POWDER COATING FINISH MEASUREMENT USING 3D PROFILOMETRY

Prepared by

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INTRO:

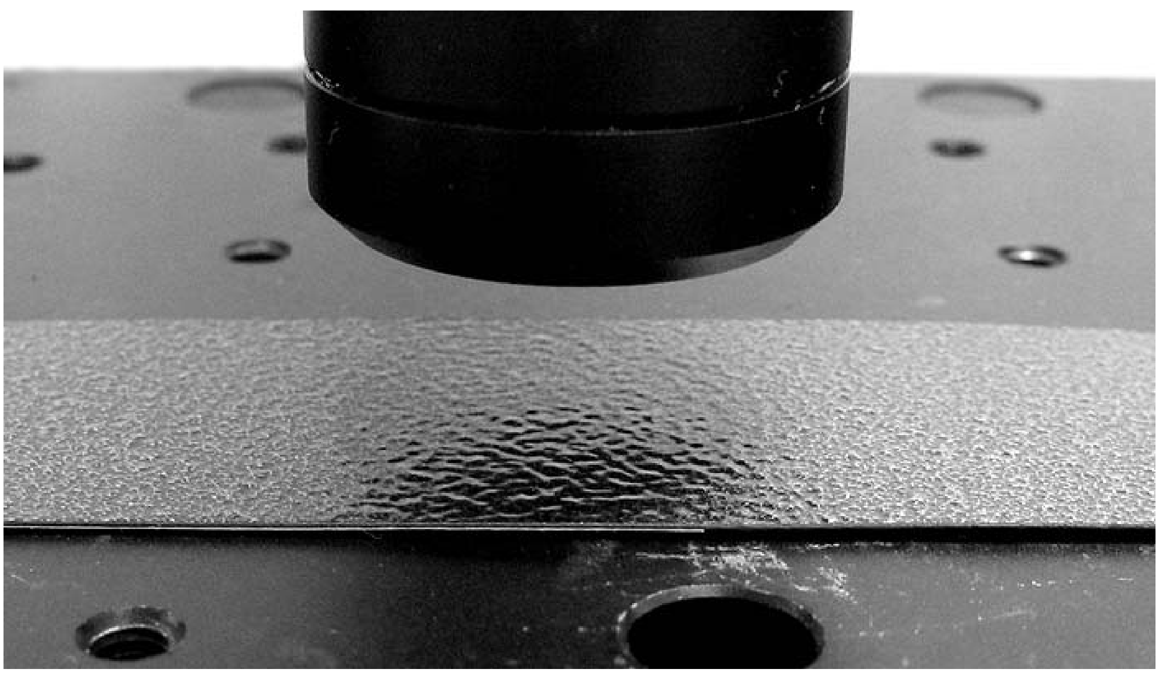
Powder coating, known for its durability, is a coating applied electrostatically as a free-flowing, dry powder then cured under heat. This forms a hard and durable coating/layer typically used on metal household appliances, automotive and aerospace parts. Traditionally Powder Coatings have been visually inspected. The intended or accepted finish of a Powder Coating will vary greatly from application and will depend on the dry powder particle size in the µm range.

IMPORTANCE OF PROFILOMETRY INSPECTION FOR R&D AND QUALITY CONTROL

Because of the large variation possible, and unreliability of visual inspection, the surface finish of powder coatings should be properly inspected for quality control. Understanding surface features can lead to the best selection surface finish and control measures. To insure 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 unmatched capability to measure Powder Coatings. Where other techniques fail to provide reliable data, due to probe contact, surface variation, angle, absorption or reflectivity, Nanovea Profilometers succeed.

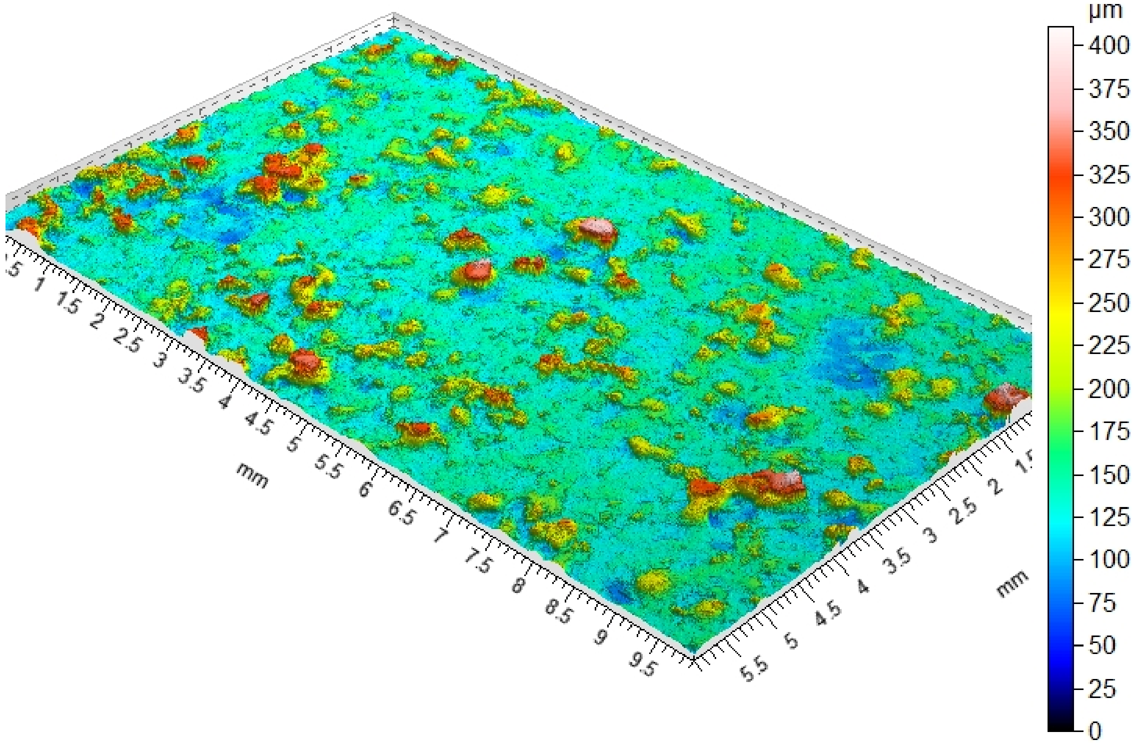
MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure and compare the surface finish of four different Powder Coated samples. Several surface parameters will be automatically calculated from the coating profile. Here we will focus on Surface Roughness, Peak to Valley and Surface Area for comparative evaluation.



RESULTS:

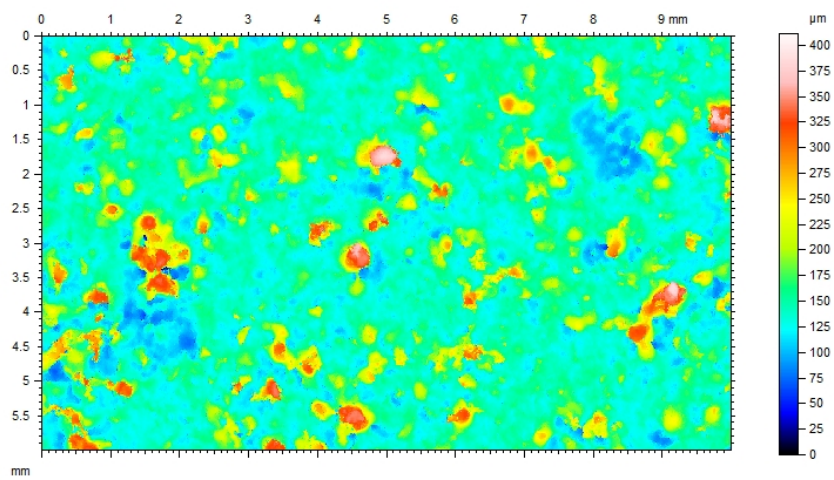
Sample 1



3D View of Sample 1

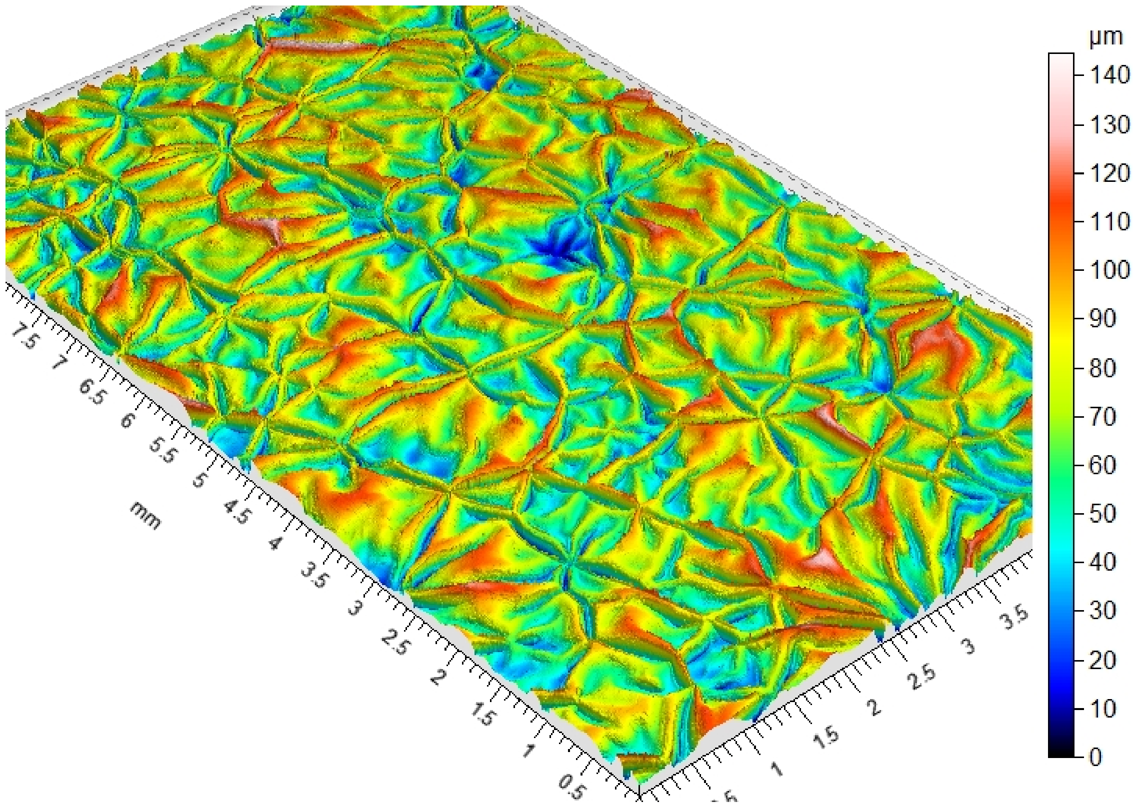
ISO 25178		
Height Parameters		
Sa	27.927	µm
Sq	41.306	µm
Ssk	2.1221	
Sku	8.7157	
Sp	257.93	µm
Sv	153.39	µm
Sz	411.31	µm
Other 3D Parameters		
Miscellaneous		
Sdar	173.34	mm²
Spar	60.000	mm²

Height Parameters of Sample 1



False Color View of Sample 1

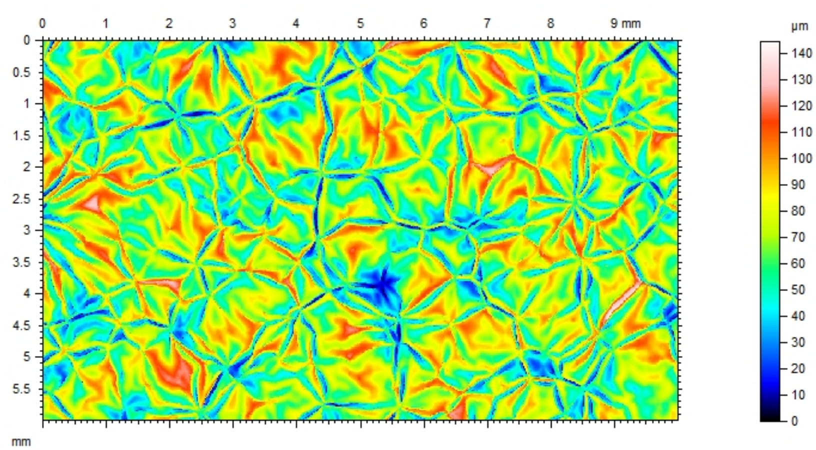
Sample 2



3D View of Sample 2

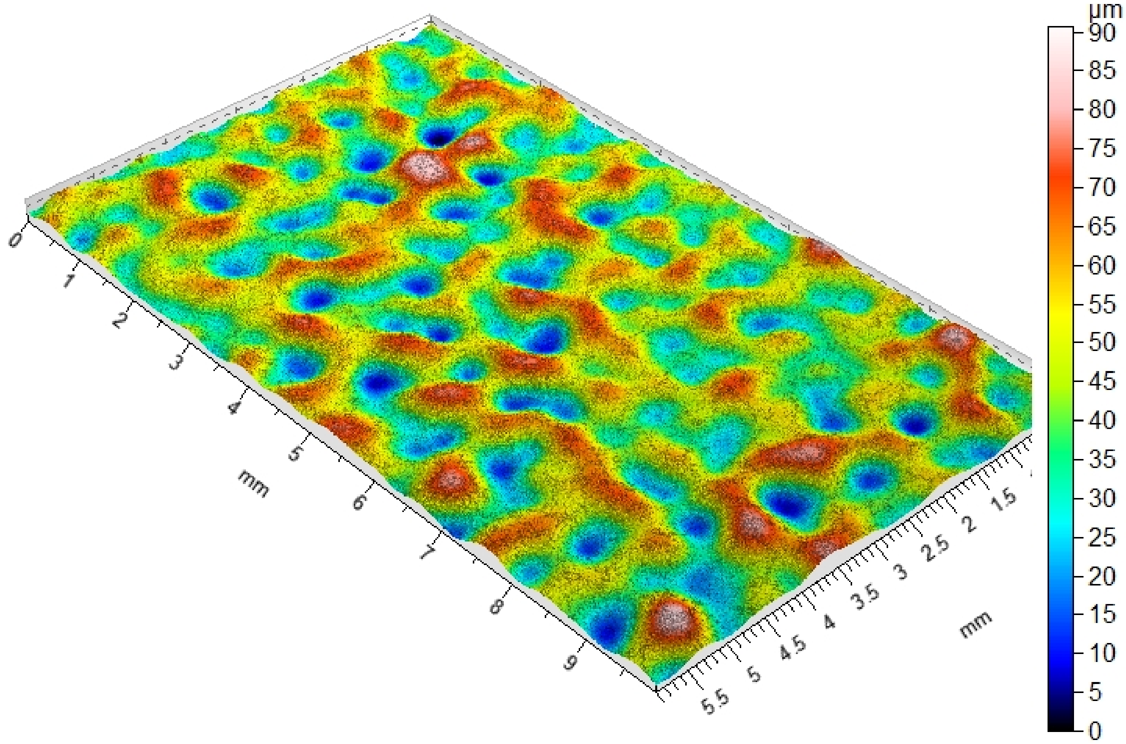
ISO 25178		
Height Parameters		
Sa	17.371	µm
Sq	21.427	µm
Ssk	-0.066279	
Sku	2.7247	
Sp	75.953	µm
Sv	68.661	µm
Sz	144.61	µm
Other 3D Parameters		
Miscellaneous		
Sdar	91.964	mm²
Spar	60.000	mm²

Height Parameters of Sample 2



False Color View of Sample 2

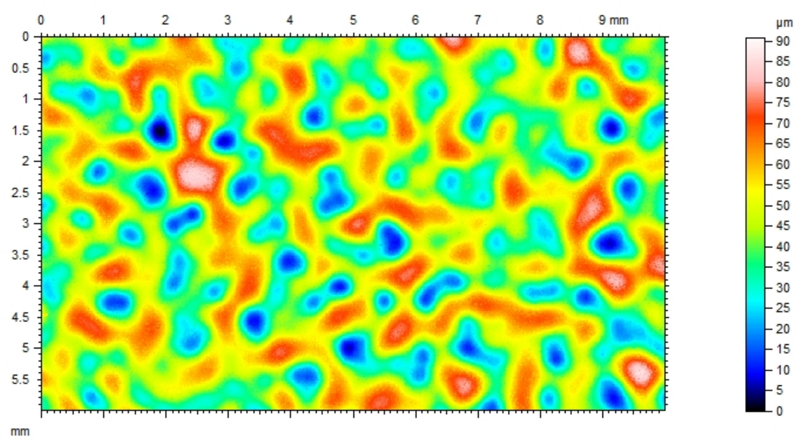
Sample 3



3D View of Sample 3

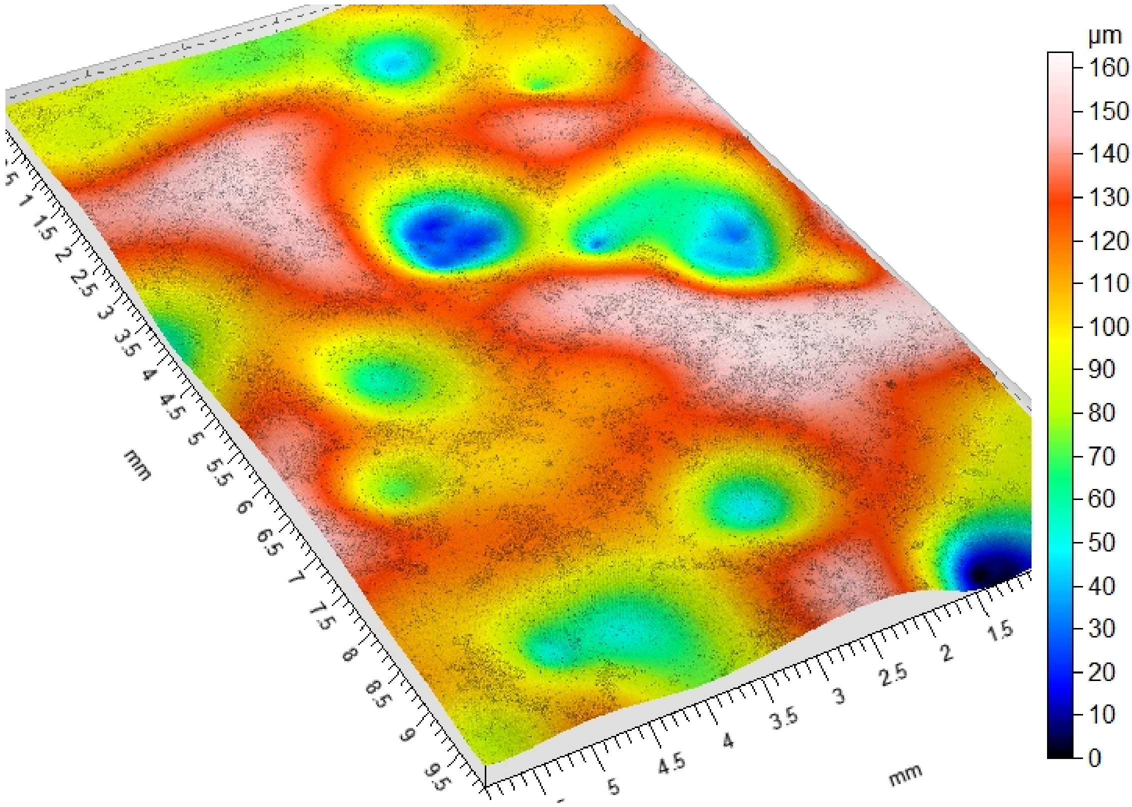
ISO 25178		
Height Parameters		
Sa	11.443	µm
Sq	13.992	µm
Ssk	-0.020995	
Sku	2.5702	
Sp	45.409	µm
Sv	45.322	µm
Sz	90.731	µm
Other 3D Parameters		
Miscellaneous		
Sdar	62.521	mm²
Spar	60.000	mm²

Height Parameters of Sample 3



False Color View of Sample 3

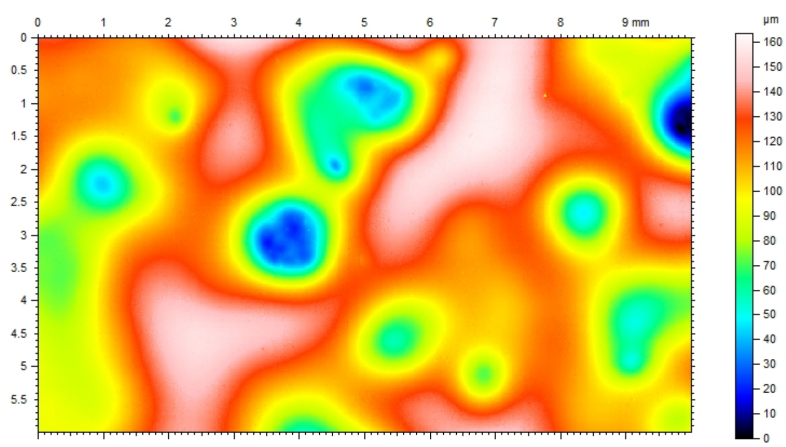
Sample 4



3D View of Sample 4

ISO 25178		
Height Parameters		
Sa	22.149	µm
Sq	27.725	µm
Ssk	-0.59415	
Sku	3.1891	
Sp	55.517	µm
Sv	108.14	µm
Sz	163.66	µm
Other 3D Parameters		
Miscellaneous		
Sdar	61.035	mm²
Spar	60.000	mm²

Height Parameters of Sample 4



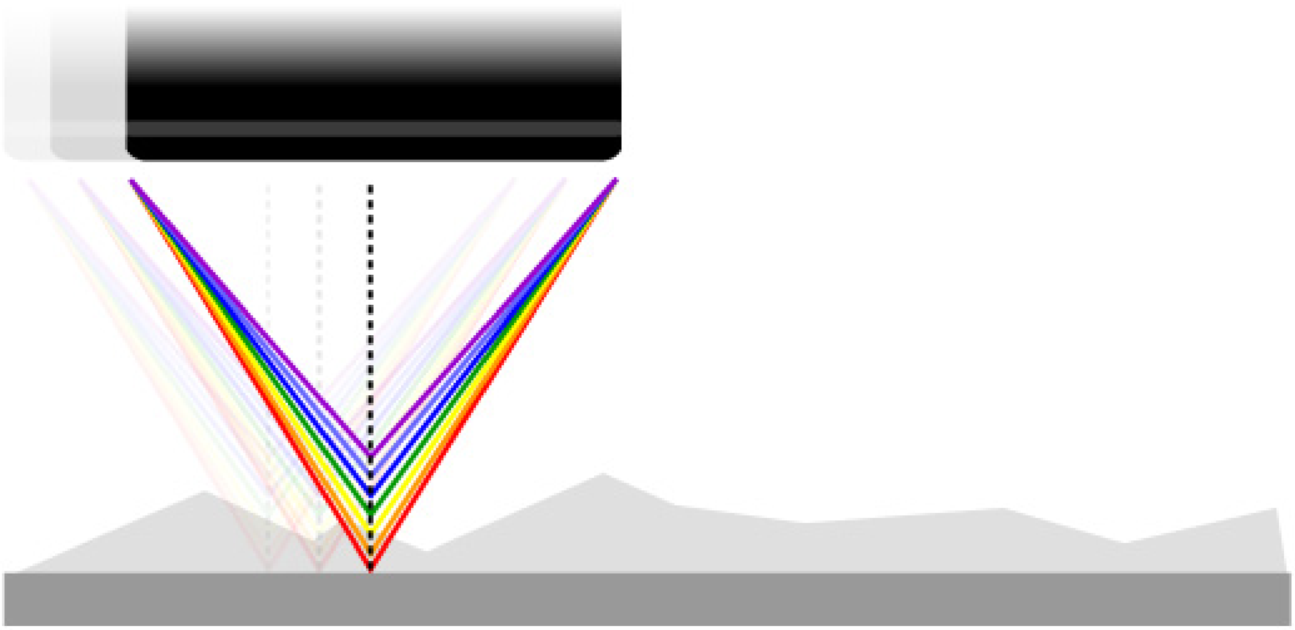
False Color View of Sample 4

CONCLUSION:

In this application, we have shown how the Nanovea ST400 3D Profilometer can precisely characterize the surface finish a of the Powder Coated samples surface. (*Note, many other measurements could have also been made besides those shown here) By looking at the three highlighted parameters, Surface Roughness, Peak to Valley and Surface Area, we can easily quantify differences between the finish and quality of the four samples that may not be obvious by visual inspection. With this information Powder Coatings can be investigated for R&D or quality control procedures. To further view in detail a 2D cross section can quickly be chosen to analyze, at nanometer range, special areas of interest. Special areas of interest could have been further analyzed with integrated AFM or Microscope 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. Learn more about the Nanovea Profilometer or Lab Services

MEASUREMENT PRINCIPLE:

The Chromatic Confocal 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.



Unlike the errors caused by probe contact or the manipulative Interferometry technique, Chromatic Confocal technology measures height directly from the detection of the wavelength that hits the surface of the sample in focus. It is a direct measurement with no mathematical software manipulation. This provides unmatched accuracy on the surface measured because a data point is either measured accurately without software interpretation or not at all. The software completes the unmeasured point but the user is fully aware of it and can have confidence that there are no hidden artifacts created by software guessing.

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

DEFINITION OF HEIGHT PARAMETERS

	Height Parameter	Definition
Sa	Arithmetical Mean Height	Mean surface roughness. $$Sa = \frac{1}{A} \iint_A \lvert z(x,y)\rvert dxdy$$
Sq	Root Mean Square Height	Standard deviation of the height distribution, or RMS surface roughness. $$Sq = \sqrt{\frac{1}{A} \iint_A z^2(x,y)dxdy}$$ Computes the standard deviation for the amplitudes of the surface (RMS).
Sp	Maximum Peak Height	Height between the highest peak and the mean plane.
Sv	Maximum Pit Height	Depth between the mean plane and the deepest valley.
Sz	Maximum Height	Height between the highest peak and the deepest valley.
Ssk	Skewness	Skewness of the height distribution. $$Ssk = \frac{1}{Sq^3}\left[\frac{1}{A} \iint_A z^3(x,y)dxdy\right]$$ Skewness qualifies the symmetry of the height distribution. A negative Ssk indicates that the surface is composed of mainly one plateau and deep and fine valleys. In this case, the distribution is sloping to the top. A positive Ssk indicates a surface with a lot of peaks on a plane. Therefore, the distribution is sloping to the bottom. Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.
Sku	Kurtosis	Kurtosis of the height distribution. $$Sku = \frac{1}{Sq^4}\left[\frac{1}{A} \iint_A z^4(x,y)dxdy\right]$$ Kurtosis qualifies the flatness of the height distribution. Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.
Spar	Projected Area	Projected surface area.
Sdar	Developed Area	Developed surface area.