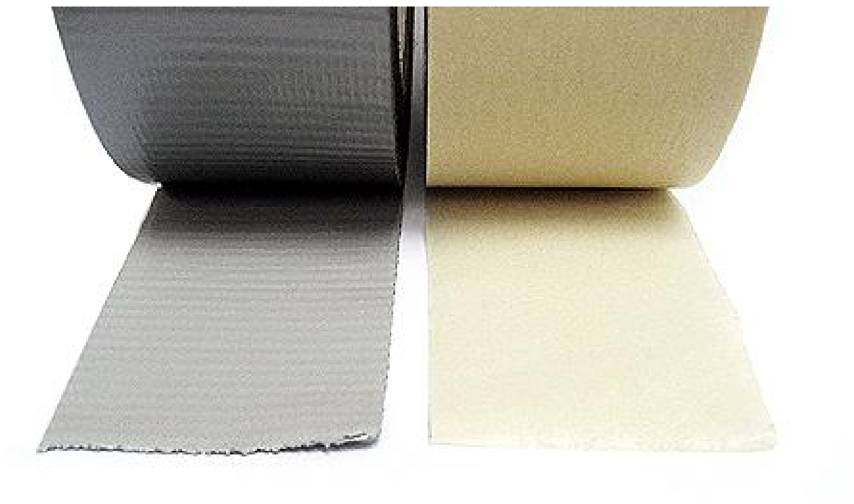
ADHESIVE SURFACE TOPOGRAPHY USING 3D PROFILOMETRY



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INTRO:

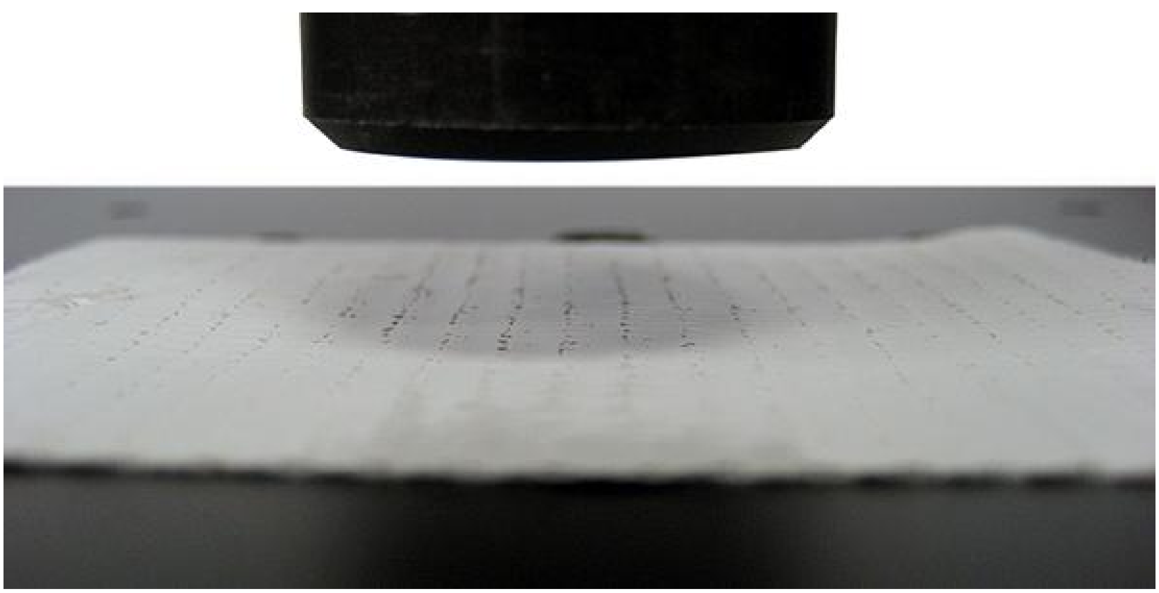
Adhesives are intended for direct contact with another surface to create varying levels of bond. These varying levels of bond, or strength, can be directly attributed to the surface area over which the two materials contact. At the nanometer level an otherwise flat appearing surface may in fact be uneven and rough altering the strength of the adhesive bond. It is for this very reason that adhesive surface topography should be closely monitored during R&D and quality control to achieve intended adhesive strength.

IMPORTANCE OF SURFACE METROLOGY INSPECTION FOR R&D AND QUALITY CONTROL

Adhesive surface topography is vital to understanding and responding to the intended use and need for adhesion. To control the strength of an adhesive bond will heavily rely upon quantifiable, reproducible and reliable measurement of adhesive surface topography. Precise measurement and evaluation of an adhesive surface, on a given material or existing structure, can lead to the best selection of substrate, depositing and control measures. The Nanovea 3D Non-Contact Profilometers utilize chromatic confocal technology with unmatched capability to measure adhesive surfaces. Where other techniques fail to provide reliable data, due to probe contact, surface variation, angle and reflectivity, Nanovea Profilometers succeed.

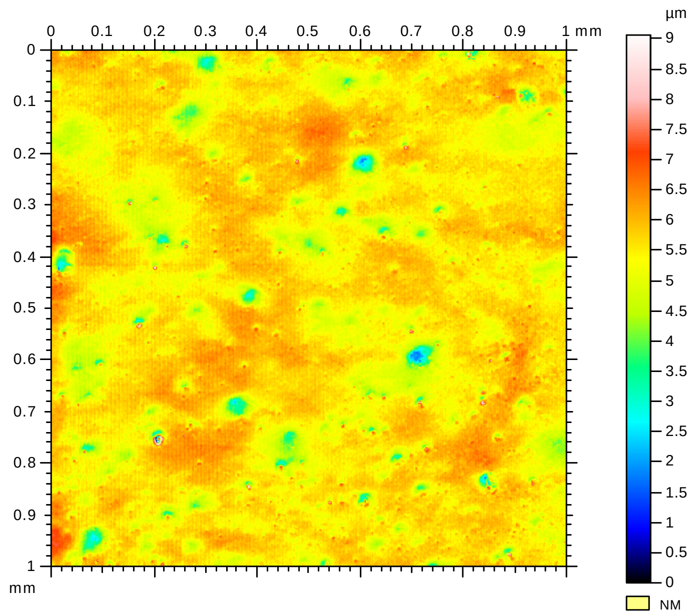
MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the surface of two adhesive tapes for comparative review. Several surface parameters can automatically be calculated including the most common, Sa (average surface roughness), step height, area and many others.

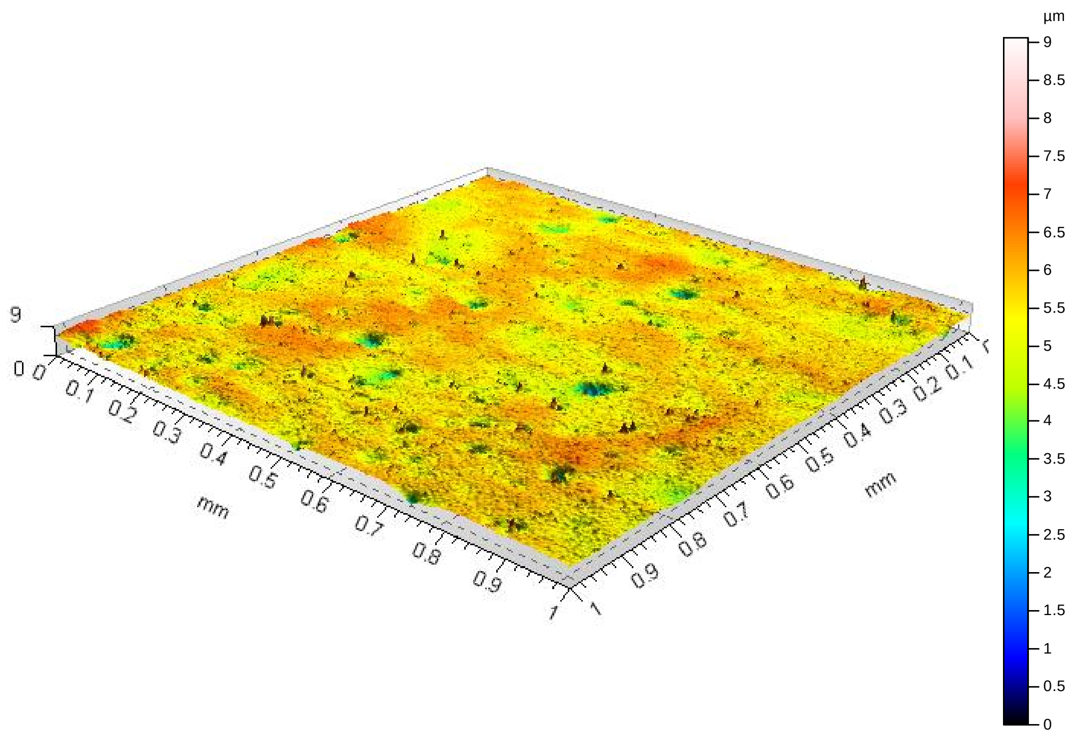


RESULTS:

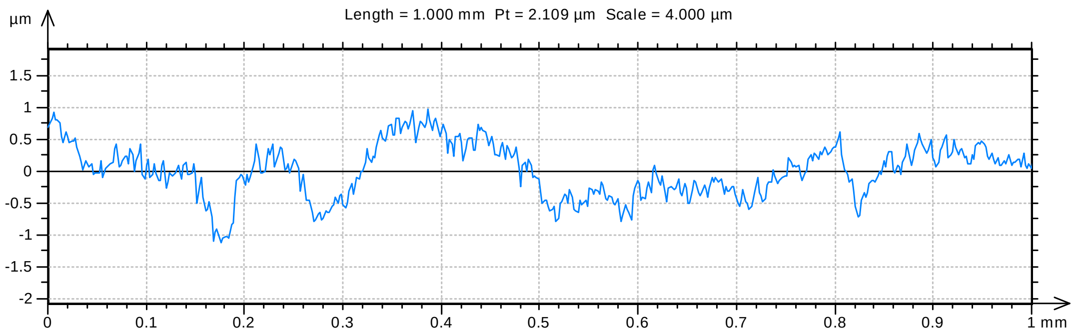
Duct Tape



Top Surface of Duct Tape

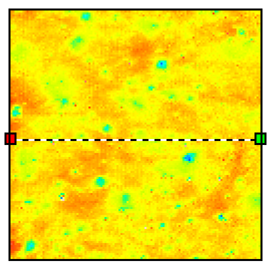


3D Image of Duct Tape Surface



Roughness Profile Extracted From Duct Tape

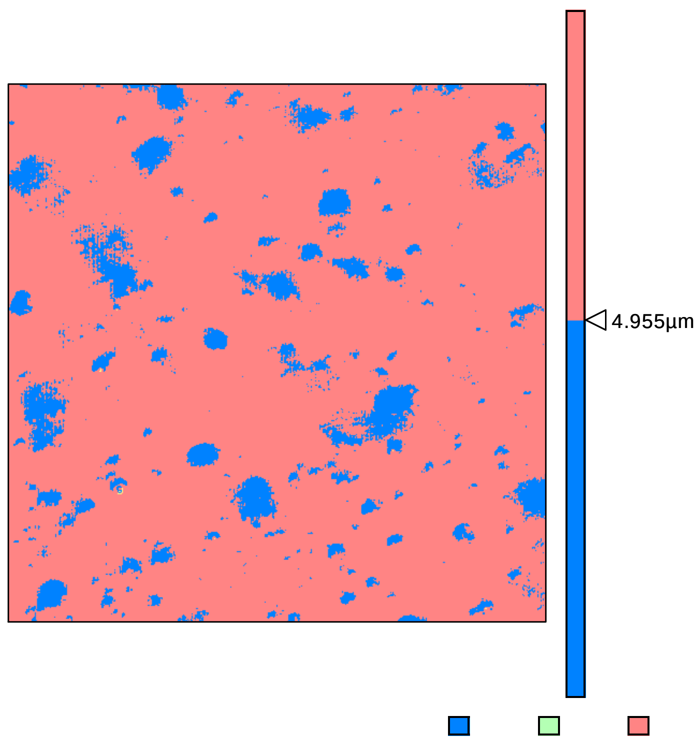
Roughness Profile Extracted



ISO 25178
Height Parameters

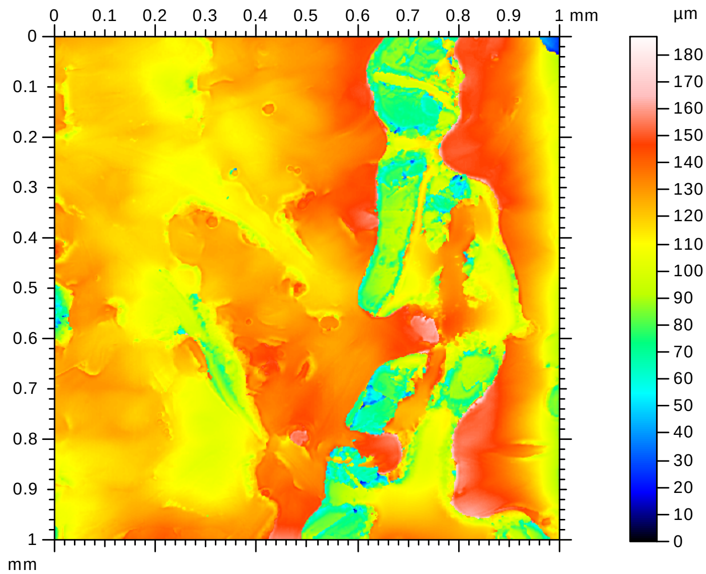
Sq	0.480	µm
Ssk	-1.231	
Sku	8.681	
Sp	3.499	µm
Sv	5.562	µm
Sz	9.062	µm
Sa	0.344	µm

Surface Area Contact

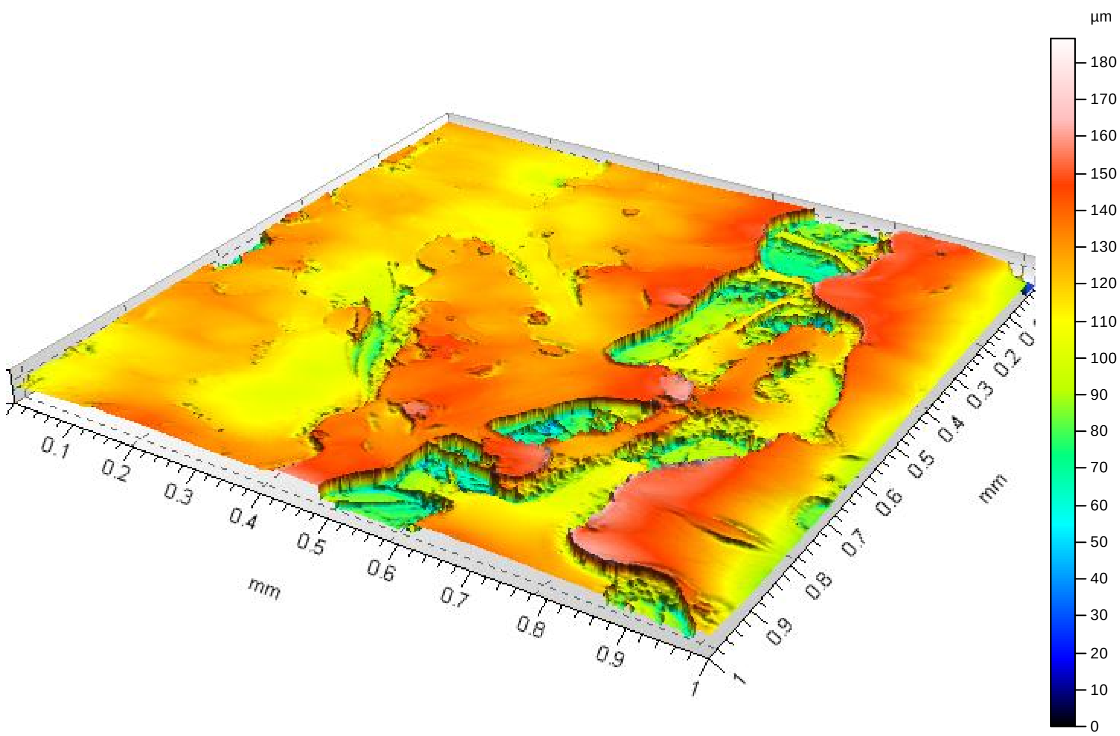


	Blue	Green	Red
Projected Area (%)	8.284	0.000	91.72
Volume of void (%)	0.7477	0.000	84.30
Volume of material (%)	99.25	0.000	15.70
Volume of void (µm.mm2/mm2)	0.03704	0.000	3.463
Volume of material (µm.mm2/mm2)	4.917	0.000	0.6447

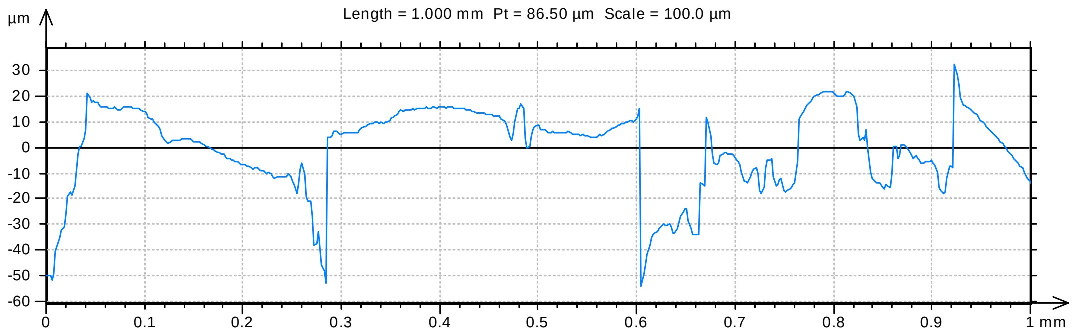
Masking Tape



Top Surface of Masking Tape

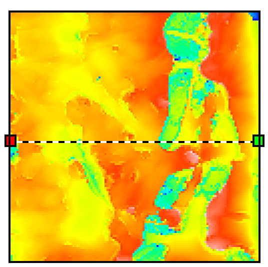


3D Image of Masking Tape Surface

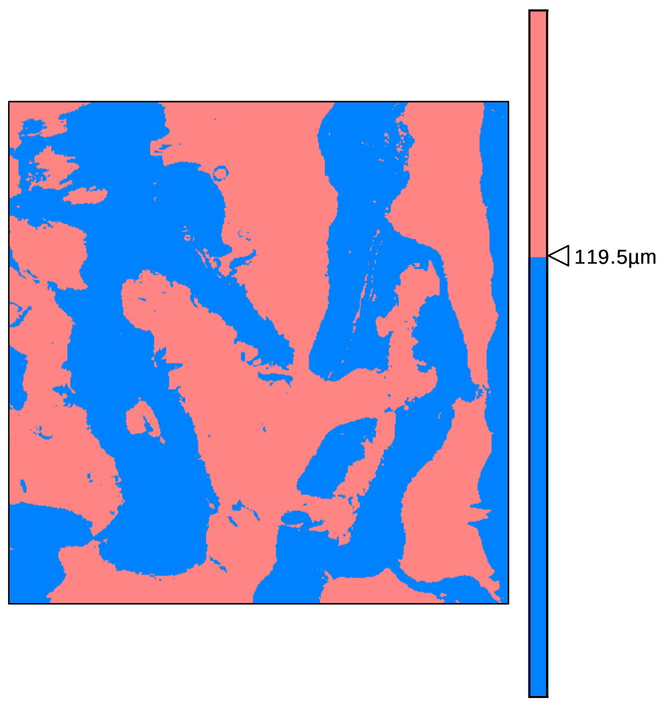


Roughness Profile Extracted From Masking Tape

Roughness Profile Extracted



Surface Area Contact



ISO 25178
Height Parameters

Sq	20.01	µm
Ssk	-0.8582	
Sku	4.289	
Sp	67.89	µm
Sv	118.7	µm
Sz	186.6	µm
Sa	14.90	µm

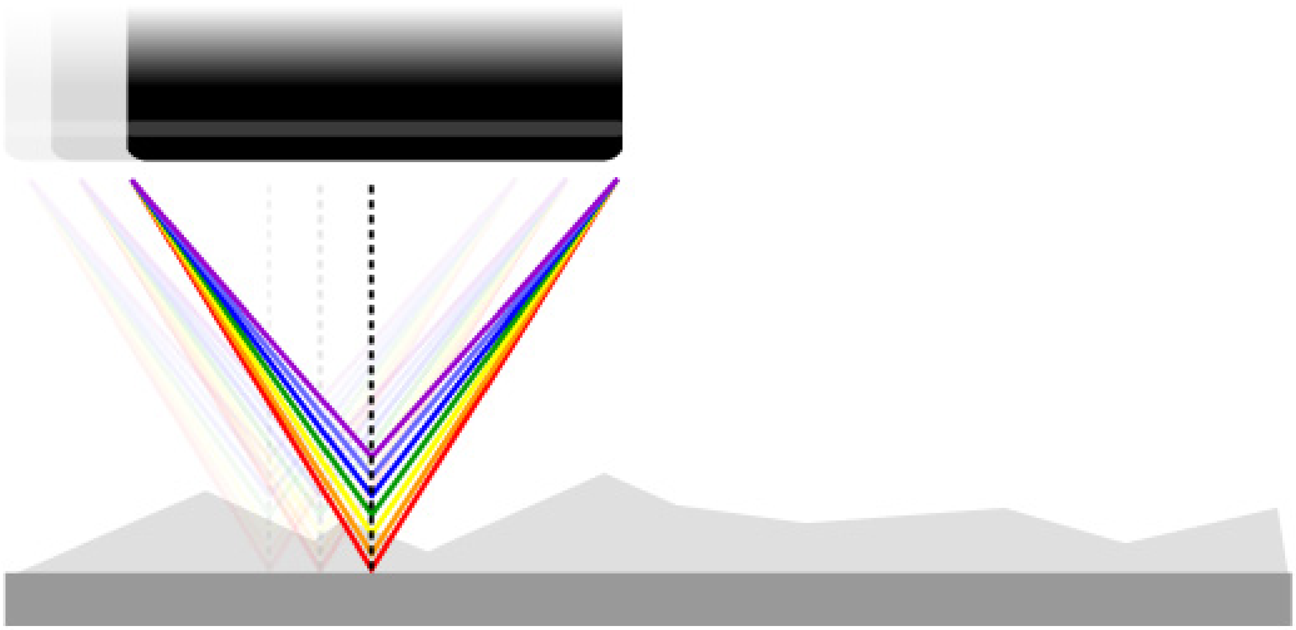
Projected Area (%)	46.45	0.000	53.55
Volume of void (%)	6.534	0.000	89.53
Volume of material (%)	93.47	0.000	10.47
Volume of void (µm.mm2/mm2)	7.807	0.000	60.08
Volume of material (µm.mm2/mm2)	111.7	0.000	7.024

CONCLUSION:

In this application, we have shown how the Nanovea ST400 3D Profilometer can precisely characterize both the topography and the nanometer details of the adhesive surface. From the 3D image the inconsistent adhesive surfaces can clearly be identified and may or may not be an important factor for its intended purpose. With this information surface contact area can be investigated and what its effect on adhesive levels may be. To further view in detail a 2D cross section can quickly be chosen to analyze, at nanometer range, step height and planarity among others. 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.

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.