NANOVEA
A Better Measure.

STEEL SURFACE CHARACTERIZATION USING 3D PROFILOMETRY

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INTRODUCTION:

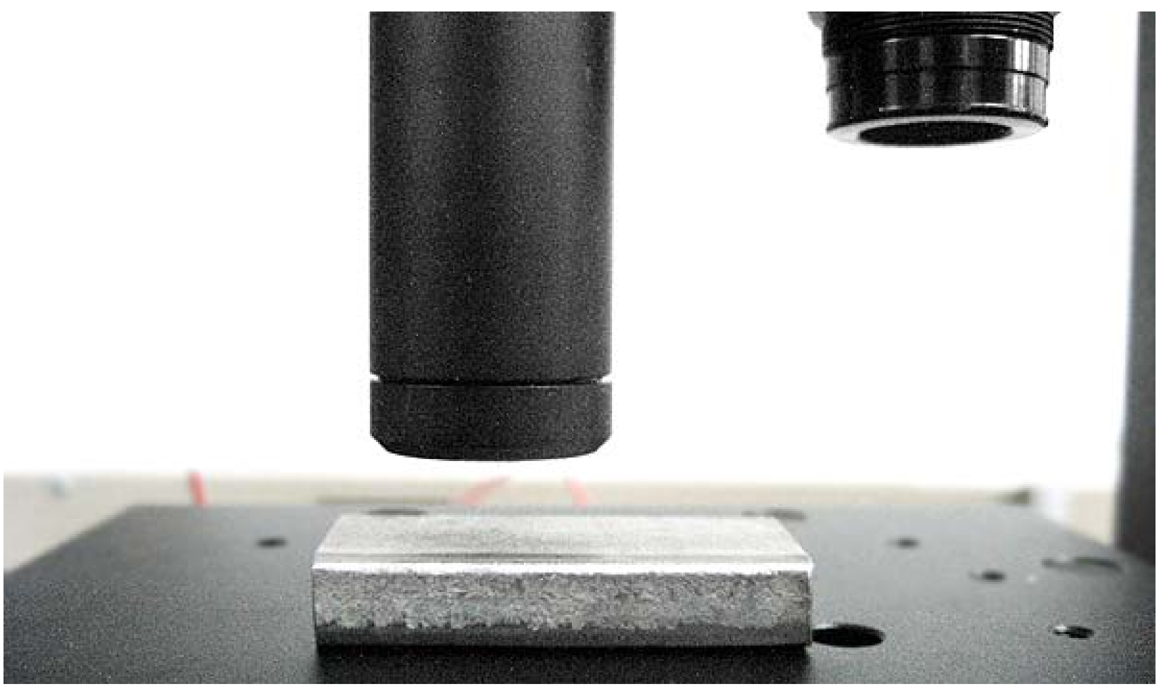
The surface roughness and pitting of a steel surface are studied using first a Video Zoom Camera and the Nanovea 3D Non-Contact Profilometer. Using both techniques allows the user to stitch a large image area and then visually select the precise area, or entire stitched area, to be measured. The field of view and measurement range is only restricted by staging which can be customized for nearly any application.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR WEAR STUDY

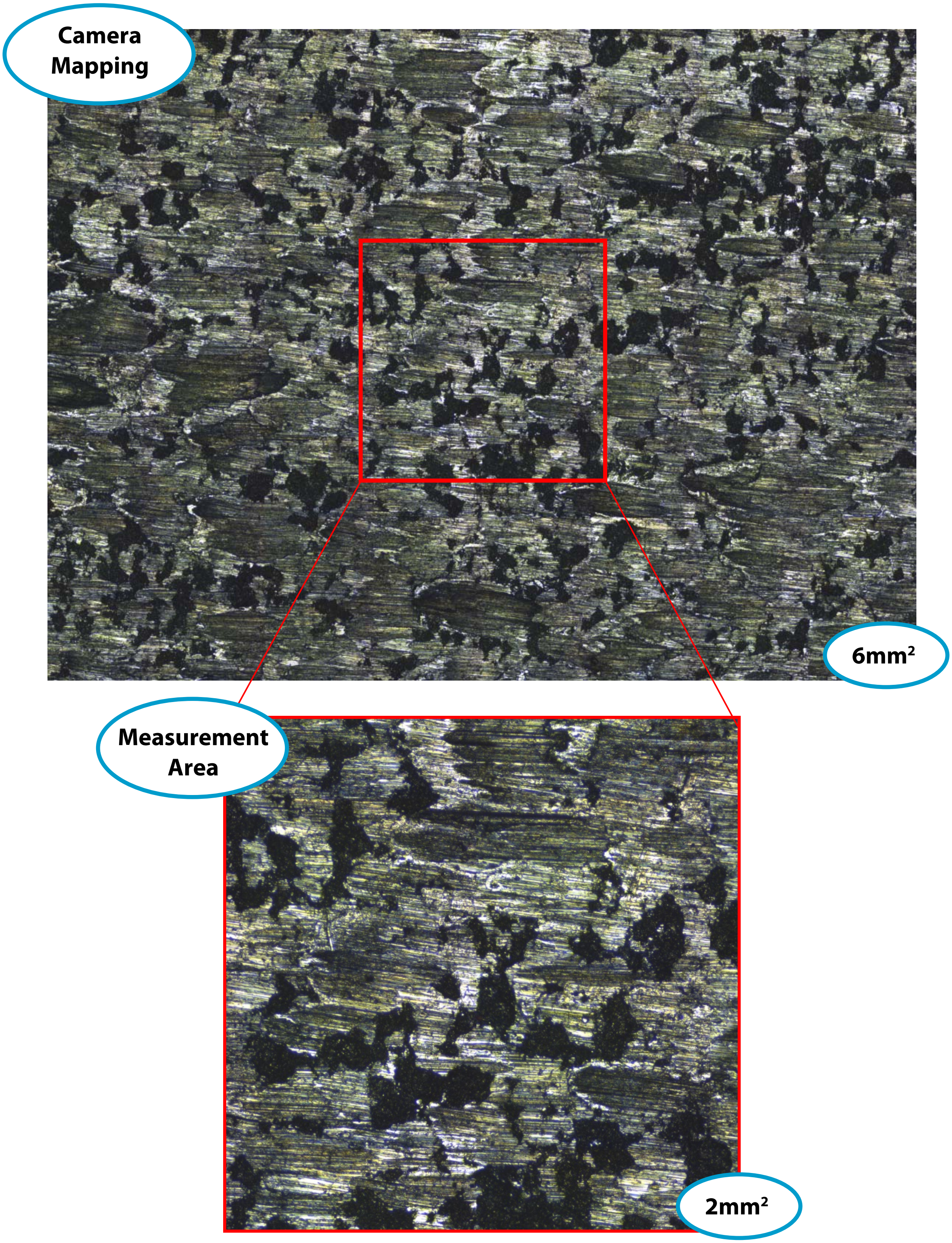
Unlike other techniques such as touch probes or interferometry, the 3D Non-Contact Profilometer, using axial chromatism, can measure nearly any surface, sample sizes can vary widely due to open staging and there is no sample preparation needed. Nano through macro range is obtained during surface profile 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; along with the benefits of combined 2D & 3D capability.

MEASUREMENT OBJECTIVE

The camera is used initially to stitch an image area, $6mm^2$, and then visually select an area of interest, $2mm^2$, for measurement. The Nanovea ST400 Profilometer is then used to create a height map of the surface and the roughness and pitting were studied.

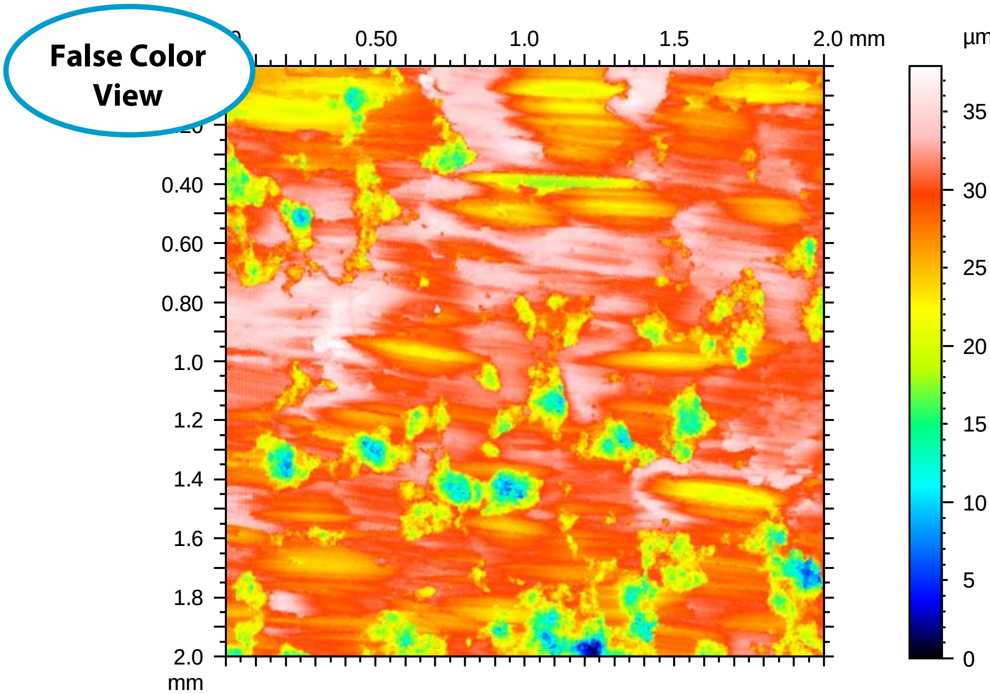


RESULTS: Video Zoom Camera Image

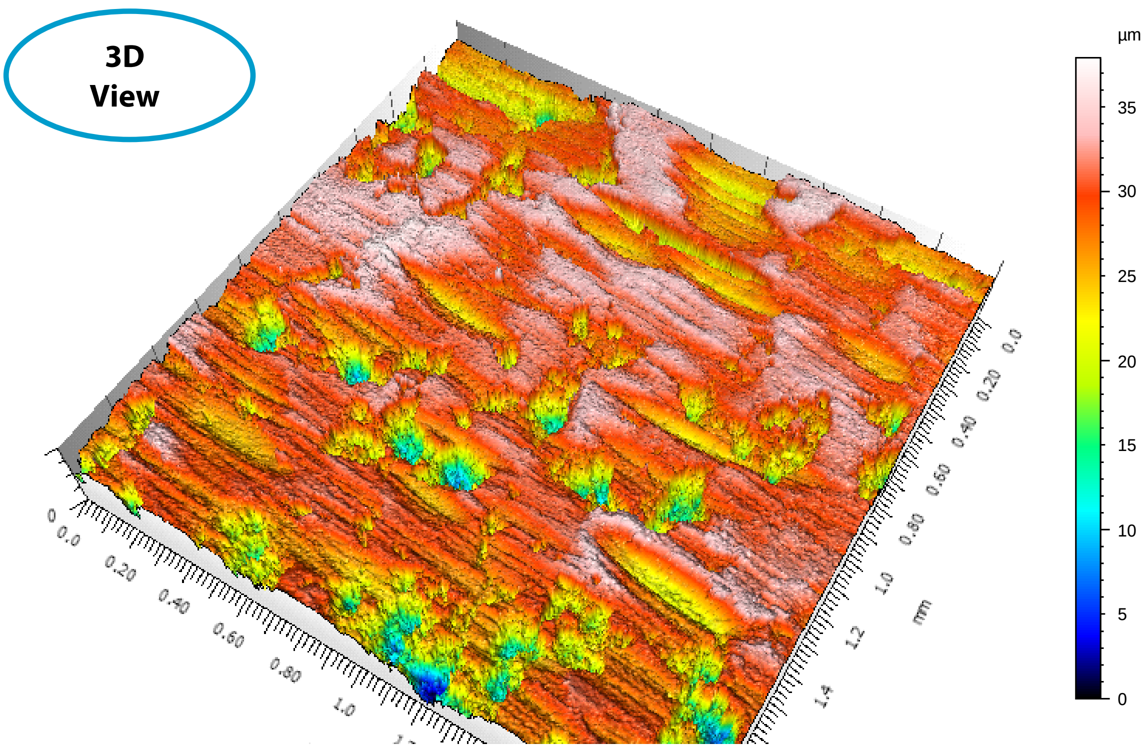


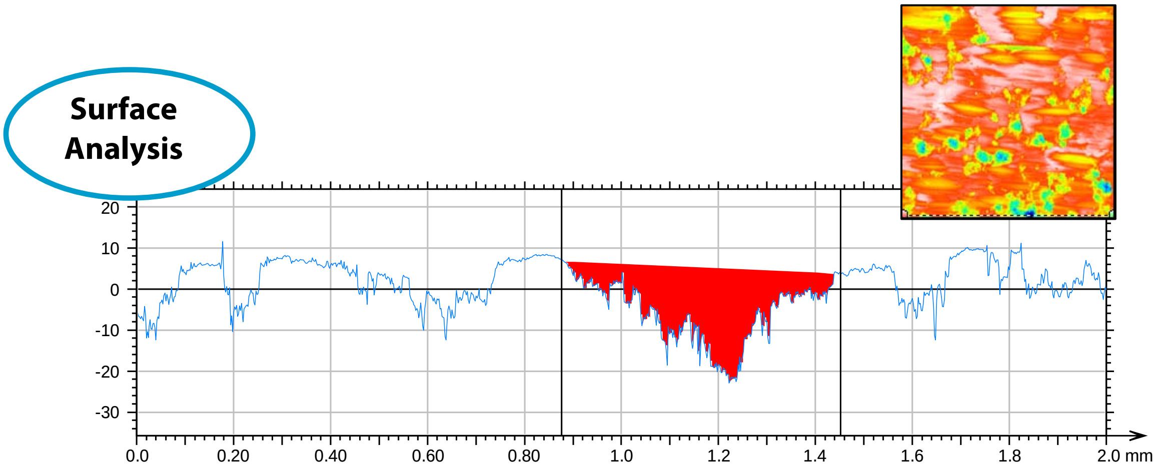
3D Surface

The False Color View and 3D View create a much a different representation of the surface compared to the camera image. Combined, they provide the user a straightforward and comprehensive tool to observe the morphology of the surface.

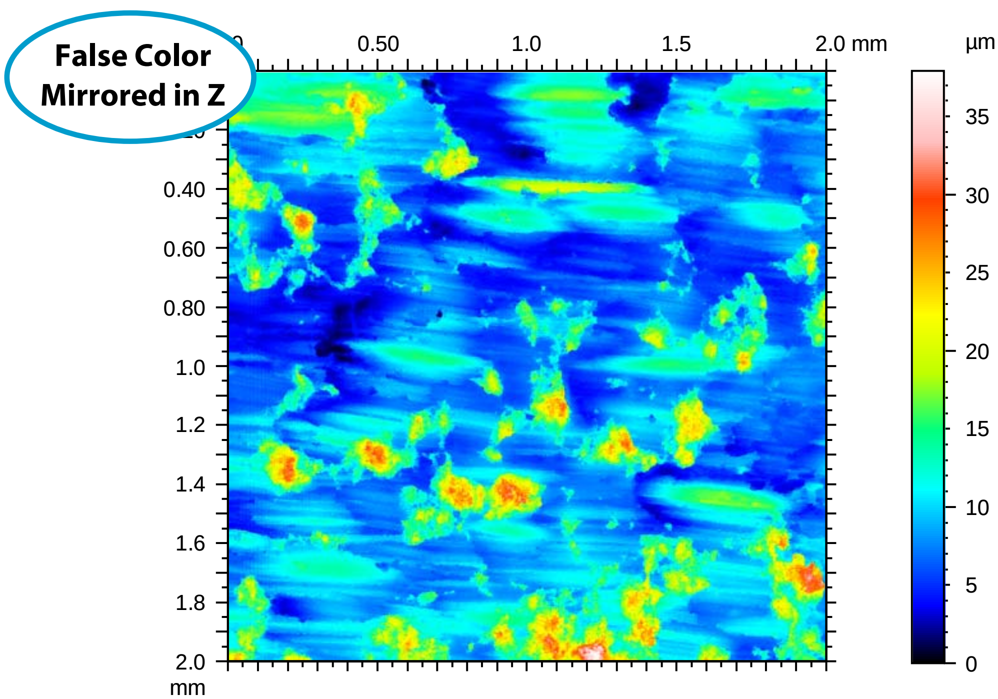


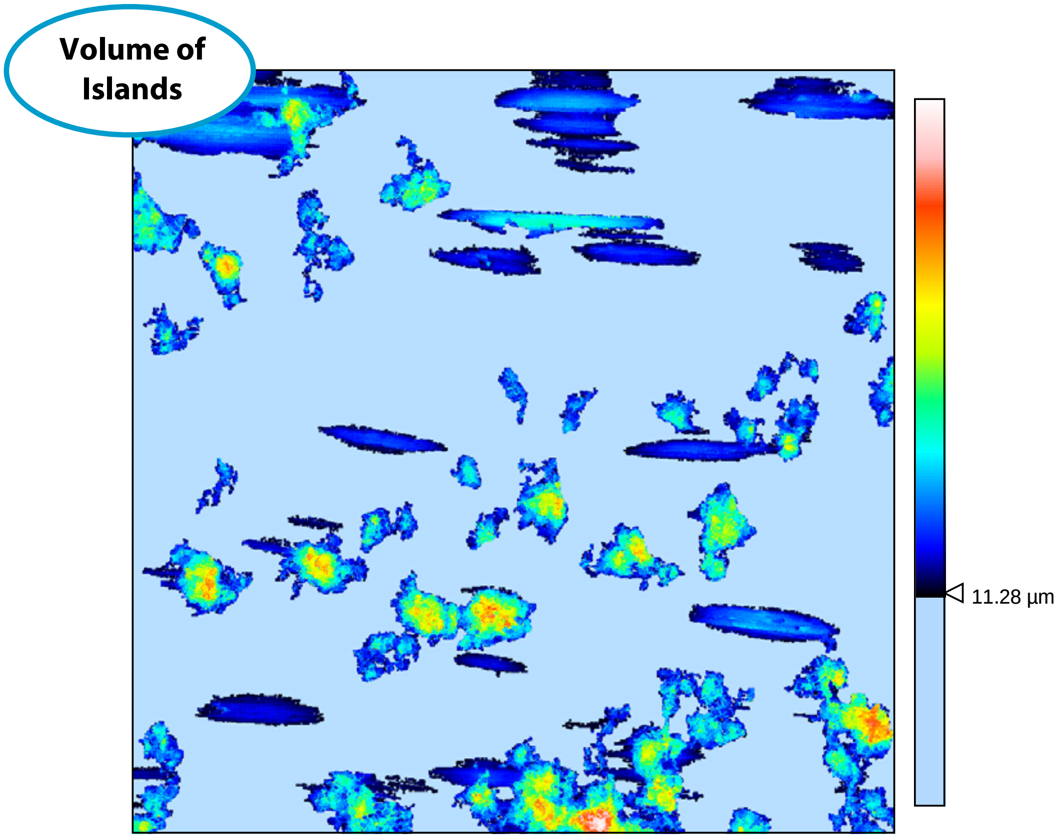
ISO 25178		
Height Parameters		
Sa	3.620	µm
Sq	4.793	µm
Sp	9.860	µm
Sv	28.05	µm
Sz	37.91	µm
Ssk	-1.312	
Sku	5.368	
Other 3D Para...		
Miscellaneous		
Spar	4.000	mm²
Sdar	4.879	mm²





Parameters	Value	Unit
Maximum depth	28.19	µm
Area of the hole	6513	µm²





Number of islands	37	
Threshold	11.28	µm

Parameters	Stat.	Value	Unit
Area	Mean	0.02522	mm^2
Volume	Mean	134896	μm^3
Max height	Mean	17.53	µm

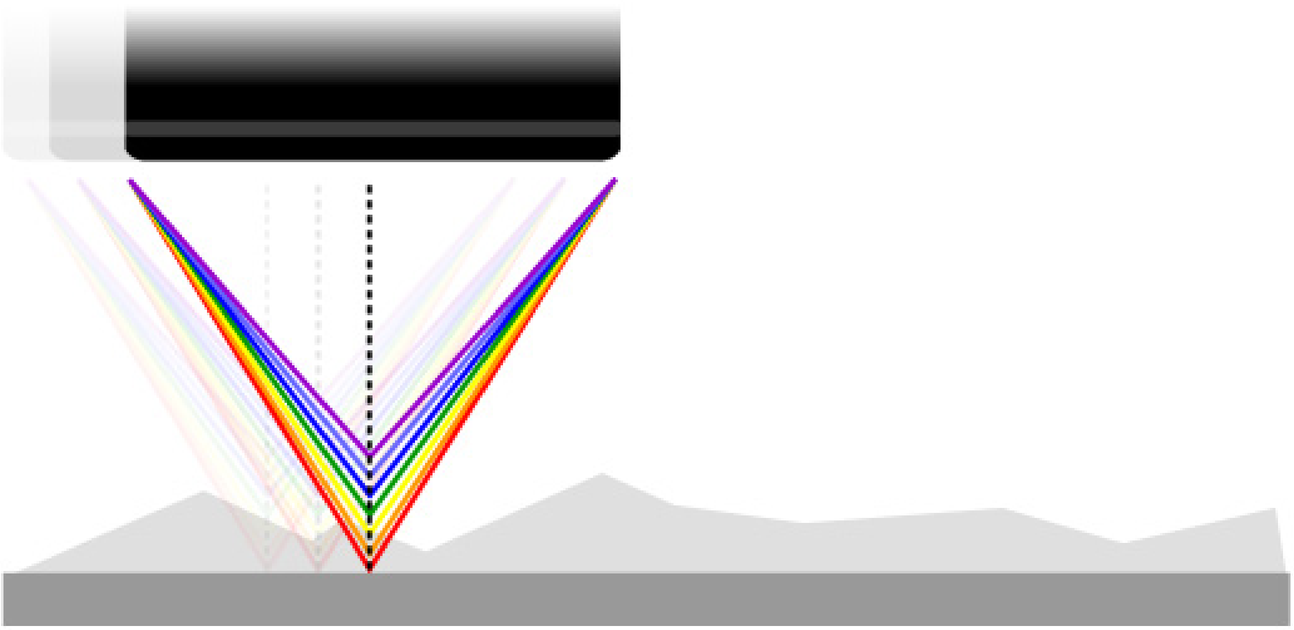
CONCLUSION:

In this application, we have shown how the Nanovea 3D Non Contact Profilometer combined with the Video Zoom Camera can characterize a metal surface in a variety of ways. The camera allows visual imaging of the surface while also providing a tool to precisely select the area to be measured. The 3D scan of the surface shows the average roughness and total height to be 3.620µm and 37.91µm respectively. The deepest pit on the surface was found to be 28µm deep, and the total volume of the pits was $1.35\text{x}10^{5}\mu m^{3}$. 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.