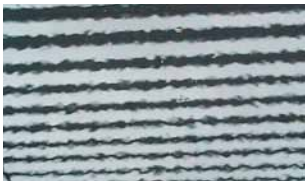
Introduction

The total appearance and the visibility of structures depend on the structure size, the observing distance and the image forming quality.

Structure size

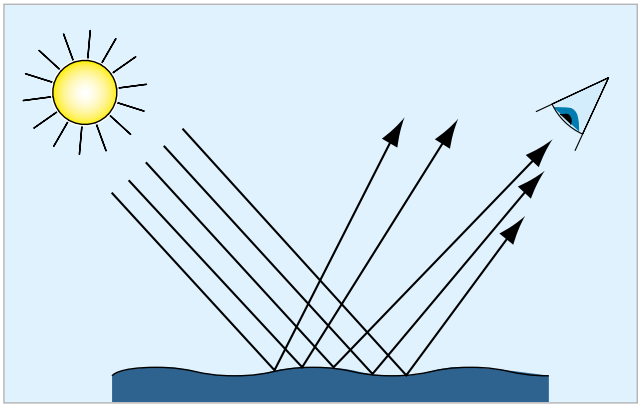
Surfaces with different structure sizes will appear visually different:

Small structures



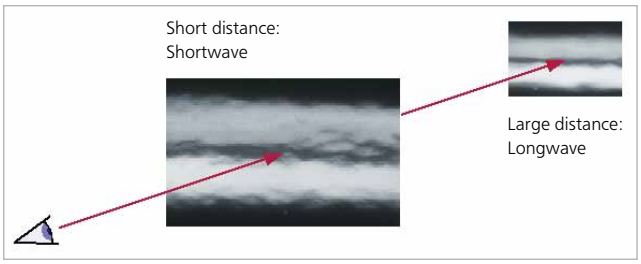
Large structures

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.



Observing distance

Visibility of structures is dependent on the observing distance. The greater the distance, the smaller objects will appear. Structures with a size of 10 to 30 mm can best be seen at a distance of approx. 3 m. Fine structures in a range of 0.1 to 1 mm can only be recognized at a close distance.



Resolution of our eyes

The resolvable structure size is also dependent on the observing distance. Very fine structures that are below the human eye's resolution (approx. 0.1 mm) can no longer be recognized as a light / dark pattern, even at a close distance. The result is a reduction of the image forming quality (IFQ). At 3 m distance, structures between 1 – 3 mm can hardly be resolved as a waviness but influence the appearance.

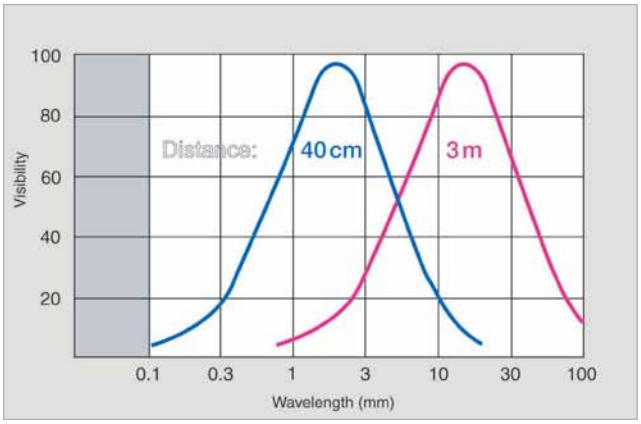
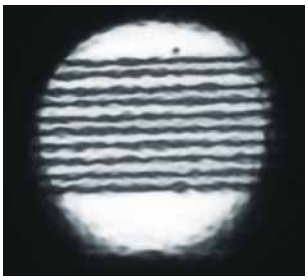


Image Forming Quality (IFQ)

The higher contrast and sharpness of a reflected object, e.g. the edges of black and white lines, the better the image forming quality will be. Fine structures disturb the reflected image, consequently edges become blurry and are no longer sharp.



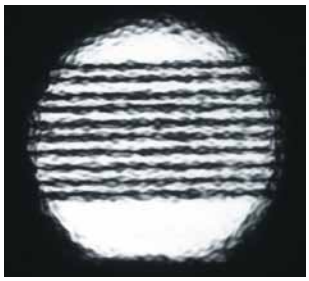


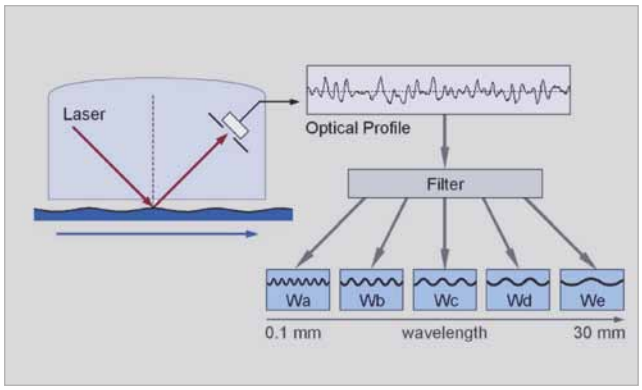
Image Forming Quality at a close distance:
Distinctness of Image (DOI)
DOI can also be described with terms like brilliance, sharpness or clarity. DOI is diminished by very fine structures close to the human eye resolution (smaller than 0.3 mm).

Image Forming Quality at a far distance:
Wet Look
At a distance of 3 m, the image forming quality is mainly influenced by structures between 1 – 3 mm. This effect is referred to as Wet Look.

wave-scan dual
see page 39.

Simulation of the Visual Perception Waviness

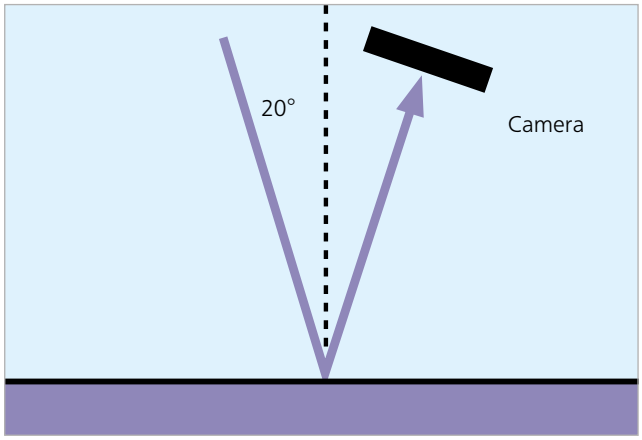
The wave-scan simulates visual perception. Like our eyes, the instrument optically scans the wavy light / dark pattern. A laser point light source illuminates the specimen at a 60° angle and a detector measures the reflected light intensity at the equal but opposite angle. The orange peel meter is rolled across the surface and measures point by point the optical profile of the surface across a defined distance.
The wave-scan analyzes the structures according to their size. In order to simulate the human eye's resolution at various distances, the measurement signal is divided into several ranges using mathematical filter functions:



Wa 0.1 ..... 0.3 mm wavelength
Wb 0.3 ..... 1 mm wavelength
Wc 1..... 3 mm wavelength
Wd 3 ..... 10 mm wavelength
We 10 ..... 30 mm wavelength
SW 0.3 ..... 1.2 mm wavelength
LW 1.2..... 12 mm wavelength

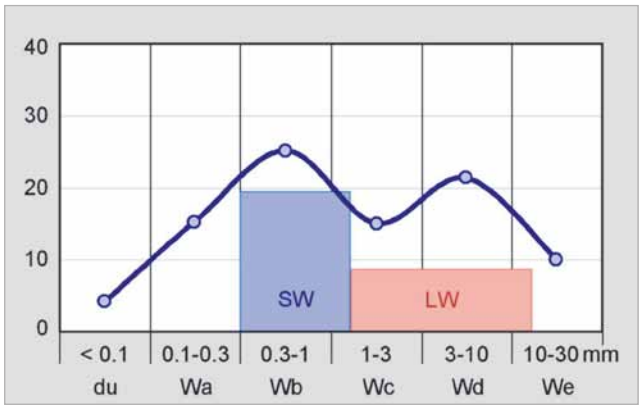
Dullness

Structures smaller than 0.1 mm influence visual perception, therefore the wave-scan uses a CCD camera to measure the diffused light caused by these fine structures. This parameter is referred to as "dullness".



Structure Spectrum

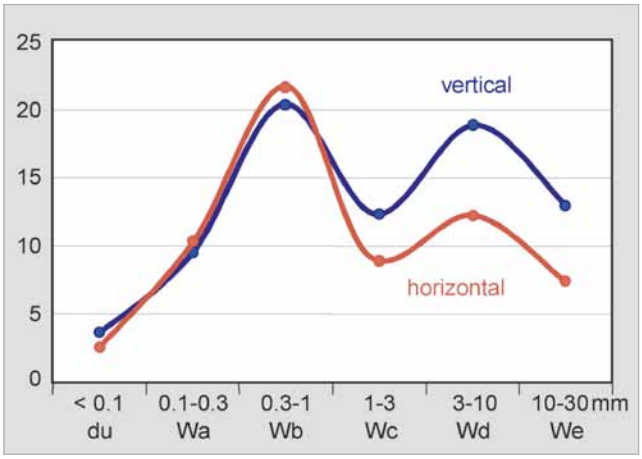
The values of dullness and Wa to We form a "structure spectrum". This allows a detailed analysis of Orange Peel and its influencing factors, being material or application parameters.

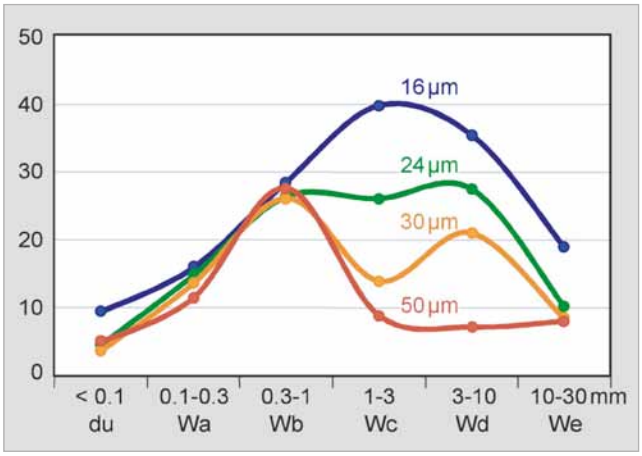


wave-scan Scales

The detailed information of the structure spectrum as well as LW and SW became the basis to correlate to customer specific scales and to the DOI as described in ASTM E430:

DOI	Function of du, Wa and Wb Correlation to ASTM E430, scaling is similar to 20° gloss
Rating:	Orange Peel based on ACT panels
Tension-Scales:	Leveling
GM-Tension	GM Specification
P-Tension	Honda Specification
H-Tension	Honda Specification
Ford Scales:	
Luster	A measurement for Gloss
Sharpness	A measurement for DOI
Orange Peel	A measurement for Leveling
Combined	An overall rating
Daimler Chrysler Scales:	
Gloss DCA	A measurement for Gloss
Dorigon DCA	A measurement for DOI
Orange Peel DCA	A measurement for Leveling
Over All DCA	An overall rating
BMW Scales:	
N1 Note 1 m	A ranking note for 1m observation
N3 Note 3 m	A ranking note for 3m observation

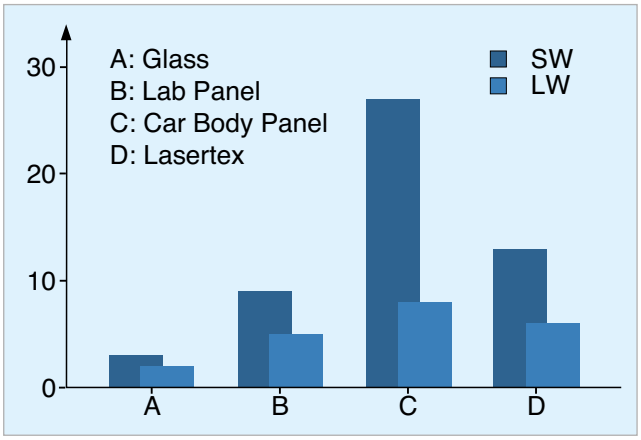




Interpretation of Measurement Results

Substrate Influence:

In the following graph, the substrate roughness telegraphs through the clear coat and reduces the brilliance of the coating. Sample D is a lasertex panel with a specific texture resulting in lower SW values.



Influence of Baking Position:

In general, horizontal surfaces have shown better flow and leveling characteristics, i.e. in the values for the longer waves (Wc ... We). The smaller waves are hardly influenced by the baking position.

Influence of Film Thickness:

The structure spectrum can help optimize the appearance, e.g. in determining the optimum film thickness. Increasing clear coat thickness improves flow and leveling. In the graph this can be seen in decreasing Wc and Wd values.