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Orange Peel Texture Measurement
Using 3D Metrology

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INTRO:

The size and frequency of surface structure on a substrate can have an intended or unintended effect on the quality of a coating gloss. Orange peel, named after its appearance, can develop from many factors including substrate but most commonly from technique. Different texture problems are commonly described by their waviness, wavelength, and the visual effect they have on the coating gloss. The smallest textures result in gloss reduction while the larger can result in visible ripples on the coated surface such as orange peel. Understanding the development of these textures and its relation to substrates and techniques will be critical to quality control.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR ORANGE PEEL MEASUREMENT

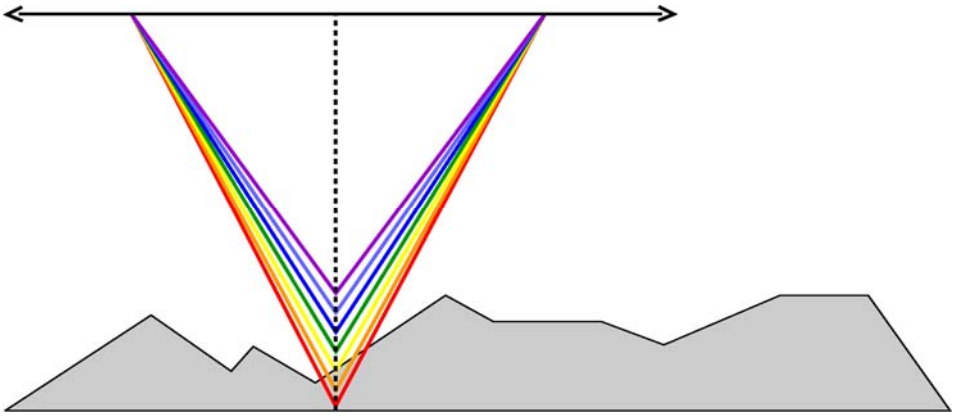
Unlike traditional 2D instruments used to measure gloss texture, 3D non contact measurement provides a quick 3D image to better understand visually the surface characteristics and having the ability to quickly investigate areas of interest. Without speed and 3D review, a quality control environment will be solely relying on 2D information that gives little overall predictability of the entire surface. Understanding texture in 3D allows for the best selection of processing and control measures. Assuring the quality control of such parameters will heavily rely upon quantifiable, reproducible and reliable inspection. The Nanovea 3D Non-Contact Profilometers utilize chromatic confocal technology with unique capability to measure the steep angles found during fastener measurement. Where other techniques fail to provide reliable data, due to probe contact, surface variation, angle, or reflectivity, Nanovea Profilometers succeed.

MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the orange peel result on a paint gloss. There is an endless list of surface parameters that can be automatically calculated after the 3D surface scan. Here we will review a 3D surface and select areas of interest to further analyze, including quantifying and investigating the characteristics of the orange peel.

MEASUREMENT PRINCIPLE:

The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white light will re-focus at a different distance from the lens (different height). When the measured sample is within the range of possible heights, a single monochromatic point will be focalized to form the image. Due to the confocal configuration of the system, only the focused wavelength will pass through the spatial filter with high efficiency, thus causing all other wavelengths to be out of focus. The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity and allows direct correspondence to the Z height position.

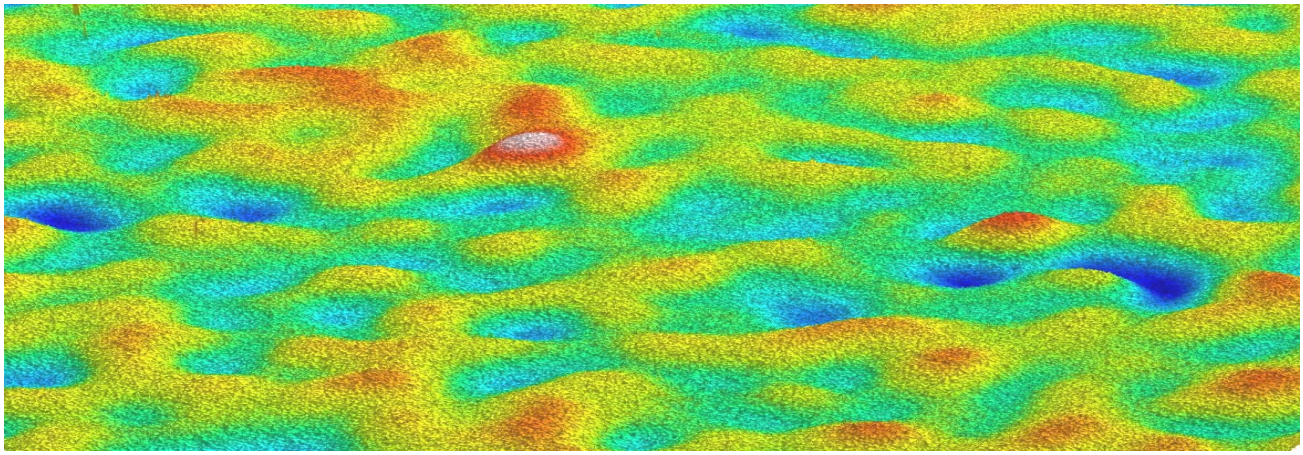


Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive, polished/rough. Measurement includes: Profile Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height Depth Thickness and many others.

MEASUREMENT DISCUSSION:

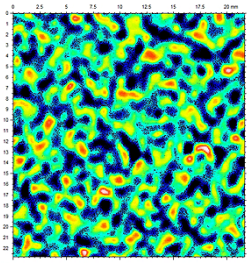
Measurements area randomly selected on the paint coated sample. Small height variation, down to nanometers up to 27mm can easily be measured. To describe the density and depth of the peaks and valleys we have several options. Density of peaks can be quantified under Sds (EUR 15178N), for this measurement we have an Sds of 3,444.084/mm^2. Another way to look at density would be the autocorrelation length parameter Sal (ISO 25178), which in this example is 0.734mm. The depth of the valleys can be quantified in several ways, for example we have an average depth from a mean plane equal to 2.166µm and a valley fluid retention Svi (EUR 15178N) of 0.115.

RESULTS:



3D Profile of Orange Peel Surface

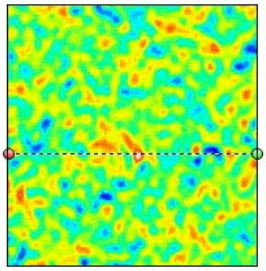
Density of Peaks



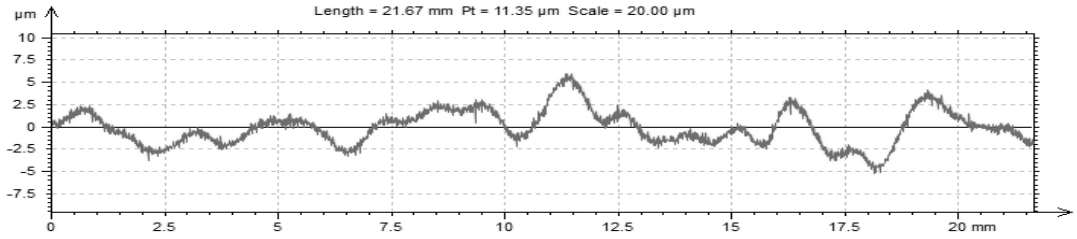
3D Roughness Parameters

ISO 25178		
Height Parameters		
Sq	1.400	µm
Ssk	0.03889	
Sku	3.131	
Sp	7.000	µm
Sv	5.893	µm
Sz	12.89	µm
Sa	1.108	µm

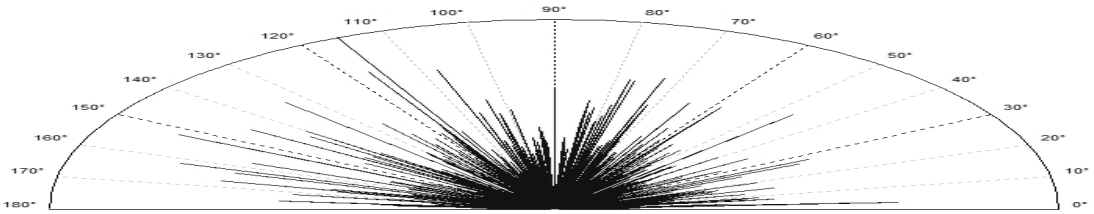
2D Surface Extraction Area



2D Surface Roughness Extraction

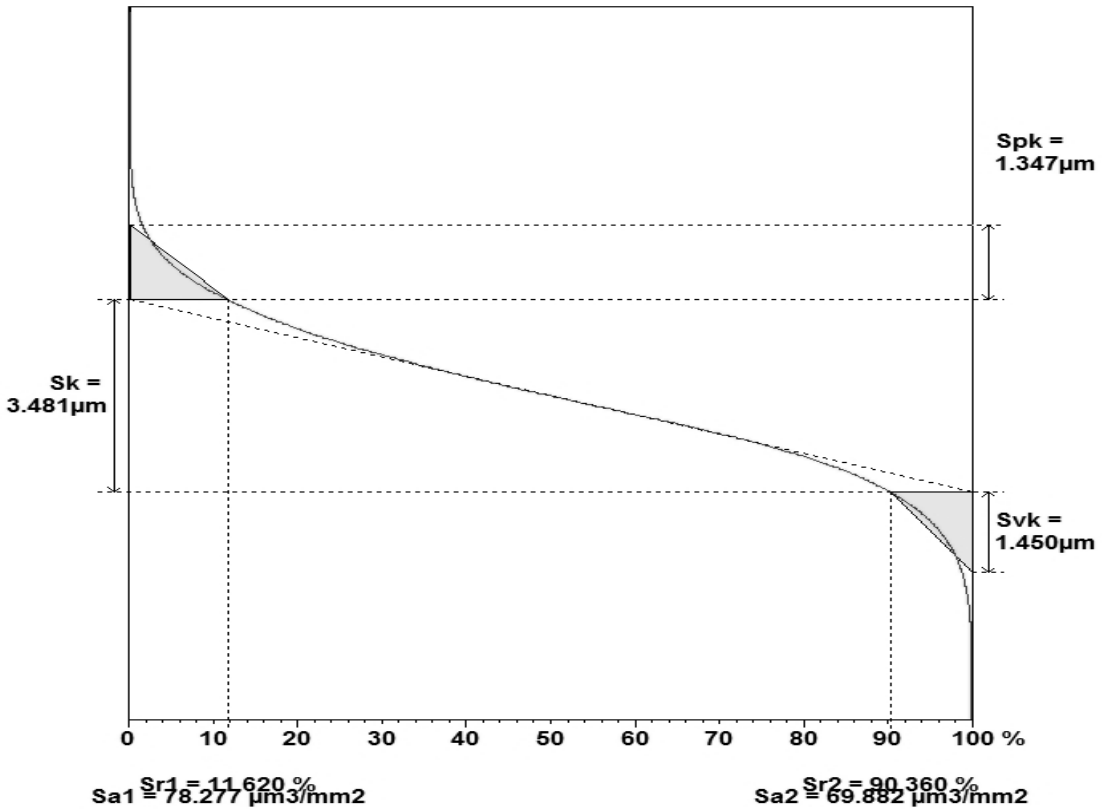


3D Directional Surface Mapping



From 2D extraction Pitch, Height, Angle, Surface Area, Roughness and many others can be automatically calculated

CONCLUSION:



A great graphical representation of the depth distribution can also be seen in the bearing ratio curve (above). Within the software this is an interactive feature that allows the user to view distributions and percentages at varying depths.

In this application, we have shown how the Nanovea ST400 3D Non Contact Profilometer can precisely characterize both the topography and the nanometer details of the orange peel texture of a gloss coating. From the 3D surface measurements, areas of interest can quickly be identified and then analyzed with a list of endless measurements (Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height and others). A 2D cross section can quickly be chosen to analyze further details. With this information gloss texture can be broadly investigated with a complete set of surface measurement resources. Special areas of interest could have been further analyzed with integrated AFM module. Nanovea 3D Profilometers speeds range from 20mm/s to 1m/s for laboratory or research to the needs of hi-speed inspection; can be built with custom size, speeds, scanning capabilities, Class 1 Clean Room compliance, with Indexing Conveyor and for Inline or online Integration.