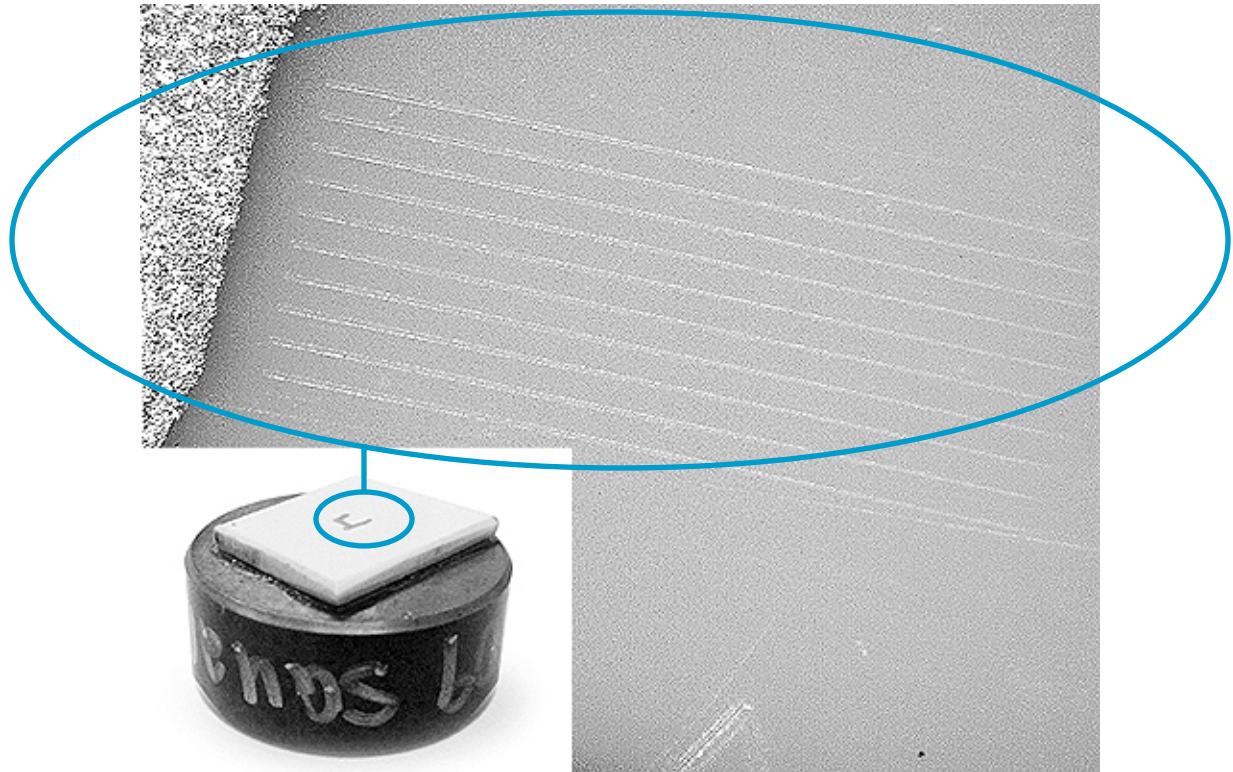


**MICRO SCRATCH DEPTH  
USING 3D PROFILOMETRY**



Prepared by  
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## INTRO:

Flaws, such as scratches, texture, pits and dents are small changes in the surface of a product or raw material that might indicate a defect. Flaws can be consistent or random and can be difficult to detect by human eye. It will be critical to not only detect these defects but to also measure at high speed with extreme precision either during inline processing or sample inspection during research. An example of this would include the detection of micro scratches. Here the measurement of depth and area is of critical interest.

### IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR SCRATCH DEPTH

Using the 3D non contact Profilometer, in 2D mode, the depth and area of micro scratches can be provided in seconds on nearly any material; unlike any other non contact optical measurement technique. If 3D surface measurement is needed the surface area can be selected and speeds will vary based on resolution and or staging options. Detection and control of scratch flaw detection can allow for the best selection of processing and control measures. Assuring the quality control of such parameters will heavily rely upon quantifiable, reproducible, reliable and fast inspection. The Nanovea 3D Non-Contact Profilometers utilize axial chromatic technology with unique capability to measure nearly any material and the steep angles found during micro scratch measurement. Where other techniques fail to provide reliable data, due to probe contact, surface variation, angle, or reflectivity, Nanovea Profilometers succeed.

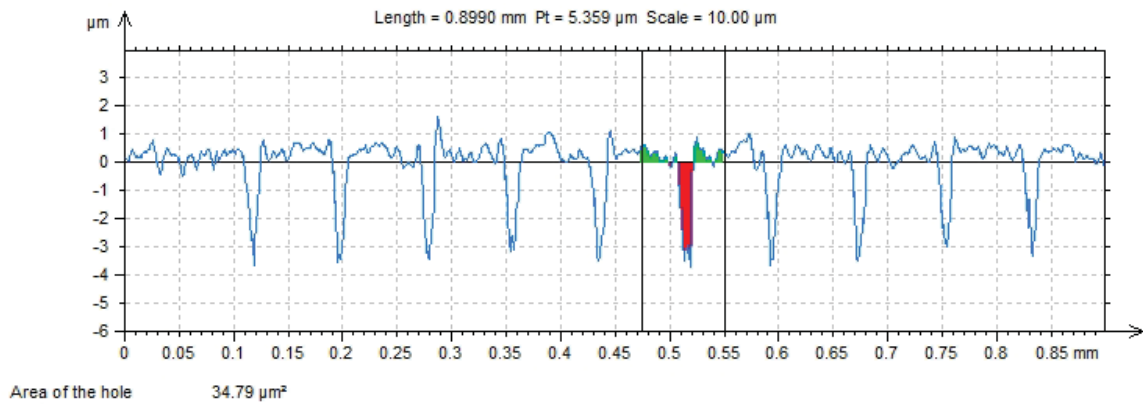
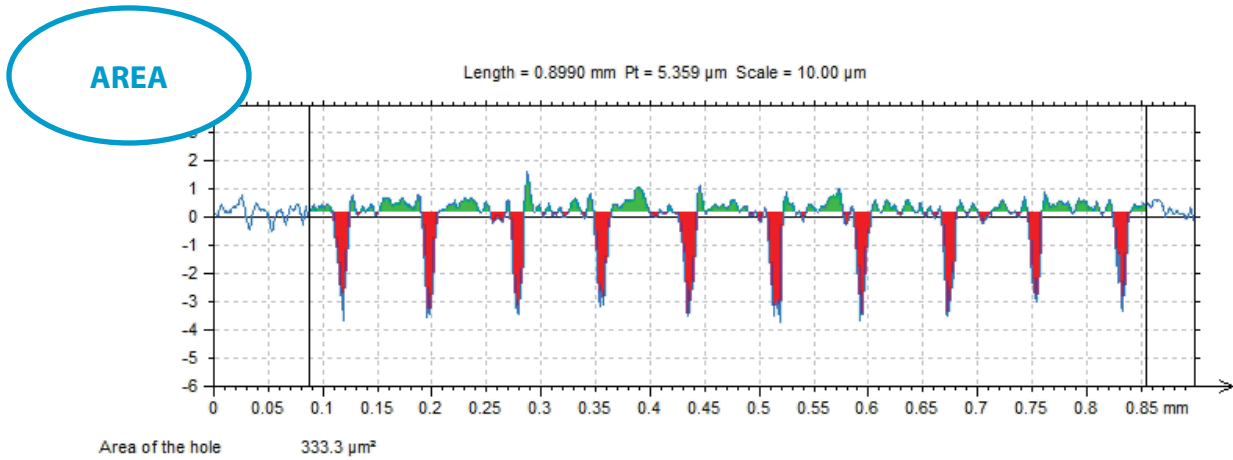
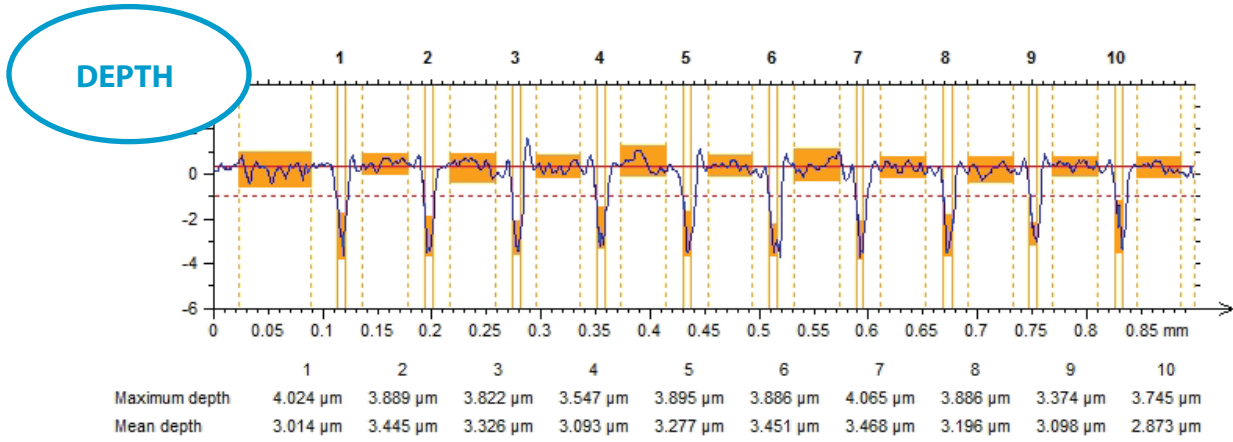
### MEASUREMENT OBJECTIVE

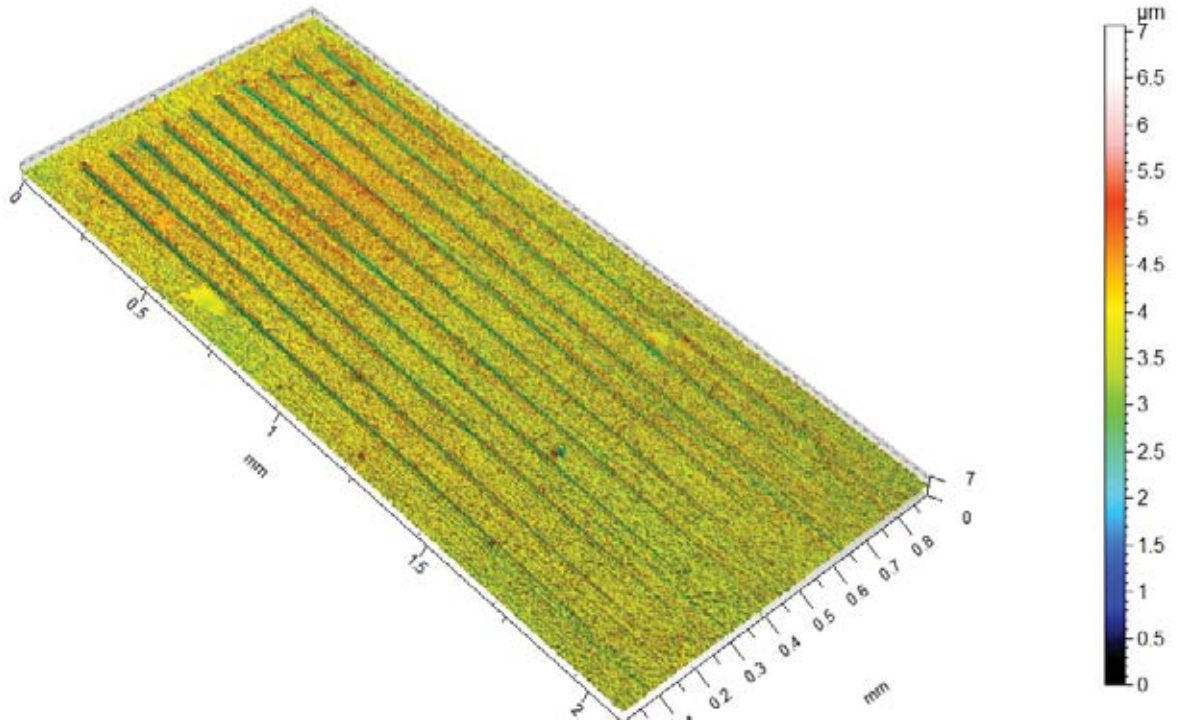
In this application the Nanovea ST400 Profilometer is used to measure a row of micro scratches created using Nanovea's Mechanical Tester in scratch mode. In seconds the Profilometer, with a single line pass in 2D mode, provides depth and area measurement.



## 2D RESULTS: Scratch Depth & Volume Measurement

Parameters Used: X- Scan Length: 1.0Scan Step Size: 1.0Points: 1001Y-Scan Length: 2.2Profile Step Size: 1.0 Profiles: 2201Total Points: 2,203,201Pen Settings: 110Acquisition Rate: 200Averaging: 1



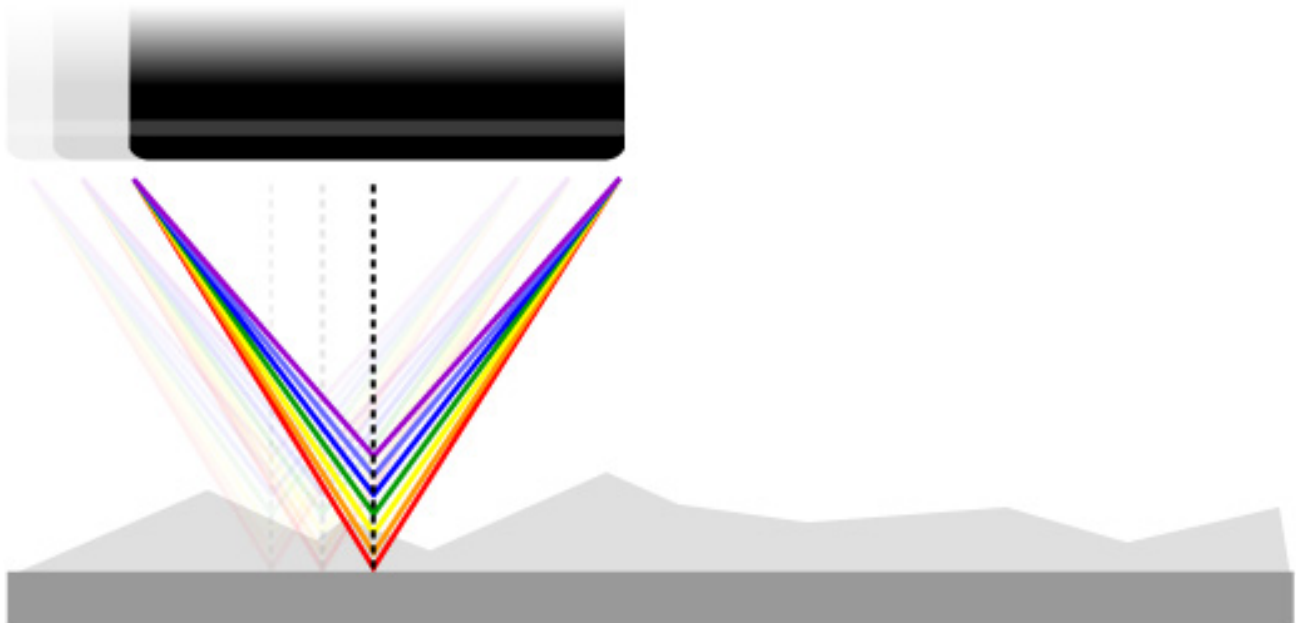


## CONCLUSION:

In this application we have shown how the Nanovea ST400 3D Non Contact Profilometer can precisely measure, in seconds, with a single line scan the depth and area of micro scratches. Other measurements can be used on a 2D single line scan, include roughness, flatness, step height and many others. This along with the use of predefined pass-fail parameters on these measurements can create a quick and repeatable analysis process. If a 3D surface measurement is needed, a full area can be measured and areas of interest can quickly be analyzed with a list of endless measurements (Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height and others). With this information surface flaw detection, such as micro scratches, can be quickly measured in 2D or broadly investigated with a complete set of surface measurement resources in 3D. 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. And now also with complete portable capability. Learn more about [Nanovea Profilometer](#)

## 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. $Sa = \frac{1}{A} \iint_A  z(x, y)  dx dy$
Sq	Root Mean Square Height	Standard deviation of the height distribution, or RMS surface roughness. $Sq = \sqrt{\frac{1}{A} \iint_A z^2(x, y) dx dy}$ <p>Computes the standard deviation for the amplitudes of the surface (RMS).</p>
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. $Ssk = \frac{1}{Sq^3} \left[ \frac{1}{A} \iint_A z^3(x, y) dx dy \right]$ <p>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.</p> <p>Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.</p>
Sku	Kurtosis	Kurtosis of the height distribution. $Sku = \frac{1}{Sq^4} \left[ \frac{1}{A} \iint_A z^4(x, y) dx dy \right]$ <p>Kurtosis qualifies the flatness of the height distribution.</p> <p>Due to the large exponent used, this parameter is very sensitive to the sampling and noise of the measurement.</p>
Spar	Projected Area	Projected surface area.
Sdar	Developed Area	Developed surface area.