NOZZLE PLATE DIMENSIONS USING 3D PROFILOMETRY

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INTRO:

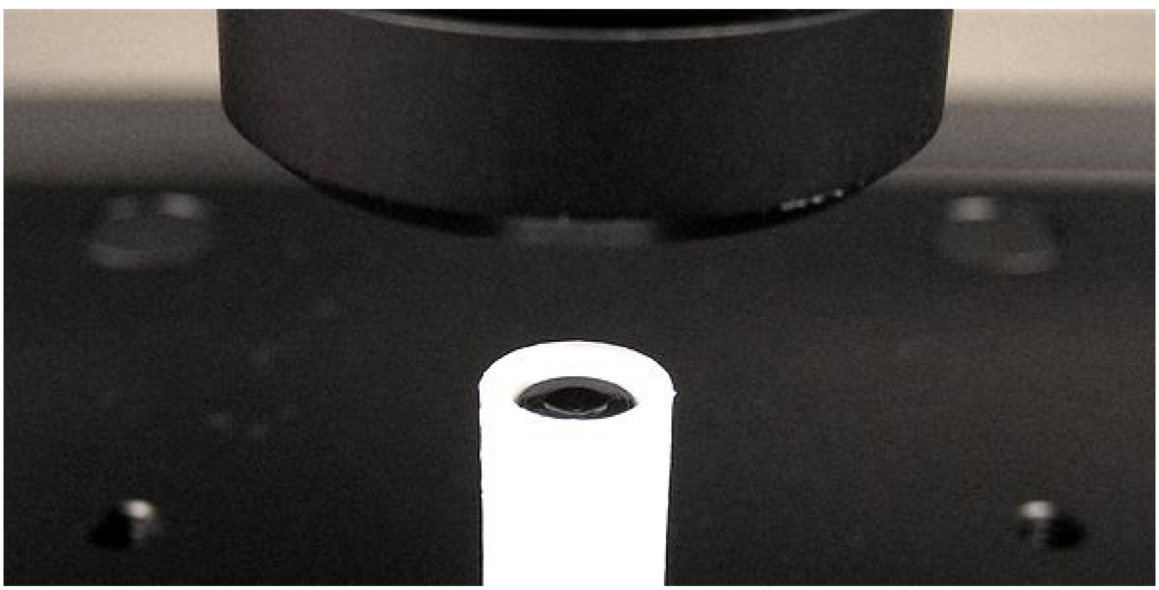
Micromachining and Micro Molding are both fabrication technologies used for the development of devices and components at the micro through macro scale. To provide quality control at this scale requires the capability to inspect various surface measurements including roughness, area, dimension and others. A crucial step during the micro fabrication process before production begins in large quantities.

IMPORTANCE OF SURFACE METROLOGY INSPECTION FOR R&D AND QUALITY CONTROL

Micro part topography is vital to understanding and responding to the intended use and need for the given component. To control the intended use of a given component will heavily rely upon quantifiable, reproducible and reliable measurement of the parts surface topography and dimension. Precise measurement and evaluation of the surface can lead to the best selection of process and control measures. Here we use the Nanovea 3D Non-Contact Profilometer, utilizing chromatic confocal technology, with ideal capability to measure micro components. Where other techniques fail to provide reliable data, due to probe contact, surface variation, angle and reflectivity, Nanovea Profilometers succeed.

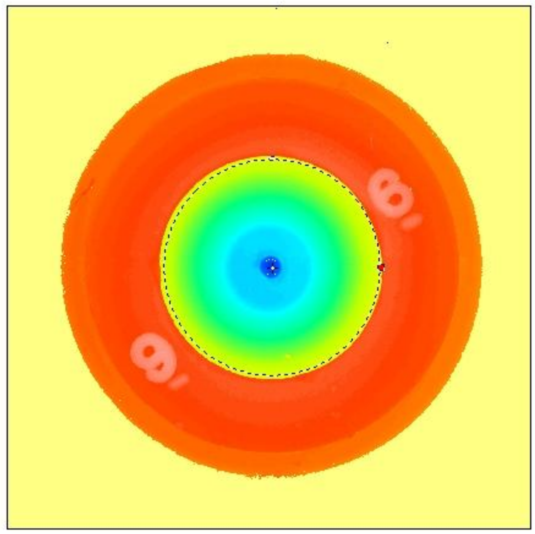
MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the features of a plastic nozzle plate. Several surface parameters can automatically be calculated including the most common, Sa (average surface roughness), step height, area and many others.

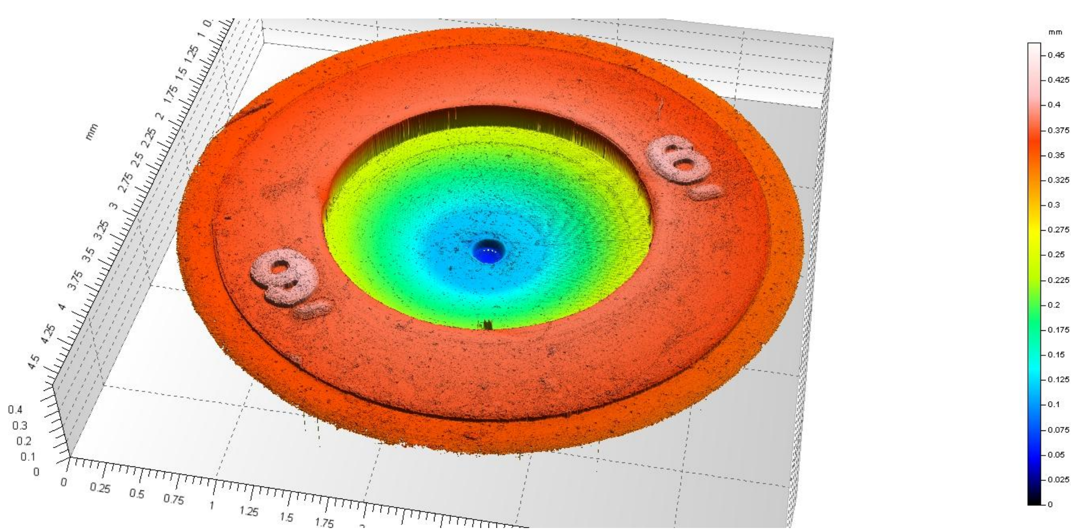


RESULTS:

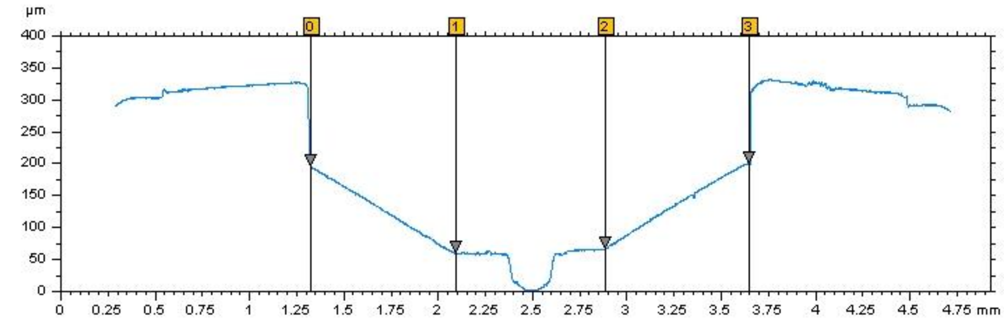
Nozzle Plate



Top Surface of Nozzle Plate

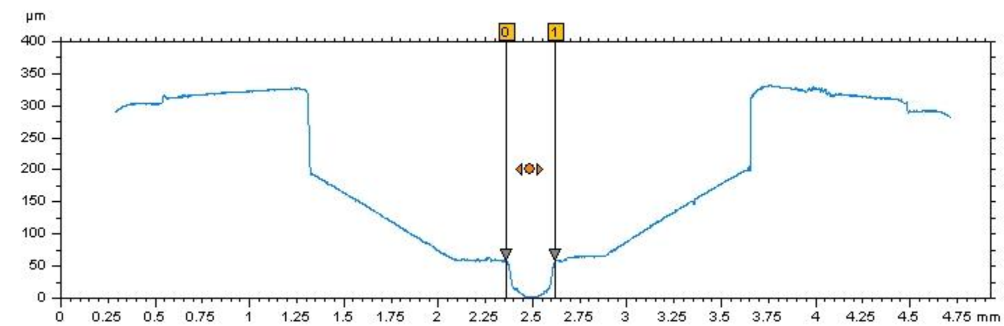


3D Image of Duct Tape Surface



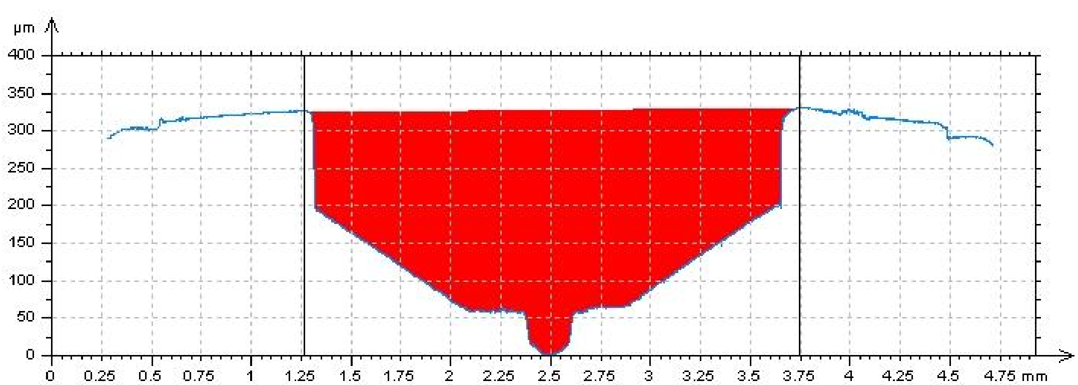
	0-1	2-3
Horizontal distance	0.771734 mm	0.756936 mm
Height difference	-135.999 µm	133.447 µm
Angle	-9.99431°	9.99846°

Nozzle Plate Angle Measurement



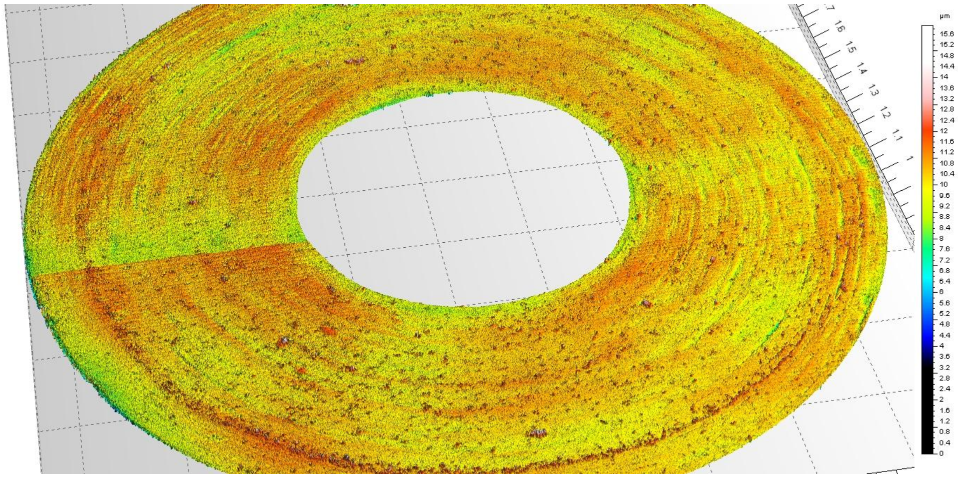
	0-1
Horizontal distance	0.261191 mm

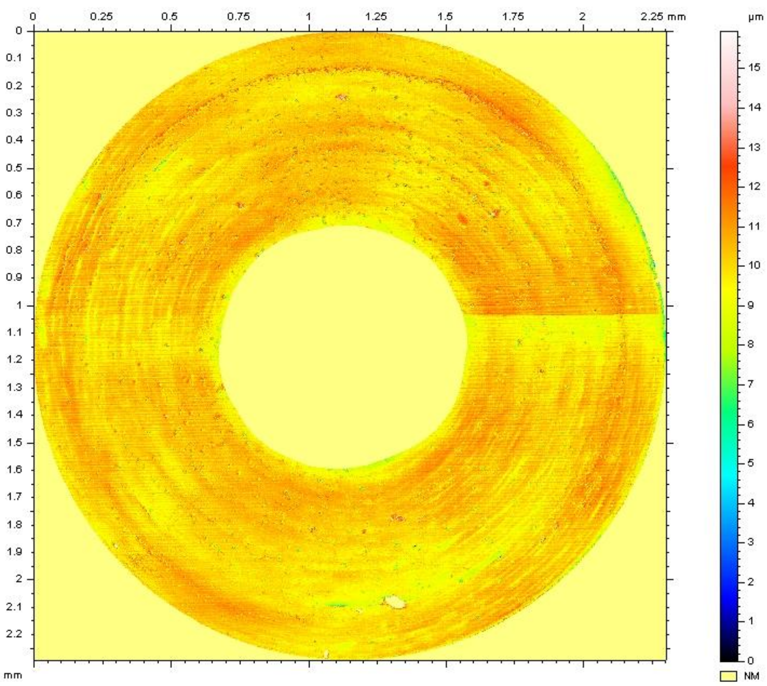
Nozzle Plate Width Measurement



Area of the hole 0.528084 mm2

Nozzle Plate Area Measurement





ISO 25178		
Height Parameters		
Sq	0.697611	µm
Ssk	-0.750849	
Sku	9.8402	
Sp	5.76172	µm
Sv	10.1807	µm
Sz	15.9424	µm
Sa	0.500446	µm

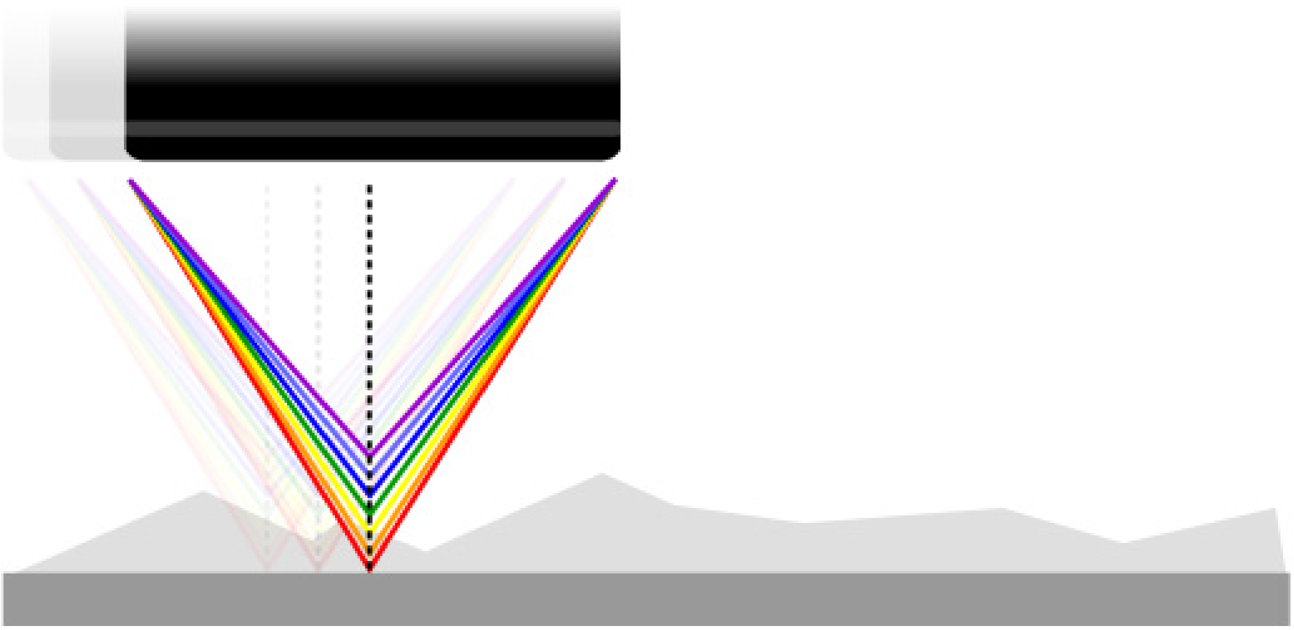
Nozzle Plate Roughness Profile

CONCLUSION:

In this application, we have shown how the Nanovea ST400 3D Profilometer can precisely characterize both the topography including profile, dimensions, area and surface roughness. From the 3D and 2D images the measurement information provided can clearly assist with quality control to assure the components intended critical dimensions. This information can be used to investigate with quantifiable, reproducible and reliable measurement of a components performance and the effect that alterations may have. 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.