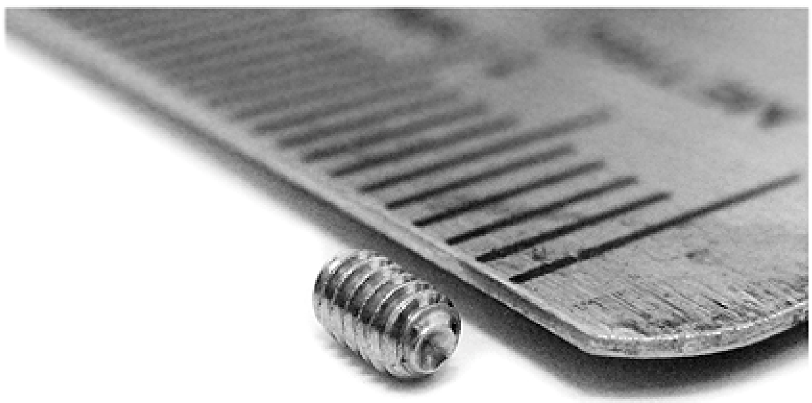
MICRO FASTNER MEASUREMENT USING 3D PROFILOMETRY



Prepared by
Craig Leising

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

INTRO:

Advances in Microelectronics, Biomedical and many others has grown the demand for micro manufacturing, or micromachining, of fastener components at smaller, more precise sizing on many different materials. Assuring the precision of these small parts by traditional methods, such as gauges, are incapable of reliable measurement and fail to provide adequate quality control. For this reason, like many micro machined parts, non contact optical measurement becomes a vital tool for quick and reliable quality control measurement.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR WOOD MEASUREMENT

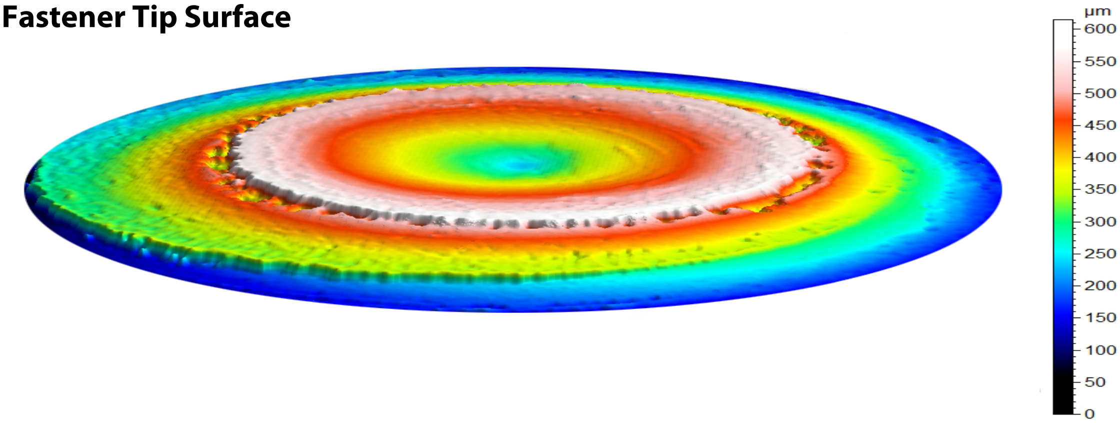
3D non contact measurement of micro parts is not a capability provided by just any optical measurement technique; in fact few can do so properly. And because roughness, shape, forms and dimensional characteristics of a micro fastener is vital to its end use, it will be crucial to monitor and control the end result with reliability. Understanding these parameters allows for 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 a micro set screw. There is an endless list of surface parameters that can be automatically calculated after the surface scan. Here we will review a 3D profile and select areas of interest to further analyze, including the 3D dimensions of the tip and 2D extractions for depth and dimensional calculations of the fastener threading.

RESULTS:

Fastener Tip Surface

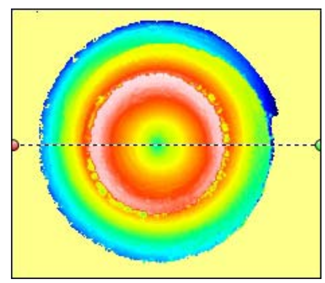


3D Profile of Tip Surface

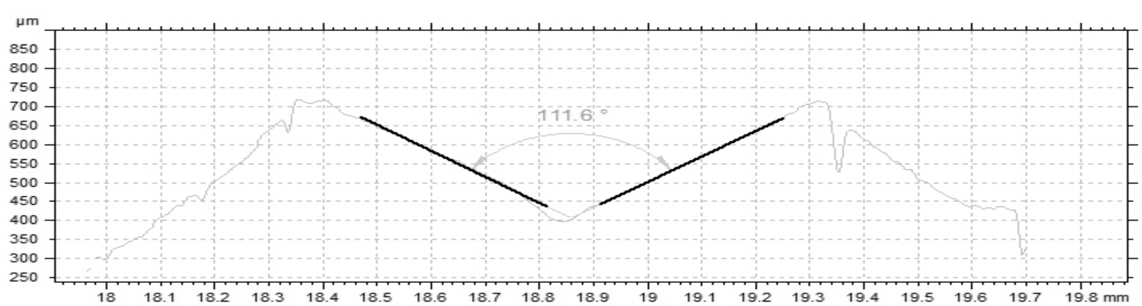
3D Roughness Parameters

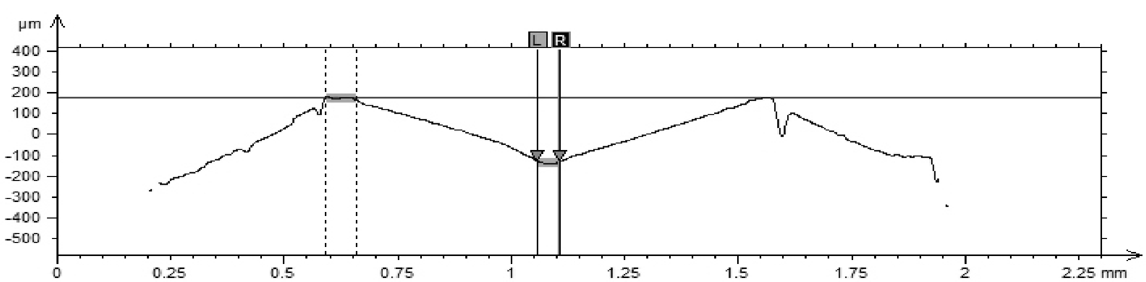
ISO 25178		
Height Parameters		
Sq	7.088	µm
Ssk	-0.096	
Sku	3.665	
Sp	47.354	µm
Sv	62.377	µm
Sz	109.731	µm
Sa	5.605	µm

2D Surface Extraction



2D Surface Extraction Results

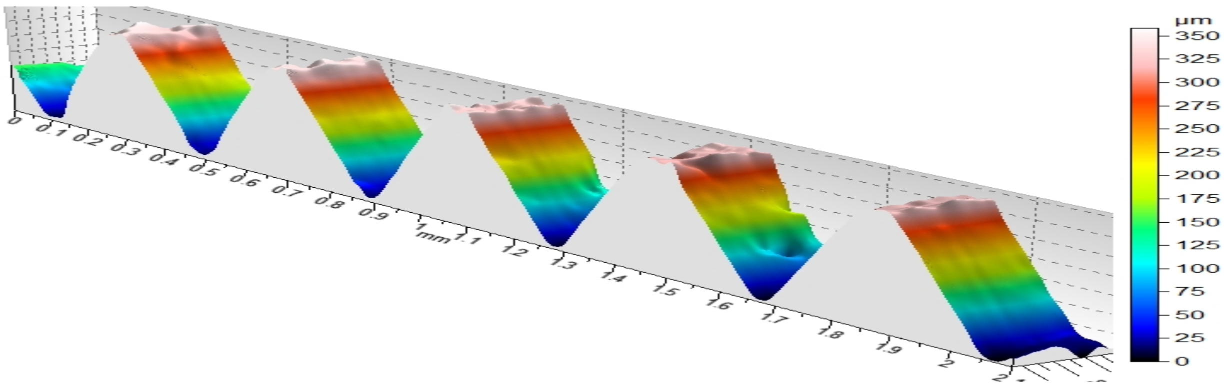




Maximum height **318.1 µm** **Mean height** **313.2 µm**

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

Fastener Thread Surface

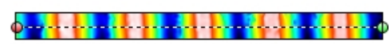


3D Profile of Side Surface

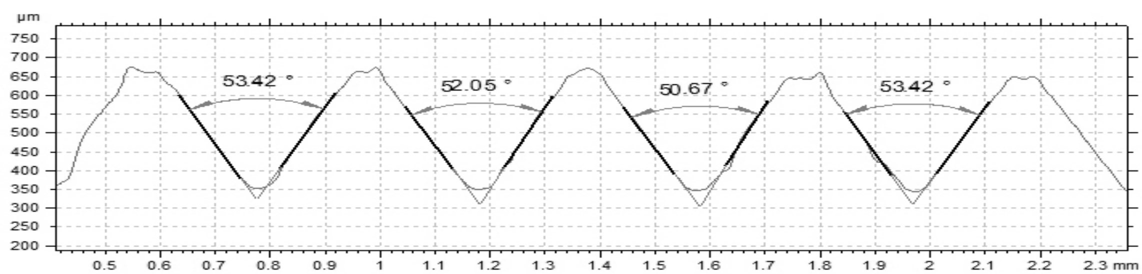
3D Roughness Parameters

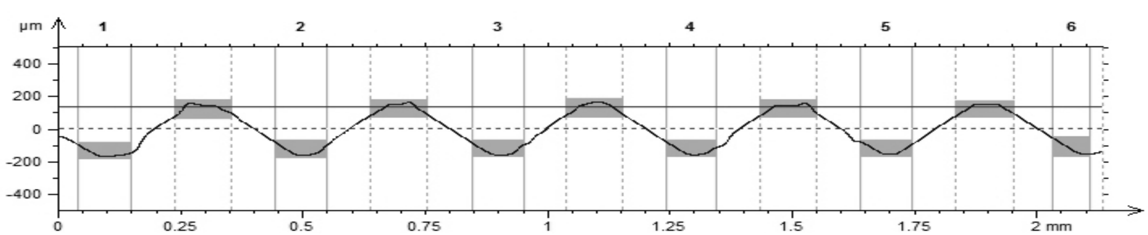
ISO 25178		
Height Parameters		
Sq	58.071	µm
Ssk	-1.704	
Sku	5.254	
Sp	88.034	µm
Sv	231.213	µm
Sz	319.246	µm
Sa	42.492	µm

2D Surface Extraction



2D Surface Extraction Results





	1	2	3	4	5	6
Maximum depth	302.4 µm	296.5 µm	294.0 µm	292.5 µm	289.9 µm	289.4 µm
Mean depth	284.1 µm	271.5 µm	269.1 µm	268.2 µm	262.0 µm	258.2 µm

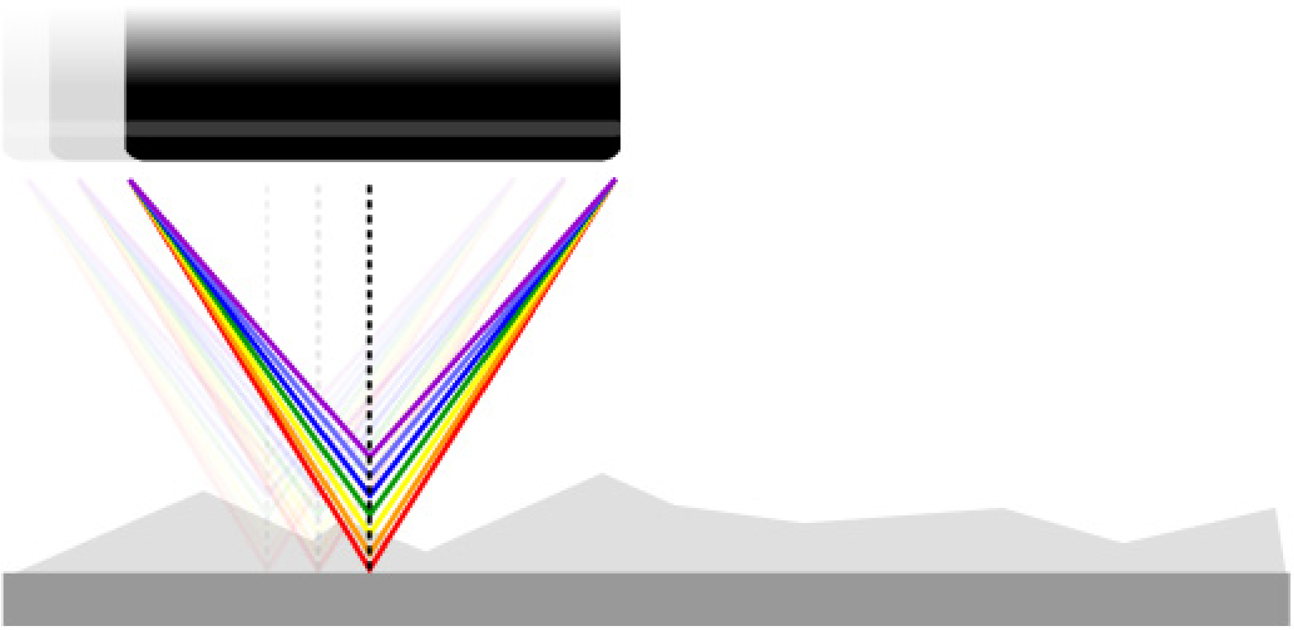
From 2D extraction Pitch, Height, Angle, Surface Area, Roughness and many others can be automatically calculated

CONCLUSION:

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 a micro threaded surface. 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 threaded surface areas 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.

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.