

Uniform Color and Appearance of Exterior Automotive Finishes

The paint finish of a car has to meet two main requirements: protect the vehicle from weathering influences (e.g. corrosion, loss of gloss) or other mechanical impacts (e.g. car wash and chip resistance) and, of course make the car visually appealing. Eye catching finishes should not only have a “beautiful” color, but look like a mirror - “high gloss and perfectly smooth”. Uniformity is especially important: Any color and appearance differences between car body and add-on parts will be most noticeable and be associated with lower quality, or could even result in costly warranty complaints.

Therefore, target values with tolerances for color and appearance are defined by the automotive OEM makers. Meeting these target values is a challenging task for everybody in the supply chain, as color and appearance is not only a multi-dimensional phenomena, but also can be influenced by a variety of material, substrate and process parameters.

Orange peel and DOI control with wave-scan family

The appearance of a finish can be described by its brilliance and “smoothness”, also referred to as DOI (Distinctness of Image) and Orange Peel. For years the BYK-Gardner wave-scan family has been used as the standard to objectively quantify appearance of painted body and off-line painted parts by all major car, truck, motorcycle, boat and yacht companies.



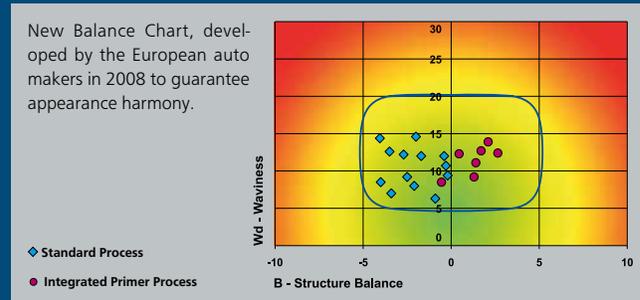
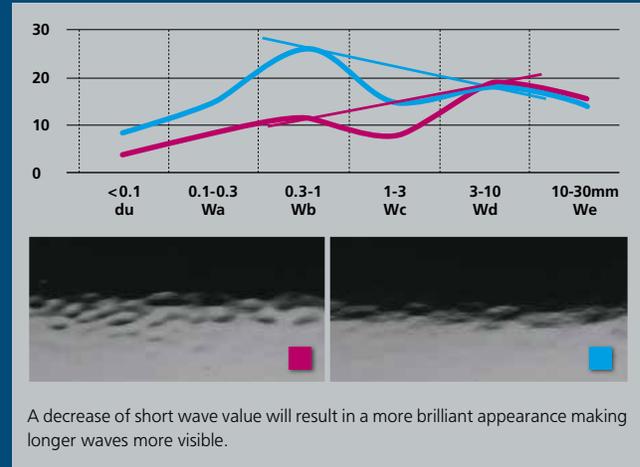
micro-wave-scan see page 44.



wave-scan dual see page 37.

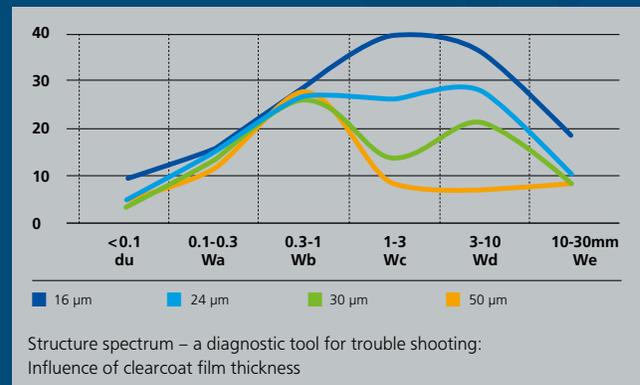
Depending on the OEM different target values and appearance scales have been developed over the years. These company specific scales are an objective check to ensure company specifications are met, and eliminate heated discussions between automotive producers and their suppliers.

In order to ensure harmony as well as brilliant and smooth appearance, long and short waviness scales should not be evaluated separately and independently optimized. Therefore, a “balance” between short waves and long wave measurement scales is essential.



Additionally, the wave-scan measurement data can be used for trouble shooting to improve quality.

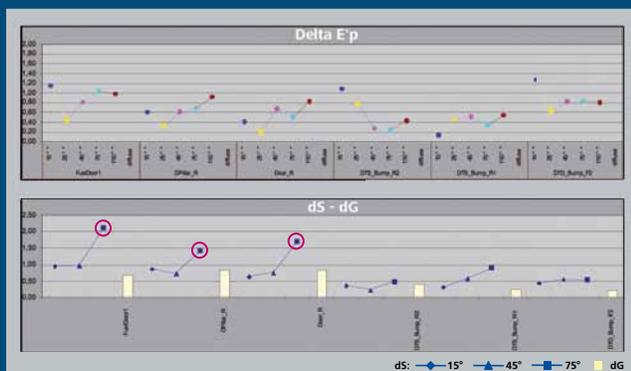
Dullness is too high	Clear coat looks milky
Wa is too high	Very fine textures caused by material properties
Wb is too high	Substrate influence
Wc is too high	Dry spray of clear coat
Wd is too high	Substrate influence
	Insufficient amount of clear coat
	Very rough substrate
	Insufficient amount of clear coat
	Very rough substrate



Multi-angle color and effect control with BYK-mac family

Color consistency is the most obvious and thus, most important quality criteria of an automotive finish. Designers are continuously looking for new colors which not only make the product look exciting, but actually underline its styling resulting in a "living" color! More than 70% of today's automotive colors are special effect finishes. A lightness or even color change can be observed under different viewing angles and a sparkling effect can be created under direct sun light.

Objective control of total color impression is needed which correlates with the visual impression and can be used for daily QC at the paint supplier for paint batch approval, as well as at the part and assembly plants. Establishing color specifications for effect finishes has been a challenging task. Further development of CIE Lab color space (1976) resulted in new color difference spaces/indices (ΔE_{CMC} , ΔE_{94} , ΔE_{99}) that supported the auto OEM makers and their suppliers in establishing specifications which were "independent" of color hue, saturation, lightness and even on the viewing angle ($\Delta E_{DIN6175-2}$). More than multi-angle color measurement is needed to capture appearance change under different lighting conditions, measuring the so-called sparkling and graininess effect helps to do this.



Color and Effect Travel

Car body and bumper are within an acceptable average $\Delta E_{DIN} < 1$. Visually one can observe more sparkling at a low grazing angle on the car body. The Delta Sparkle 75° documents this difference which is caused by different application methods resulting in different flake orientation.

The BYK-Gardner BYK-mac was designed to objectively measure color travel under 6-different viewing angles, and at the same time quantify the effect phenomena "Sparkling" and "Graininess" with a camera system under direct and diffused illumination.

Process Stability to Guarantee Uniform Color and Appearance

In order to guarantee uniformity over time and be able to proactively take measurements when color or appearance is starting to drift, process stability needs to be controlled. Therefore, a representative number of measurements have to be taken. Statistical studies have shown that a minimum of 5% of the daily production output needs to be sampled in order to make an objective judgment of process stability.

The BYK-Gardner wave-scan and BYK-mac can be used as portable devices or as automated versions which can be mounted on a robot.

The wave-scan ROBOTIC as well as the BYK-mac ROBOTIC are robust, light weight and offer fast data collection, which makes them ideal for industrial online applications.

By measuring with a robot the same measurement area is always checked, and any operator errors (wrong measurement direction...) which could have an influence on the final reading are eliminated.



BYK-Gardner Reference Customers:

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BYK-mac
see page 100.