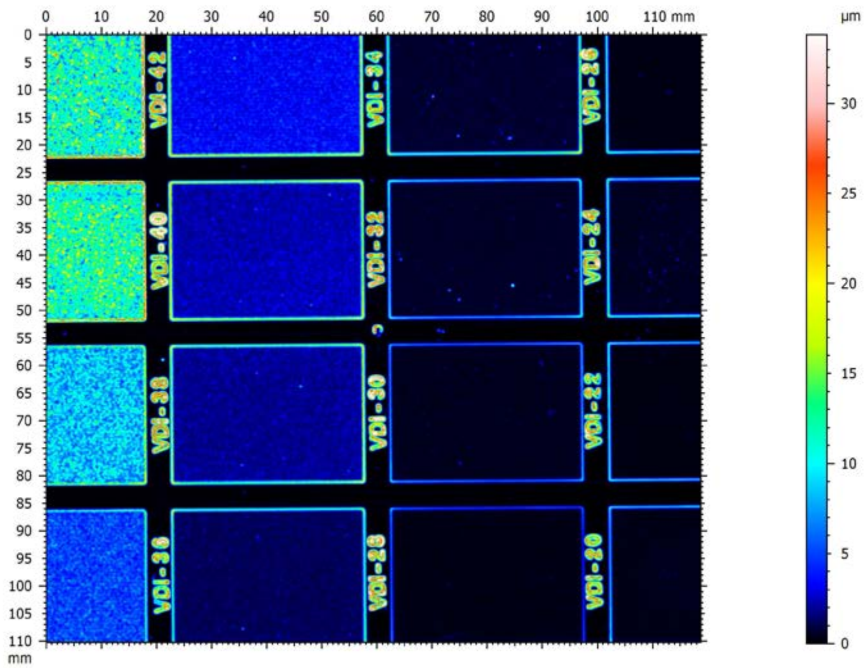
ROUGHNESS MAPPING INSPECTION
USING 3D PROFILOMETRY



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INTRO

Surface roughness and texture is vital to the end use of a product. A better understanding of the surface roughness, texture and consistency allows the best selection of processing and control measures. Fast, quantifiable and reliable inline inspection of the product surface is in need to find out the defective products in time and to determine the work conditions of the production line.

IMPORTANCE OF 3D NON-CONTACT PROFILOMETER FOR IN-LINE SURFACE INSPECTION

Surface defects of products derive from materials processing and product manufacturing. In-line surface quality inspection ensures the tightest quality control of the end products. The Nanovea 3D Non-Contact Profilometers utilize chromatic confocal technology with unique capability to determine the roughness of a sample without contact. The line sensor enables scanning the 3D profile of a large surface at a high speed. The roughness threshold calculated real-time by the analysis software serves as a fast and reliable pass/fail tool.

MEASUREMENT OBJECTIVE

In this study, the Nanovea ST400 equipped with a line sensor is used to inspect the surface of a Teflon sample with defect. We showcases the capacity of Nanovea non-contact profilometer in providing fast and reliable surface inspection in a production line.

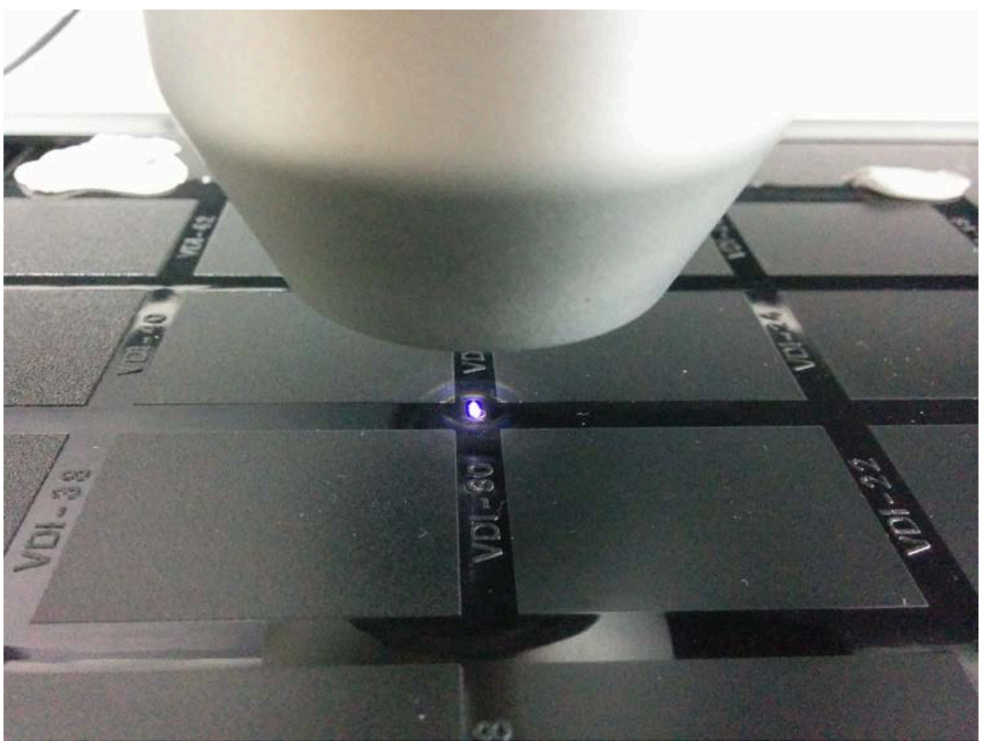


Fig. 1: Optical line sensor scanning on the Roughness Standard sample.

RESULTS AND DISCUSSION

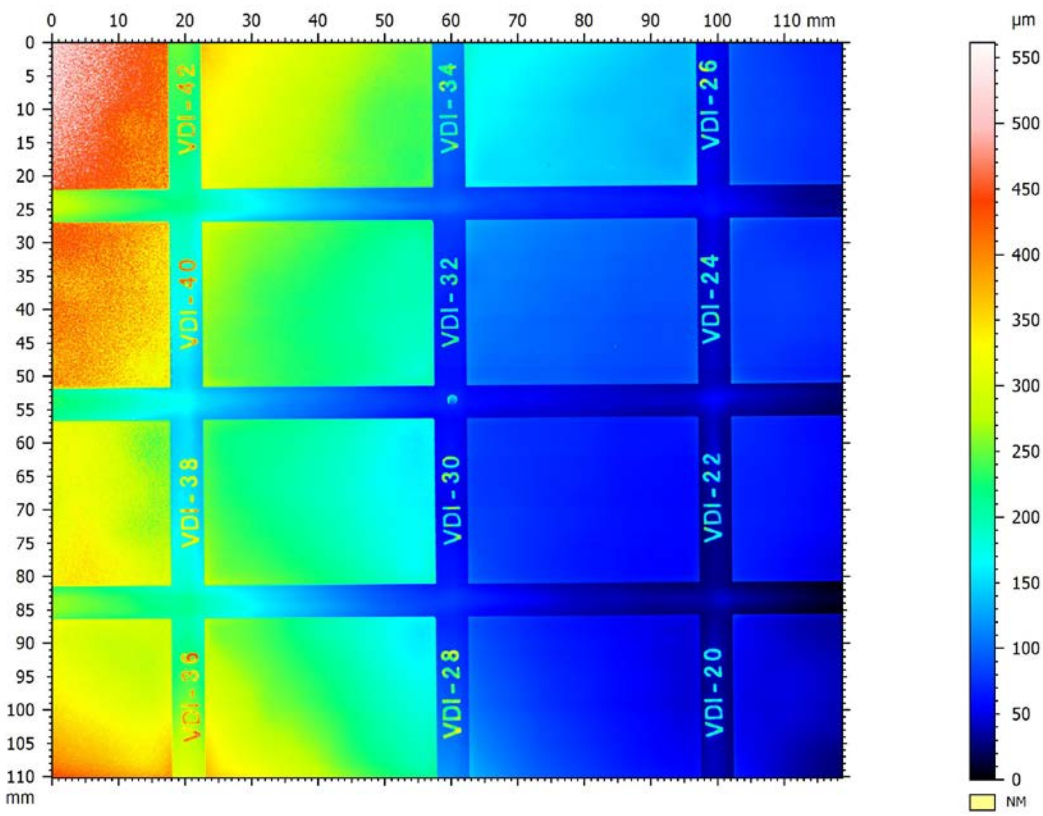
3D Surface Analysis of the Roughness Standard Sample

The surface of a Roughness Standard was scanned using a Nanovea ST400 equipped with a line sensor that generates a bright line of 192 points, as shown in Fig. 1. These 192 points scan the sample surface at the same time, leading to significantly increased scan speed.

Fig. 2 shows false color views of the Surface Height Map and Roughness Distribution Map of the Roughness Standard Sample. In Fig. 2a, the Roughness Standard exhibits a slightly slanted surface as represented by the varied color gradient in each of the standard roughness blocks. In Fig. 2b, homogeneous roughness distribution is shown in different roughness blocks, the color of which represents the roughness in the blocks.

Fig. 3 shows the examples of the Pass/Fail Maps generated by the Analysis Software based on different Roughness Thresholds. The roughness blocks are highlighted in red when their surface roughness is above a certain set threshold value. This provides a tool for the user to set up a roughness threshold to determine the quality of a sample surface finish.

(a) Surface height map:



(b) Roughness map:

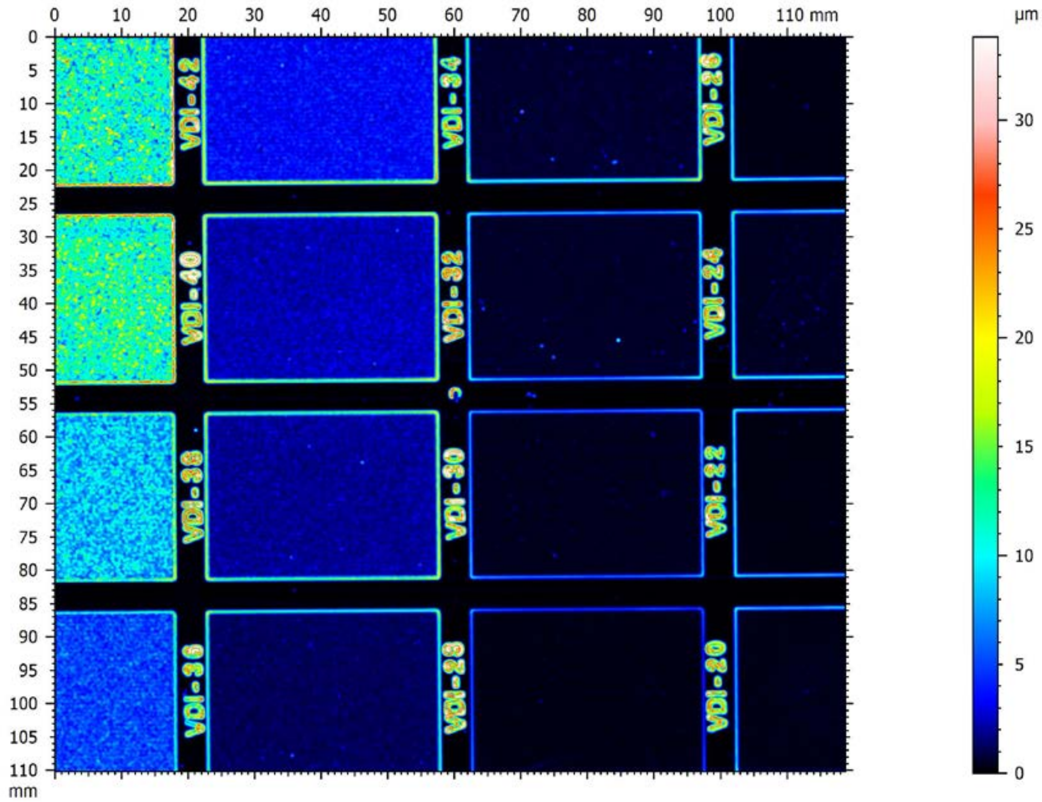


Fig. 2: False color views of the Surface Height Map and Roughness Distribution Map of the Roughness Standard Sample.

(a) **(b)**

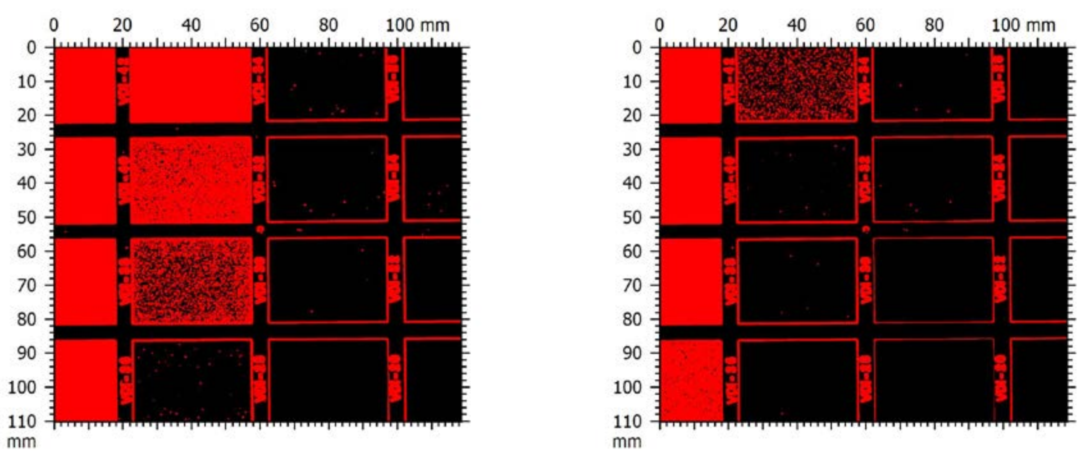
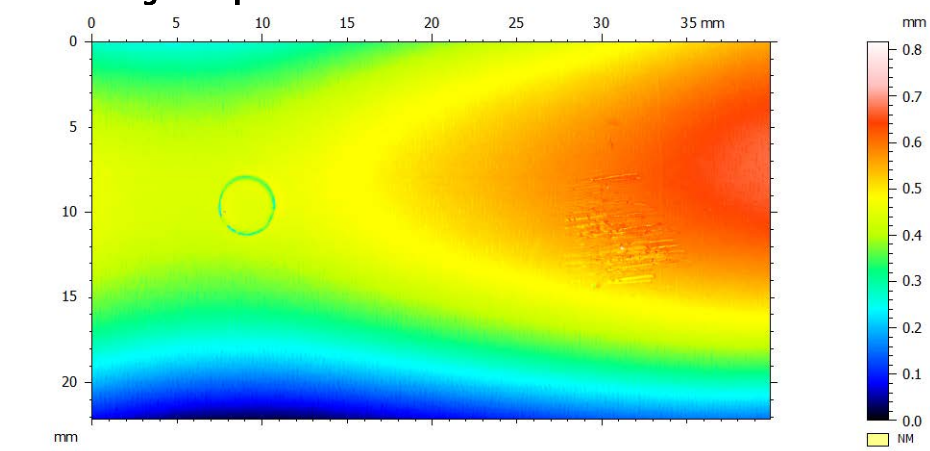


Fig. 3: Pass/Fail Map based on the Roughness Threshold.

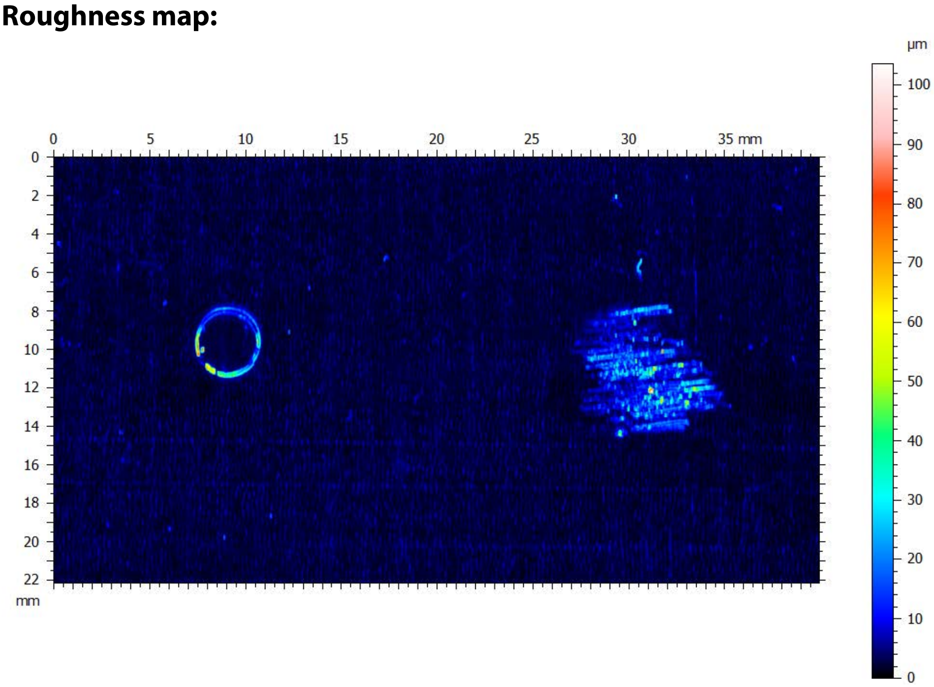
Surface Inspection of a Teflon Sample with Defects

Surface Height Map, Roughness Distribution Map and Pass/Fail Roughness Threshold Map of the Teflon sample surface are shown in Fig. 4. The Teflon Sample has a ridge form at the right center of the sample as shown in the surface height map. The different colors in the pallet of Fig. 4b represents the roughness value on the local surface. The Roughness Map exhibits a homogeneous roughness in the intact area of the Teflon sample. However, the defects, in the forms of an indented ring and a wear scar are highlighted in bright color. The user can easily set up a Pass/Fail roughness threshold to locate the surface defects as shown in Fig. 4c. Such a tool allows users to monitor in situ the product surface quality in the production line and discover defective products in time. The real-time roughness value is calculated and recorded as the products pass by the in-line optical sensor, which can serve as a fast but reliable tool for quality control.

(a) Surface height map:



(b) Roughness map:



(c) Pass/Fail Roughness Threshold Map:

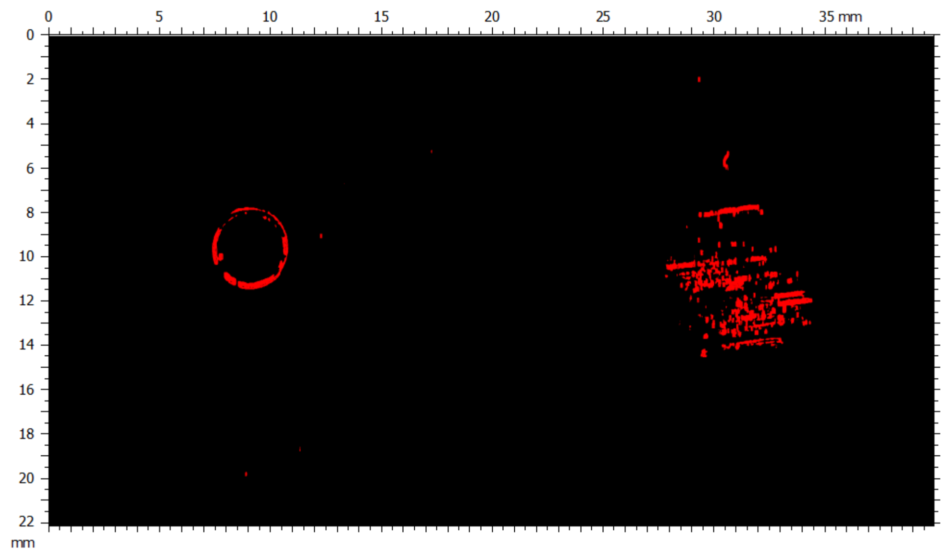


Fig. 4: Surface Height Map, Roughness Distribution Map and Pass/Fail Roughness Threshold Map of the Teflon sample surface.

CONCLUSION

In this application, we have shown how the Nanovea ST400 3D Non-Contact Profilometer equipped with an optical line sensor works as a reliable quality control tool in an effective and efficient manner.

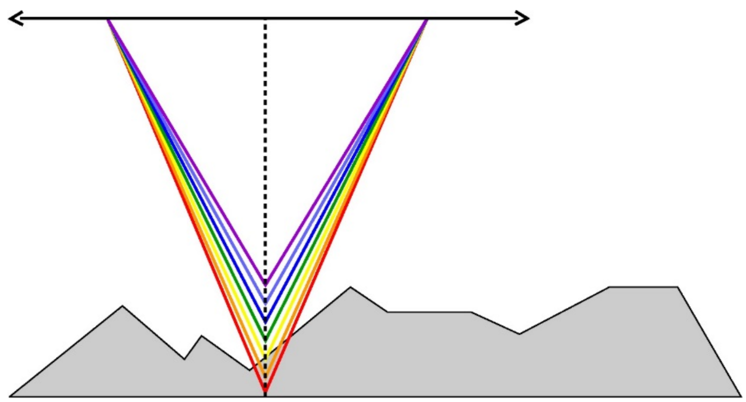
The optical line sensor generates a bright line of 192 points that scan the sample surface at the same time, leading to significantly increased scan speed. It can be installed in the production line to monitor the surface roughness of the products in situ. The roughness threshold works as a dependable criteria to determine the surface quality of the products, allowing users to notice the defective products in time.

The data shown here represents only a portion of the calculations available in the analysis software. Nanovea Profilometers measure virtually any surface in fields including Semiconductor, Microelectronics, Solar, Fiber Optics, Automotive, Aerospace, Metallurgy, Machining, Coatings, Pharmaceutical, Biomedical, Environmental and many others.

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.



Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Measure any material: transparent/opaque, specular/diffusive, and polished/rough.