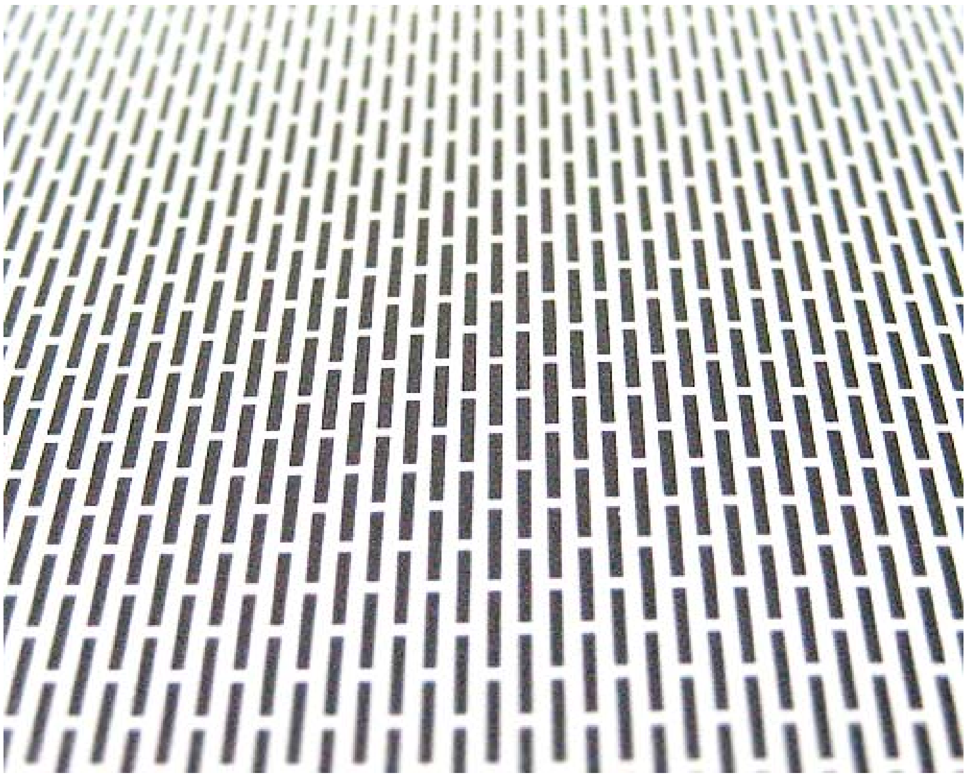
NANOVEA
A Better Measure.

STEP HEIGHT MEASUREMENT OF PRINTED ELECTRODES USING 3D PROFILOMETRY



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INTRO:

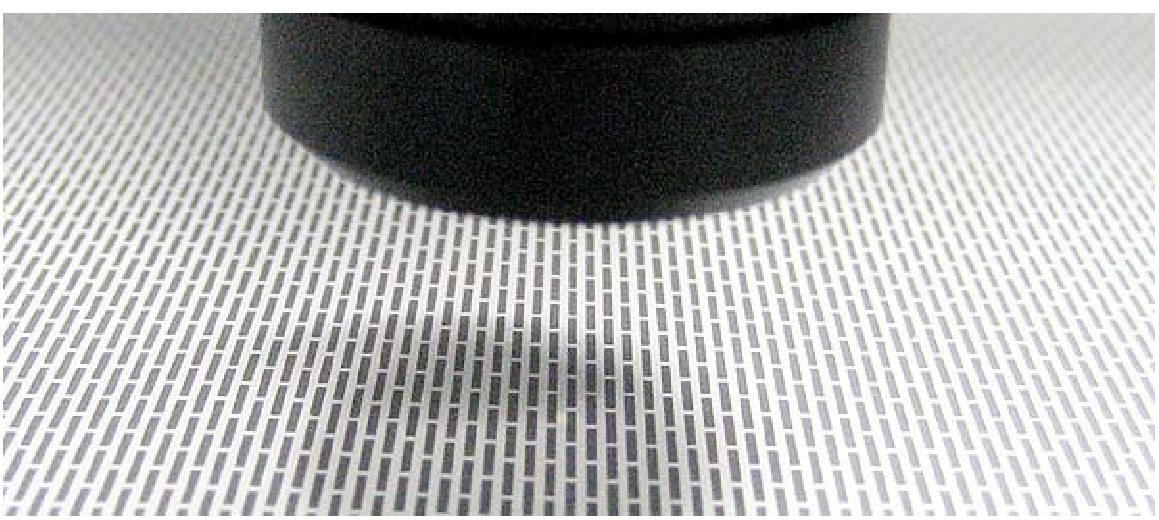
Accurately measuring step heights and lateral dimensions is very important to a vast range of industries. The measurements in this article were taken from printed electrodes on a flexible ceramic sheet. This highlights the user ability to measure very small features with wavy, uneven and/or angled samples. Measurements were taken without any special care to flatten or level the flexible samples and the analysis software was then used to level and remove any overall form or waviness and calculate dimensions. Single line passes can be done in seconds with automated results through macro templates.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR STEP HEIGHT MEASUREMENT

Unlike other techniques such as touch probes or interferometry, the 3D Non Contact Profilometer, using axial chromatism, can measure nearly any surface, sample sizes can vary widely due to open staging and there is no sample preparation needed. Nano through macro range is obtained during surface profile measurement with zero influence from sample reflectivity or absorption, has advanced ability to measure high surface angles and there is no software manipulation of results. Easily measure any material: transparent, opaque, specular, diffusive, polished, rough etc. The technique of the Non Contact Profilometer provides an ideal, broad and user friendly capability to maximize surface studies when step height will be needed; along with the benefits of combined 2D & 3D capability.

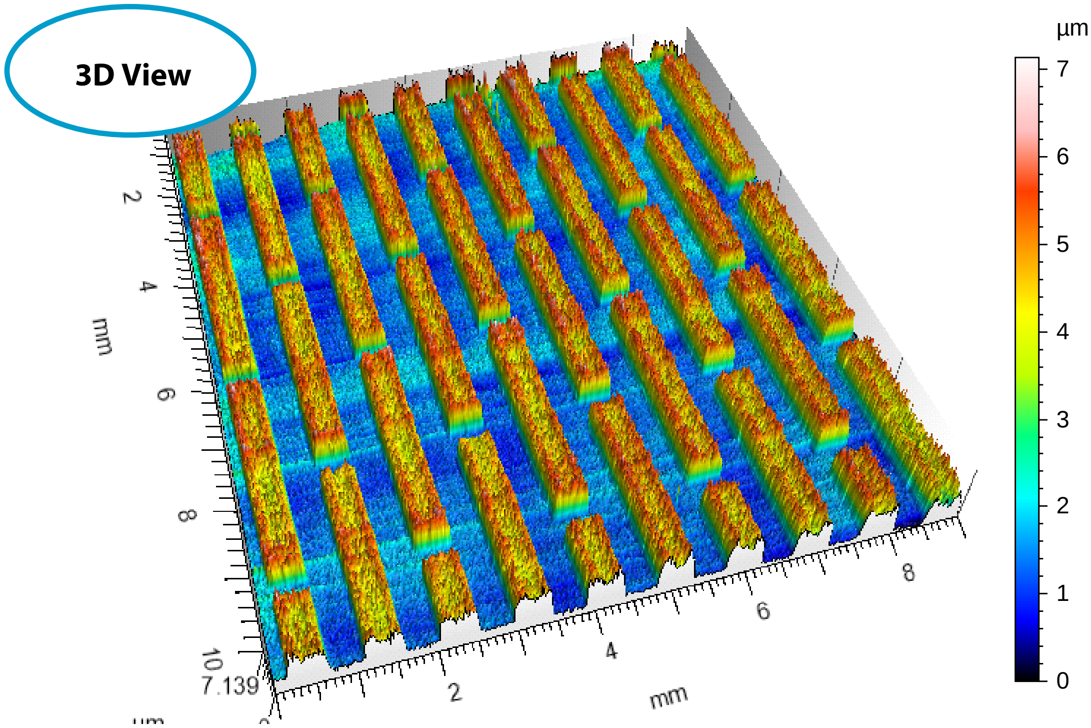
MEASUREMENT OBJECTIVE

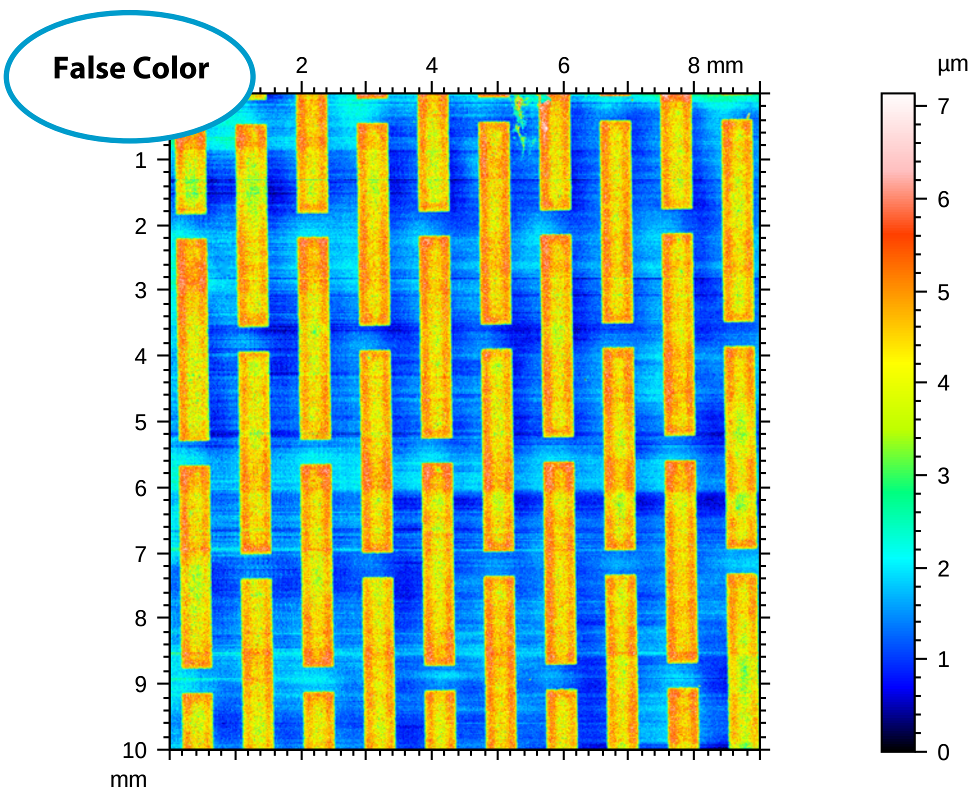
In this application the Nanovea ST400 Profilometer is used to measure printed electrodes on a flexible ceramic sheet. The area measured was large enough that it could be extrapolated to make assumptions about a much larger surface. Height and lateral dimensions will be measured to characterize the rectangular features on these samples.



RESULTS: 3D Surface

The 3D View and False Color View of a randomly selected area on the sample surface after the waviness has been removed. It provides users a straightforward tool to directly observe the distribution and morphology of the surface features from different angles.

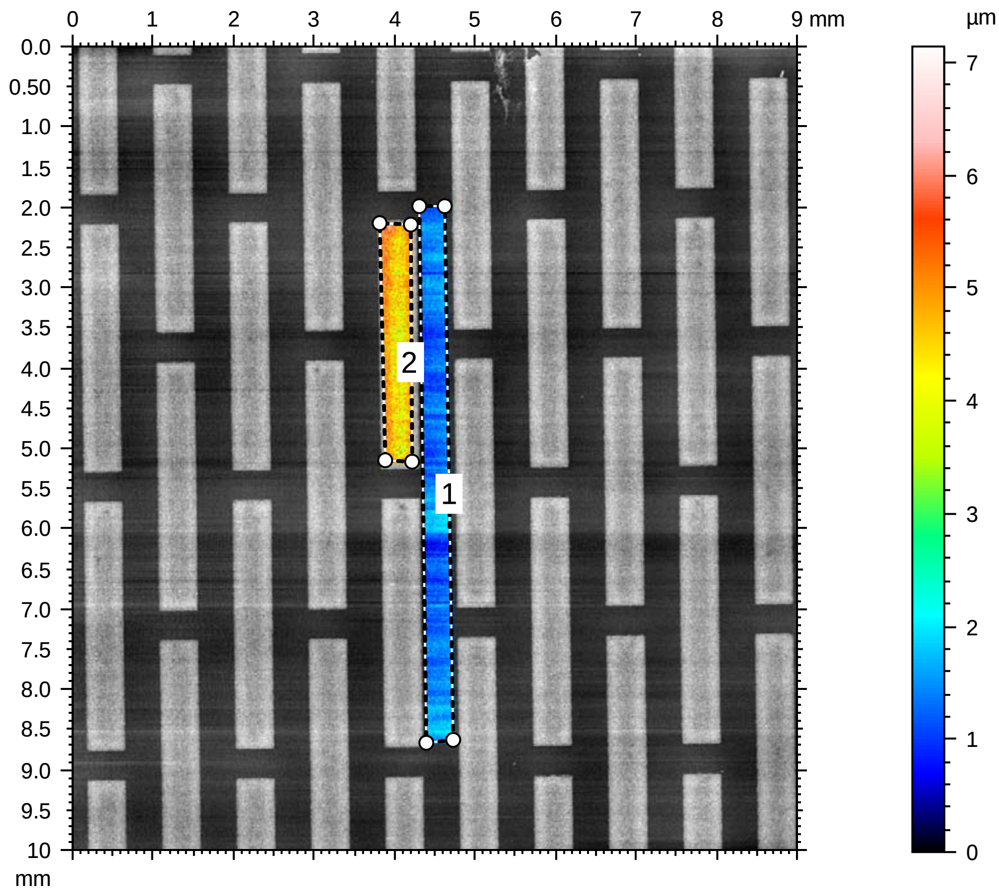




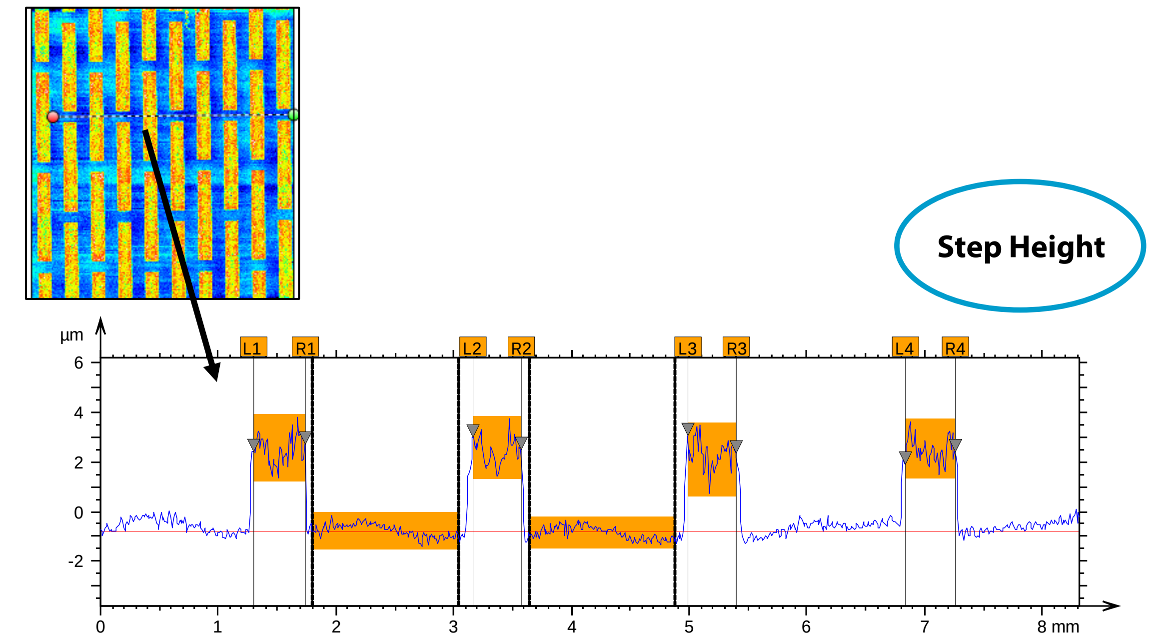
2D Surface Analysis

The surface features can be quantified in numerous ways using built-in software tools as shown in the following figures as examples. It can be observed that the features range in height from 2.8 µm to 3.3 µm. They are also 0.42 mm-0.45 mm in width, and 3.00 mm-3.03 mm in length.

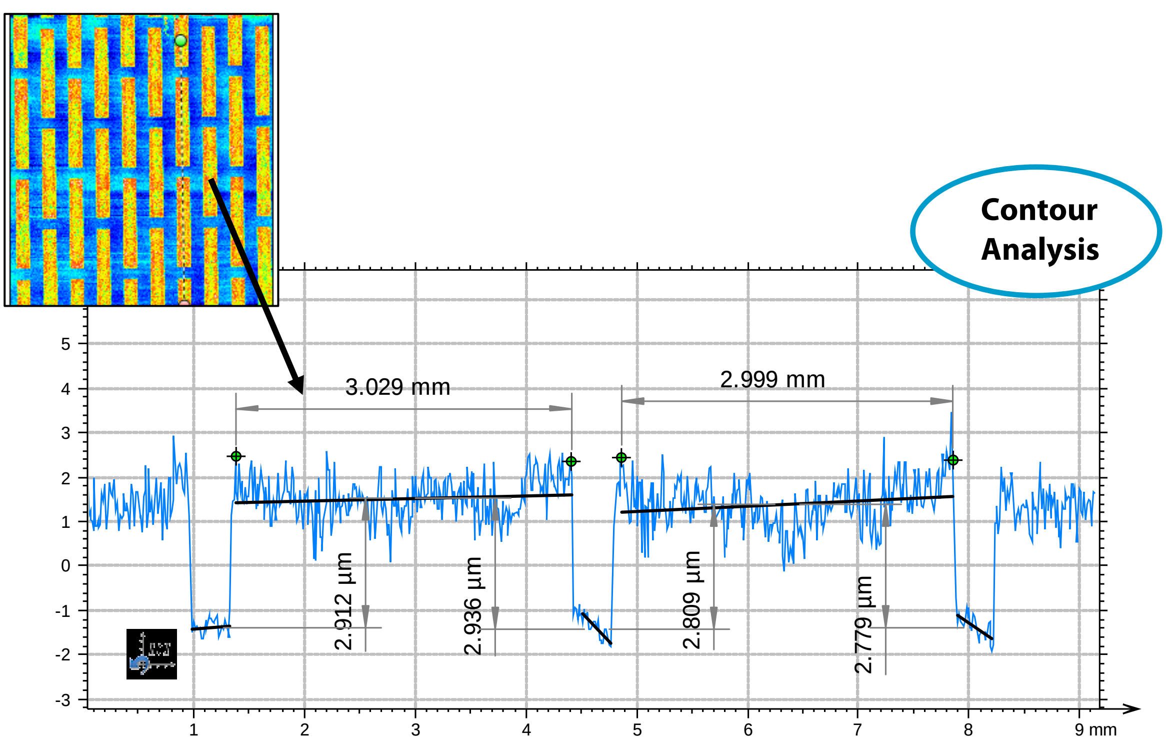
Step Height



Differential parameters	Value	Unit	
Zmean(2) - Zmean(1)	3.318	µm	



Parameters	Unit	Step 1	Step 2	Step 3	Step 4	
Width	mm	0.4459	0.4162	0.4162	0.4360	
Maximum height	µm	4.606	4.521	4.272	4.433	
Mean height	µm	3.279	3.244	3.139	3.287	



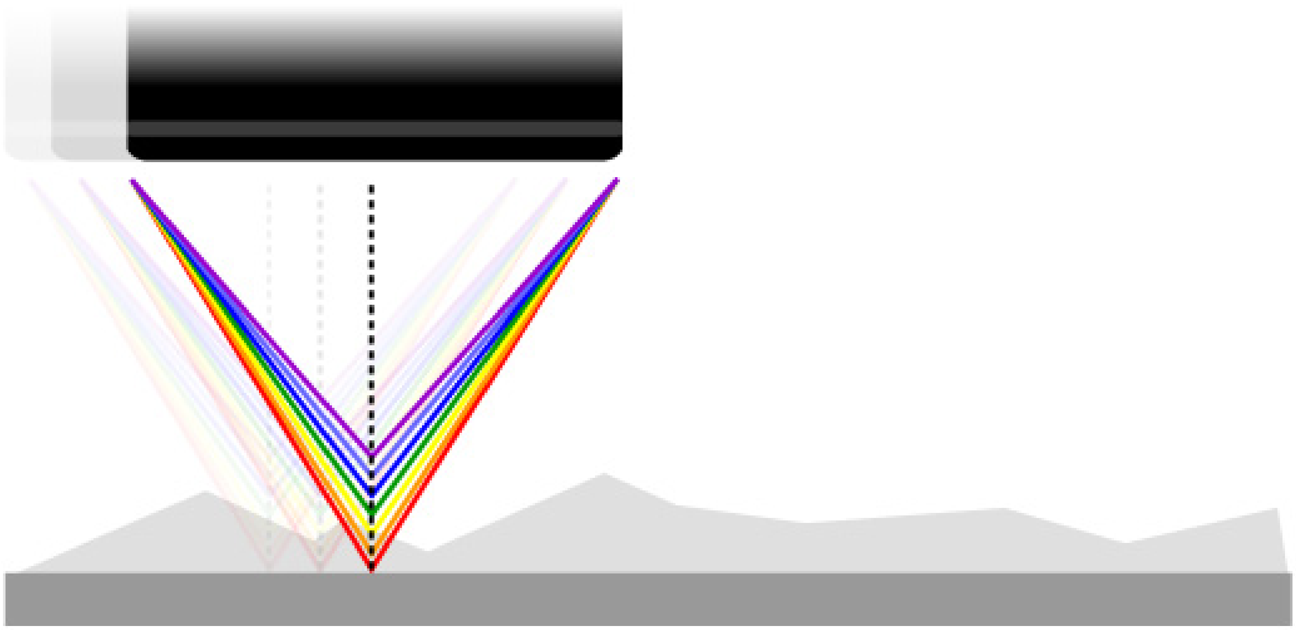
CONCLUSION:

In this application, we have shown how the Nanovea 3D Non Contact Profilometer is capable of precisely characterizing the height and lateral dimensions of a wide variety of surface features. The data shows the rectangular features to be 2.8 µm-3.3 µm in height, 0.42 mm-0.45 mm in width, and 3.00 mm-3.03 mm in length. The data shown here represents only a portion of the calculations available in the analysis software.

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.