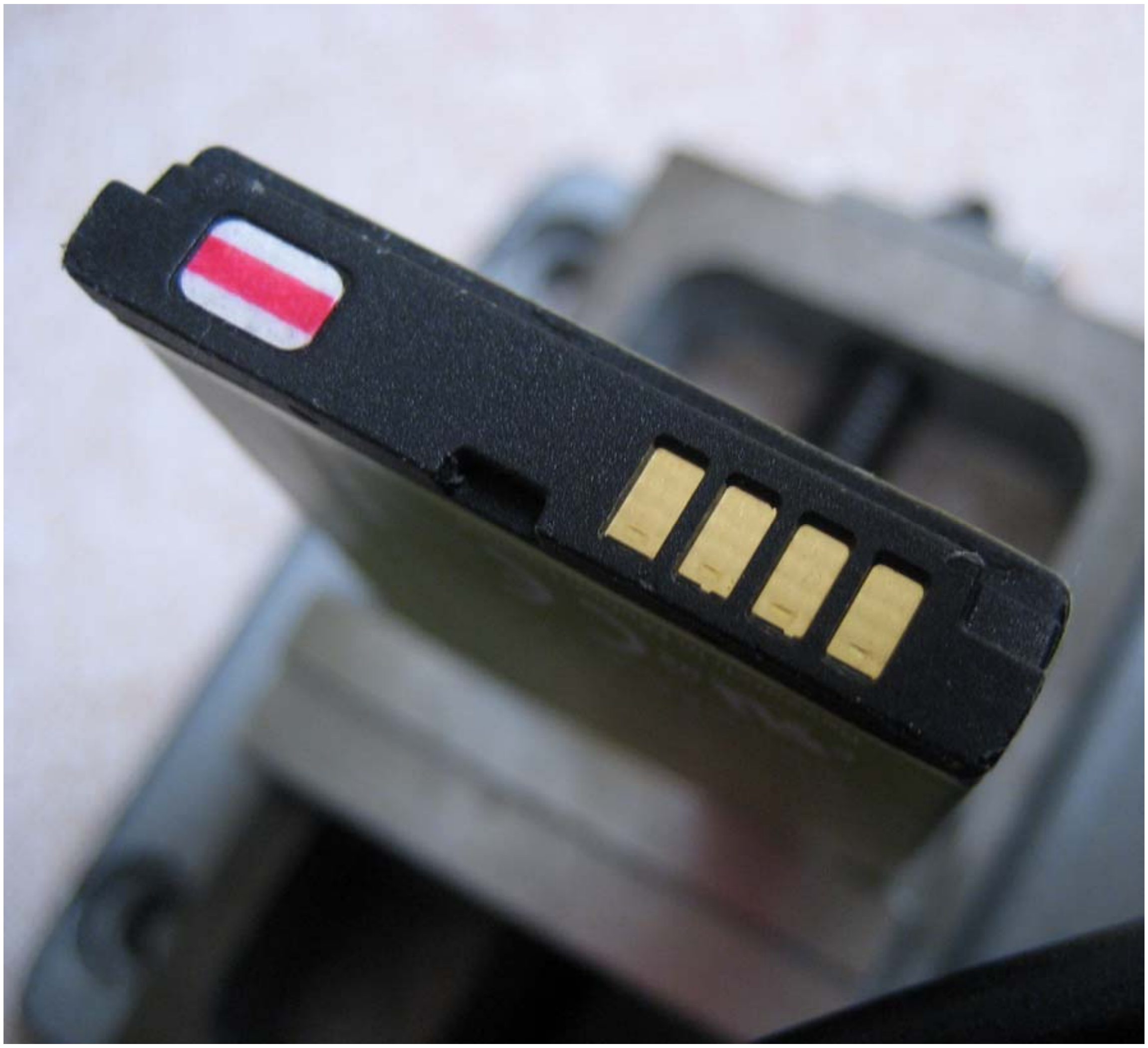
BATTERY CONTACT WEAR LOSS USING 3D PROFILOMETRY



Prepared by

Benjamin Mell

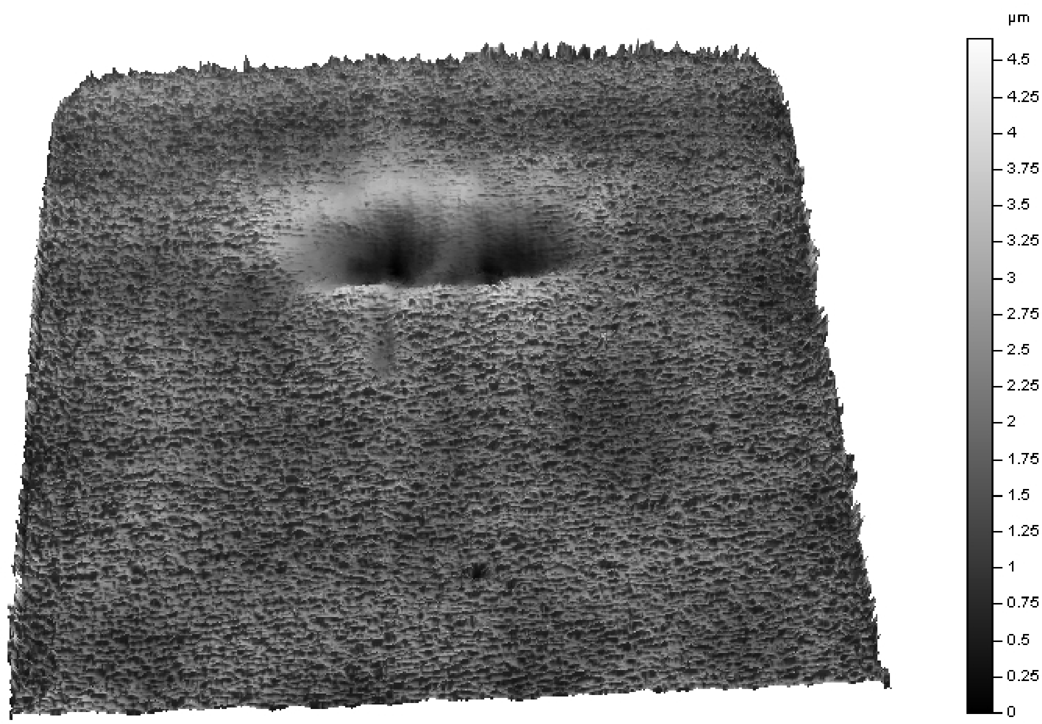
6 Morgan, Ste156, Irvine CA 92618 · P: 949.461.9292 · F: 949.461.9232 · nanovea.com

INTRO:

A contact pad of a cell phone battery is necessary to provide an electrical signal from the battery to the rest of the cell phone for power. The area of the contact, contact force, and the quality of the contact are all important factors. Material properties, including conductivity, are important for optimal contact performance.

The material used to plate both of the mating surfaces also has an impact on the performance of the contact. The two contacting materials must be metals, so that there is conduction for the signal to flow. Since Gold and Silver have excellent conductivity, they are used for plating the contact surfaces. The disadvantage of using these materials is that both elements are very soft.

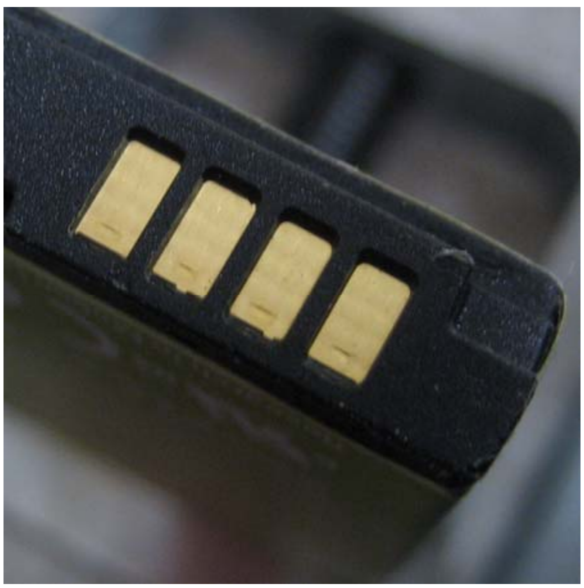
The physical connection of a contact will produce wear on the surface of the contact pad. Therefore, Gold and Silver are usually alloyed with other materials to increase their resistance to wear, however, this decreases their conductivity. In the case where there is a large amount of wear, there can be a loss of connection between the two contact materials. The result is a loss of power to the cell phone. In such a case, the battery will need to be replaced.

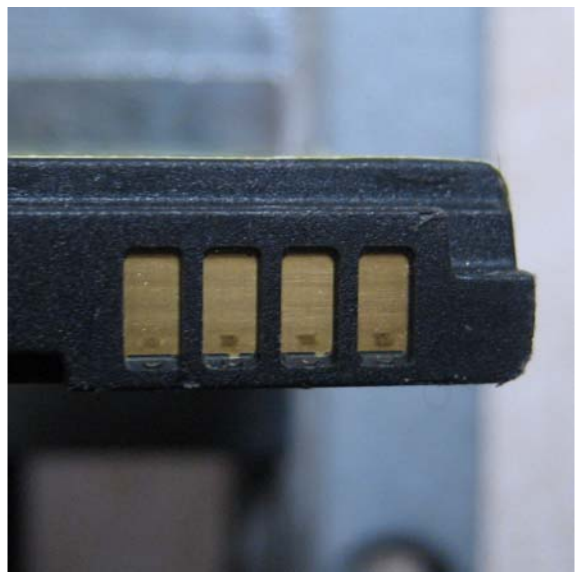


3D Rendering of Worn Battery Contact in Nanovea ST400 Analysis Software

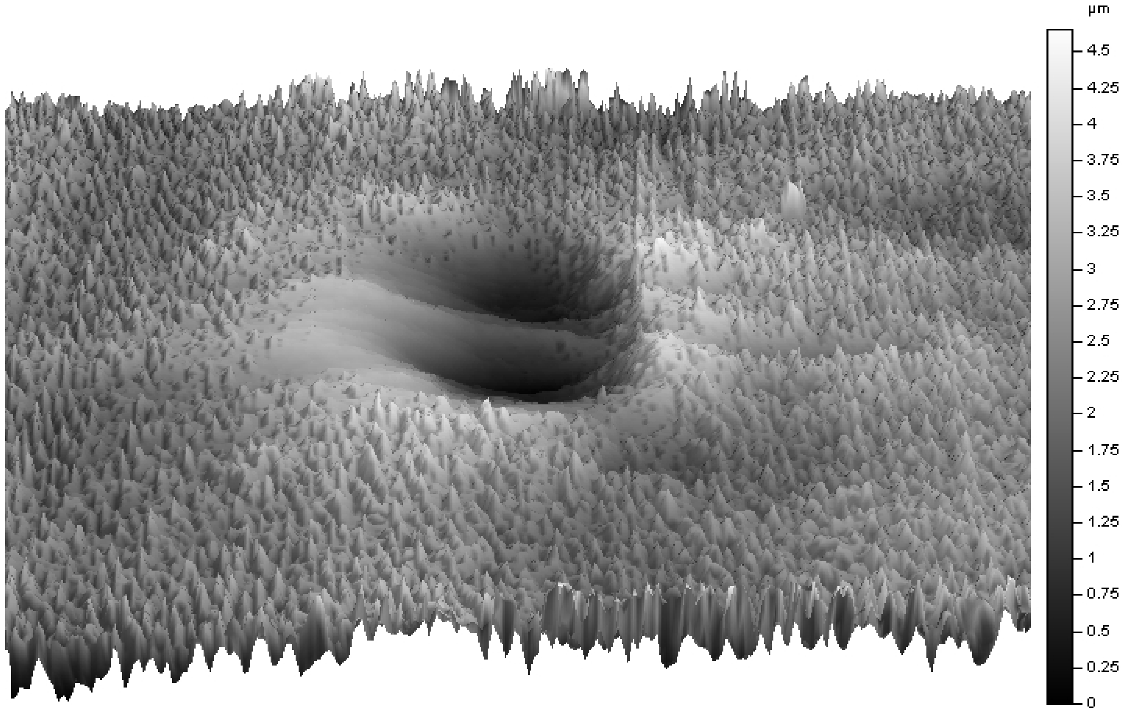
MEASUREMENT OBJECTIVE

In this application, the ST400 is used to measure the surface topography of worn Blackberry battery contact pads. By measuring the depth and volume of the worn areas, contact pad production variations and material differences can be detected by comparing the volume loss of contact pad material, from one battery to the next. Quality control by these means could reveal differences in material properties of the battery contact pads. As a result, the battery manufacturer could conduct such a study to understand how one particular contact pad material will wear from one supplier to another. Doing so may detect differences in hardness of the chosen material, or alloy, used in the production of the contact pads. This could also determine if a different material should be used versus another that may not be as wear-resistant. Another quality control check could be measuring the material volume loss of contact pad wear at various time intervals, to provide an idea of the amount of material removed in a given period of time.





In this study, two of the same batteries will be compared for volume of contact pad material loss. These batteries are used in a Blackberry 8800. The batteries have been in use for approximately 2 years. Similar values for contact material volume loss are to be expected as a result of this experiment.



3D Rendering of Worn Battery Contact in Nanovea ST400 Analysis Software

TEST RESULTS:

VOLUME and SURFACE AREA CALCULATIONS – BATTERY 1

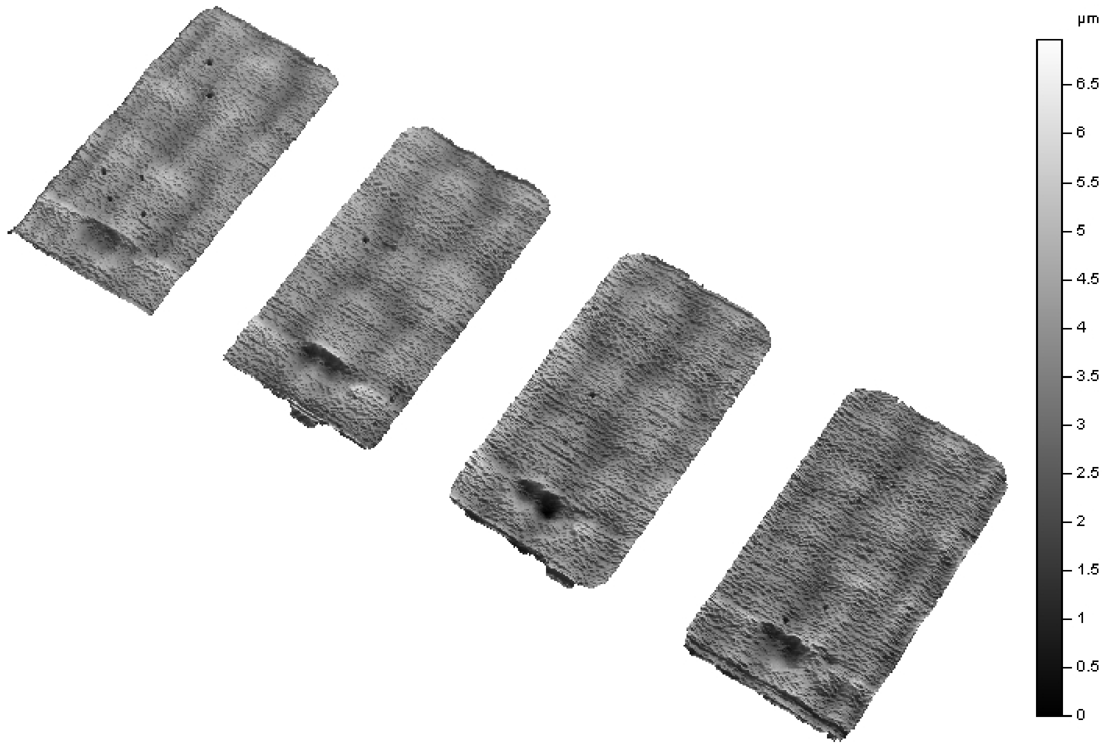
	Pad 1	Pad 2	Pad 3	Pad 4	Mean
Volume of Material Loss	0.000064892 mm^3	0.0001677 mm^3	0.0001545 mm^3	0.0001761 mm^3	0.0001408 mm^3
Surface Area of Material Loss	0.08147 mm^2	0.1262 mm^2	0.09815 mm^2	0.1071 mm^2	0.1032 mm^2

VOLUME and SURFACE AREA CALCULATIONS – BATTERY 2

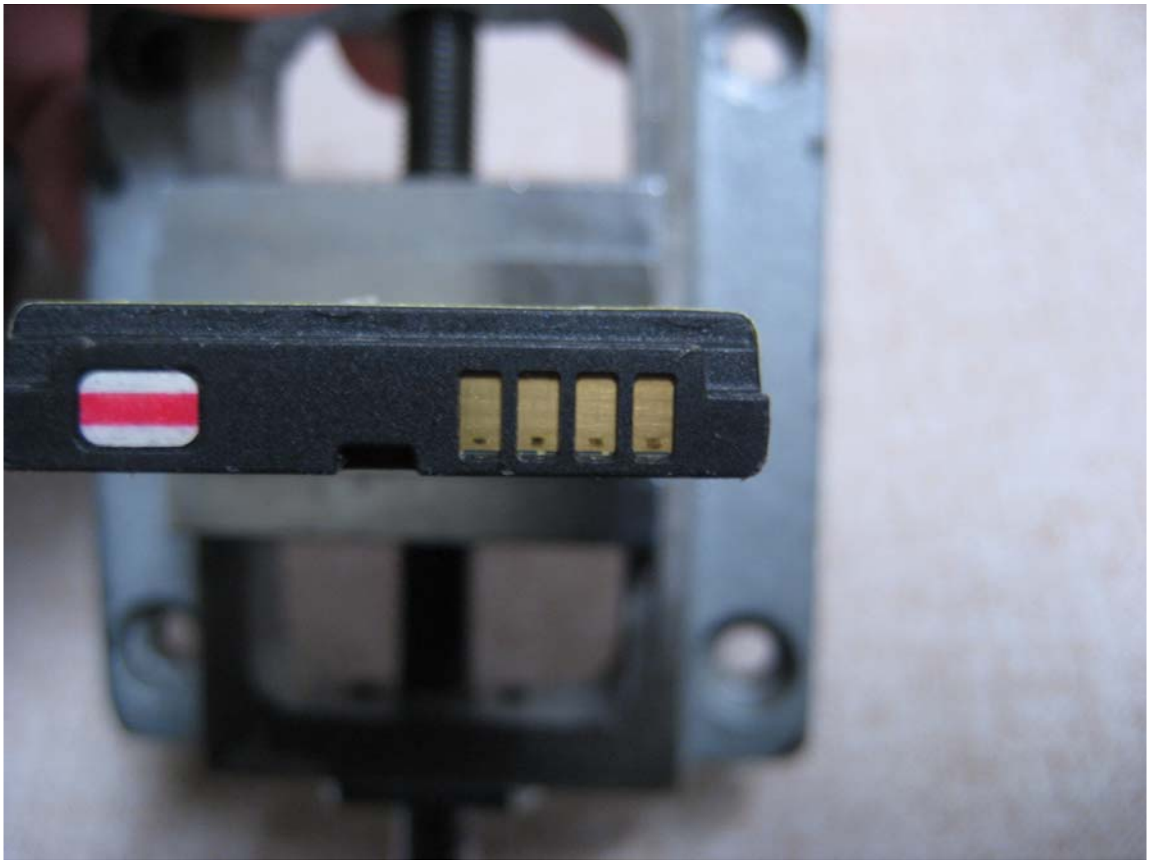
	Pad 1	Pad 2	Pad 3	Pad 4	Mean
Volume of Material Loss	0.000069917 mm^3	0.000102 mm^3	0.0001313 mm^3	0.0002262 mm^3	0.0001324 mm^3
Surface Area of Material Loss	0.07917 mm^2	0.09743 mm^2	0.1053 mm^2	0.1513 mm^2	0.1083 mm^2

TEST DISCUSSION:

From the results of the test, it can be observed that there is not a significant difference between the mean values of material volume loss and material loss surface area. An assumption can be made that these batteries and contact pads were manufactured using the same production methods and materials. A more powerful and insightful comparison would have been to conduct these measurements at approximately the one year mark and then use those calculated, one year, volume loss and surface area values in comparison to these, two year, calculated values.



3D Rendering of all 4 battery contacts

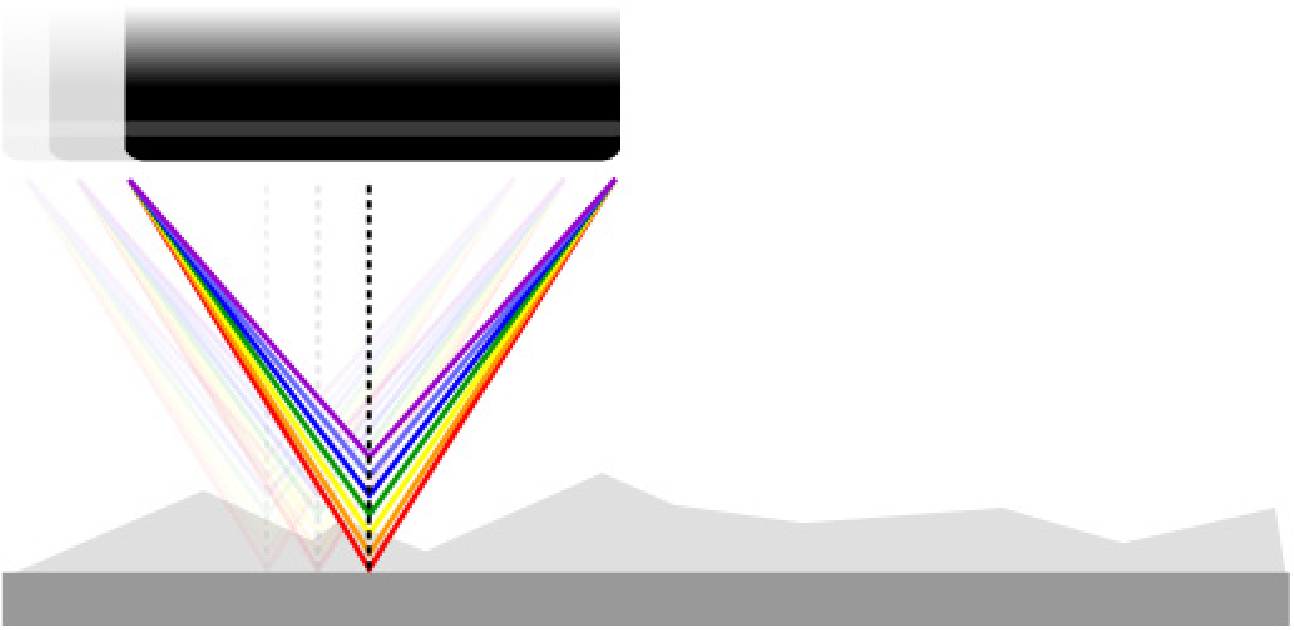


CONCLUSION:

The Nanovea ST400 can be used to accurately measure the surface topography of worn battery contacts, from which material volume loss calculations can be made from the versatile measurement technique used by the ST400. Using the measurement data, the analysis software provided with the ST400 can quickly and precisely perform volume loss analysis. Comparing contact pad material loss values between different batteries is an extremely useful quality control tool to provide an idea of how wear-resistant a material is for a battery contact application. Also, a study, such as this, performed over given intervals of time can prove to be valuable in choosing the appropriate material for the battery contact pad.

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.