

Color and Appearance for Automotive Finishes – A Survey

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TC 706

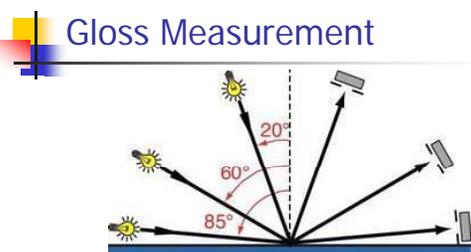
Two major factors in Appearance of Paint and Coatings

- **Gloss**
 - Different Angles – Most paint is measured at 60° angle, 20° and 85° also used in specific situations
- **Color**
 - Color Measurement
 - Color Matching
- Example – Automotive Finishes, Clear Coat and Matte. Most people today like Clear Coat finishes.

Color Measurement in Automotive Applications.

- Outside of Car – Clear Coat Finishes
- Appearance
 - Gloss
 - Factors/Issues – Haze, Orange Peel, Transparency
 - Color
 - Color Measurement
 - Color Matching
- Inside of Car – Coatings, plastics and upholstery

Gloss Measurement

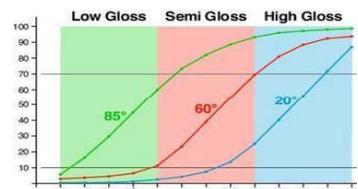


The diagram illustrates the geometry of gloss measurement. A horizontal surface is shown at the bottom. Three incident light rays originate from the left and strike the surface at different angles: 20°, 60°, and 85°. Corresponding reflected rays are shown on the right. The 20° angle is associated with high gloss coatings, 60° is typical for most measurements, and 85° is used for matte coatings.

- 60° Gloss is typical for most measurements
- 20° Gloss for High Gloss Coatings
- 85° Gloss for Matte Coatings
- Industry specific measurements at 45° and 75° Angles

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Gloss



The graph plots gloss units (0 to 100) against 13 samples. Three curves are shown: 85° (green background), 60° (red background), and 20° (blue background). The 85° curve rises steeply from sample 1 to 5, then levels off. The 60° curve rises from sample 5 to 10, then levels off. The 20° curve rises from sample 10 to 13, then levels off. The regions are labeled 'Low Gloss', 'Semi Gloss', and 'High Gloss'.

- In this case study 13 samples were visually ranked from matte to high gloss and measured with 3 specified geometries. In the steep slopes of the curves, the differences between the samples can be clearly measured, while in the flat part, the measurement geometry no longer correlates with the visual.

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Gloss Problems

- Haze
 - High quality (class A) surfaces are expected to have a clear and brilliant appearance. Microstructures, e. g. poor dispersion, can cause a milky appearance. This effect is described as milkiness or haze.
 - A high gloss surface with microscopic texture has diffused light with low intensity adjacent to the main direction of reflection. The majority of the incident light is reflected in the specular direction which makes the surface appear highly glossy with image forming qualities, but with a milky haziness on top of it.

http://www.byk.com/instruments/applications/application_haze-hazemeter_1_US.php

Gloss Problems

- Haze

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Gloss Problems

- Orange Peel
 - The waviness of automotive paints is in a range of approx. 0.1 to 30 mm wavelength. These phenomena are often visually evaluated and subjective terms like degree of peel or texture are used as descriptions.
 - Orange peel can be seen on high gloss surfaces as a wavy pattern of light and dark areas.
 - Depending on the slope of the structure element the light is reflected in various directions. Only the elements reflecting the light in the direction of our eyes are perceived as light areas.

http://www.byk.com/instruments/applications/6_1_US.php

Gloss Problems

- Orange Peel

http://www.byk.com/instruments/applications/6_1_US.php

Transparency

- Wide Angle Scattering -> Haze
 - Light is diffused in all directions causing a loss of contrast. ASTM D 1003 defines haze as that percentage of light which in passing through deviates from the incident beam greater than 2.5 degrees on the average. Orange Peel
 - The waviness of automotive paints is in a range of approx. 0.1 to 30 mm wavelength. These phenomena are often visually evaluated and subjective terms like degree of peel or texture are used as descriptions.
 - Orange peel can be seen on high gloss surfaces as a wavy pattern of light and dark areas.
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Transparency

- Narrow Angle Scattering -> See-through Quality
 - Light is diffused in a small angle range with high concentration. This effect describes how well very fine details can be seen through the specimen. The see-through quality needs to be determined in an angle range smaller than 2.5 degrees.
 - Measurement and analysis of haze and see-through quality guarantee a uniform and consistent product quality and help analyze influencing process parameters and material properties, e.g. cooling rate or compatibility of raw materials.

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Transparency

- A light beam strikes the specimen and enters an integrating sphere. The sphere's interior surface is coated uniformly with a matte white material to allow diffusion. A detector in the sphere measures total transmittance and transmission haze. A ring sensor mounted at the exit port of the sphere detects narrow angle scattered light (clarity).

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International Standards

<ul style="list-style-type: none"> • ASTM C 346 • ASTM D 2457 • ASTM D 523 • DIN 67530 • ISO 2813 Gloss measurement • ISO 7668 Gloss measurement • JIS Z 8741 • TAPPI T 480 	<p>Gloss measurement</p>	Gloss
<ul style="list-style-type: none"> • ASTM D 2457 • ASTM D 523 • ASTM E 430 • DIN 67530 • ISO 2813 Gloss measurement • ISO D15 13803 	<p>Gloss measurement</p> <p>Gloss measurement</p> <p>Haze measurement</p> <p>Gloss measurement</p> <p>Gloss measurement</p> <p>Haze measurement</p>	Haze
<ul style="list-style-type: none"> • ASTM D 1003 • ASTM D 1044 • ISO 13468 	<p>Transparency measurement</p> <p>Transparency measurement</p> <p>Transparency measurement</p>	Transparency

http://www.byk.com/instruments/applications/75_1_US.php

Two major factors in Appearance of Paint and Coatings

- **Gloss**
 - Different Angles – Most paint is measured at 60° angle, 20° and 85° also used in specific situations
- **Color**
 - Color Measurement – Example Metallic Coatings
 - Color Matching – More Complicated
- Example – Automotive Finishes, Clear Coat and Matte. Most people today like Clear Coat finishes. Many like Metallic finishes.

Metallic Coatings

- Change appearance on angle of viewing
- Change appearance with different lighting conditions

http://www.byk.com/instruments/applications/69_1_US.php

Visual Inspection of Metallic Coatings

http://www.byk.com/instruments/applications/69_1_US.php

Multiangle Color Measurement

- ASTM, DIN and ISO standards define multi-angle color measurement to objectively describe the color of metallic finishes. Research studies show that a minimum of three, and optimally five viewing angles are needed. The measurement geometry for multi-angle color measurement is specified by aspecular angles. The aspecular angle is the viewing angle measured from the specular direction in the illuminator plane. The angle is positive when measured from the specular direction towards the normal direction.

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Multi-angle Color Measurement

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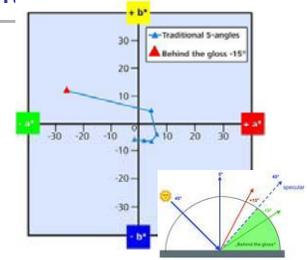
Multi-angle color measurement

- Directional illumination is used versus circumferential illumination because circumferential illumination minimizes the contribution from directional effects such as the Venetian blind effect and surface irregularities. Thus, averaging of the circumferential illumination would cause the measured color values of two specimens to be the same, while visually the two specimens would not match.
- For color QC, the colorimetric data L^* , a^* , b^* (or L^* , C^* , h°) and delta E^* can be used. The tolerances are usually higher for the near specular (15° , 25°) and the flop angle (75° , 110°) than the 45° tolerance. In order to have a unique tolerance parameter independent of color, weighted factors have to be used. Therefore, automotive companies often have set specifications on delta E CMC or delta E' based on DIN 6175-2 using 3 or 5 angle instrumentation. Another useful index is the flop index, a measure of the change in lightness of a metallic color as it is tilted through the entire range of viewing angles.

http://www.byk.com/instruments/applications/69_2_US.php

Multi-angle Color Measurement

In order to fully capture the color travel of these interference pigments it is necessary to add viewing and illumination angles. To keep the whole procedure practical for industrial use with a portable instrument it was determined that an additional angle behind the gloss e.g. - 15° is of benefit.



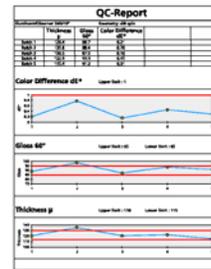
Measurement of color travel "behind the glass" at -15°

http://www.byk.com/instruments/applications/69_2_US.php

Color Measurement & Matching

- Color Factors and Instruments**
- Color
 - Color Measurement
 - [Spectro-Guide](#) – Report Sample on Next Page
 - Color Matching
 - [In-Store Color Matching](#)

Sample Report



References

- <http://www.byk.com/instruments/about.php>