exposure. Courtesy Solvay. https://www.solvay.us/en/print.html?tcmURI=tcm:182-228910 accessed 2018-05-17.

However, it is common to graphically plot changes in gloss, particularly gloss retention/loss, as a percentage change from initial versus exposure duration (time or radiant energy exposure), as shown in Figure 2 for a number of coating types on outdoor Miami exposure.

Measuring Gloss

Since there is an angular dependency on gloss readings for various materials, the measuring angle Θ has been standardized to account for low, medium and high gloss materials. As an illustration, in Figure 3, 13 paint samples ranging from flat matte to high gloss level were measured at Θ angles of 20°, 60° and 85° using a 60° gloss meter. In the steep slopes of each curve the differences between samples can be clearly measured, while in the flat part of the curves at each end the measurements no longer correlate with the visual appearance.

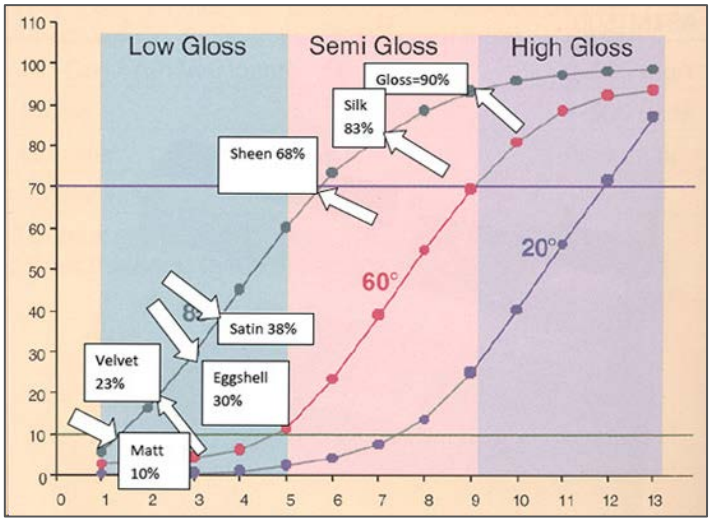

Figure 3: Plot of gloss for 13 coatings using 60° angle.

Source: http://imbustudios.com/16-paint-gloss-levels-chart-modernday/paint-gloss-levels-chart-glosslevels-grand-snapshoot-level/, accessed 2018-04-24

Therefore, the measurement angle Θ is selected based on the range of gloss to be measured according to Figure 3. For example, 20° is used for automotive basecoat/clearcoat finishes, 60° for general polymeric materials and plastics, and 85° for vinyl siding and

automotive instrument panels. While usually gloss loss occurs, with instrument panels an increase in gloss, which can occur from plasticizers and other additives migrating to the surface, can result in glare and pose a safety hazard.

Gloss Range	60° GU Value	Use Θ Geometry
Low gloss	< 10	85°
Semi-gloss	10 to 70	60°
High gloss	> 70	20°

Figure 4. Recommended measurement angle selection based on the 60-degree measurement range.

In addition to the most common 60° measurement, 45° is often used for the gloss measurement of plastic films, ceramics, anodized aluminium and textile products. An angle of 75° is typically used for the measurement of paper and paper products. Figure 4 lists 60° gloss range values. When a material falls within the low or high gloss ranges shown, the measurement angle should be switched as shown in the table.

For correct readings, gloss measurements are best made on flat non-textured specimen surfaces. Your gloss meter manufacturer can be a good source of educational materials.

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