

**Fractography Analysis
Using 3D Metrology**



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INTRO:

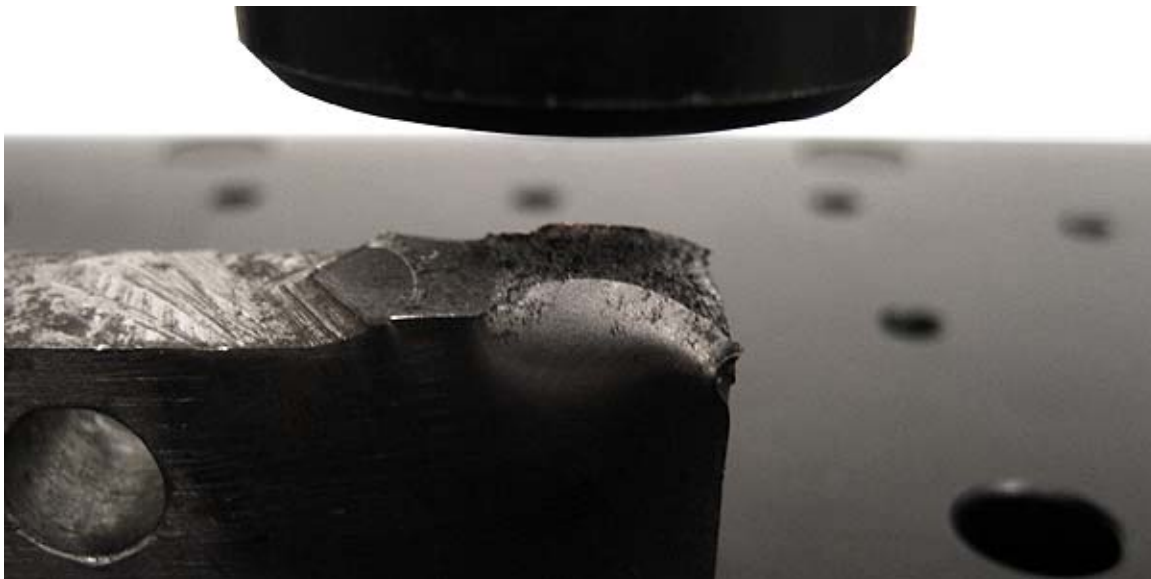
Fractography is the study of features examined on fracture surfaces and has historically been investigated via Microscope or SEM. Microscope being used for macro scale analysis and SEM particularly when it is the nano or microstructure that is vital to the analysis. Both ultimately allowing for the identification of the fracture mechanism type. Although effective, the Microscope clearly has its limitations and the SEM in most cases, other than atomic level analysis, is unpractical for fracture surface measurement and lacks broad use. With advances in optical measurement technology, the 3D Non Contact Profilometer is now the instrument of choice, providing nano through macro scale 2d & 3D surface measurement.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR FRACTURE INSPECTION

Unlike an SEM, the 3D Non Contact Profilometer can measure nearly any surface, sample sizes can vary widely due to open staging, there is no sample preparation needed and horizontal and vertical dimensions are far superior to that of an SEM. Nano through macro range is obtained during measurement (Profile Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage, Volume Area, Step-Height Depth Thickness and others) and measurement has zero influence from sample reflectivity and has advanced ability to measure high surface angles. Easily measure any material: transparent, opaque, specular, diffusive, polished, rough etc. The 3D Non Contact Profilometer provides broad and user friendly capability to maximize surface fracture studies at a fraction of the cost of an SEM.

MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the surface fracture section of a steel sample. There is an endless list surface parameters that can be automatically calculated after the profile scan. Here we will show a 3D Profile, a 2D extraction and a surface directional map.

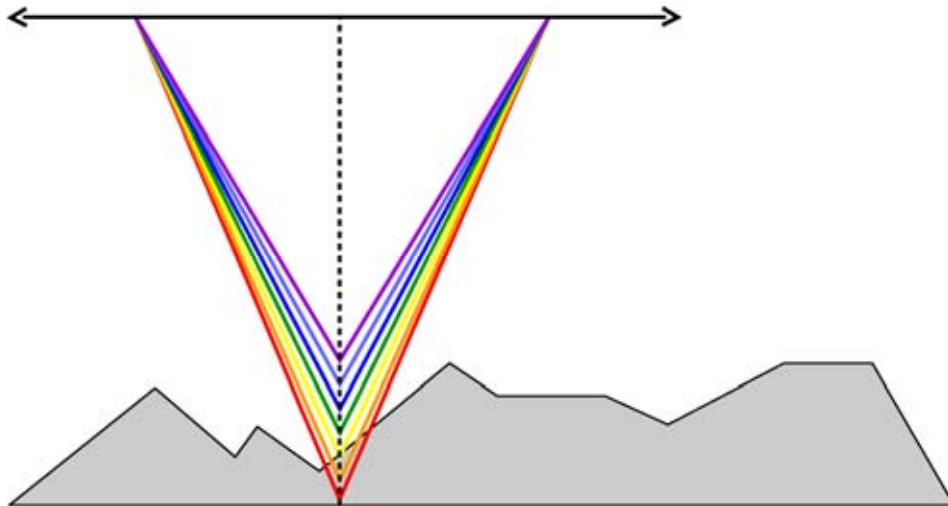


MEASUREMENT SET-UP & TIPS:

Measurements area randomly selected on the sample, drastic changes in surface topography is not an issue for Nanovea Profilometers. Small height variation down to nanometers up to 27mm of height variation can easily be measured.

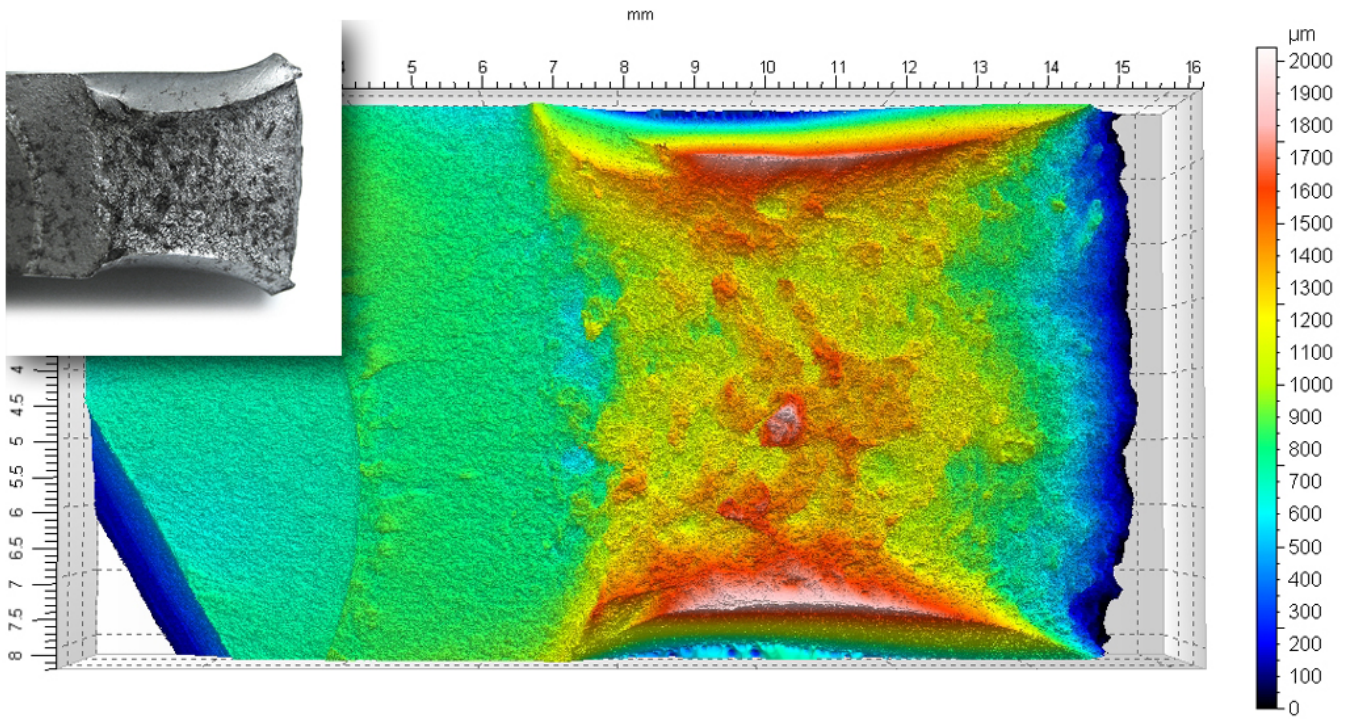
MEASUREMENT PRINCIPLE:

The axial chromatism 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.



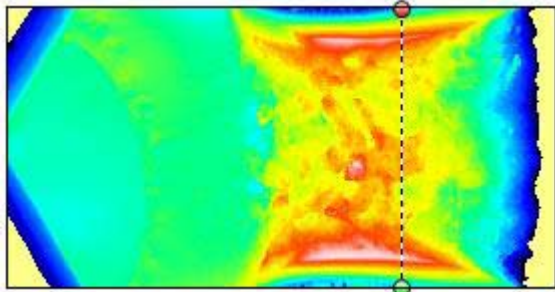
Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive, polished/rough.

**RESULTS:
TOP SURFACE**

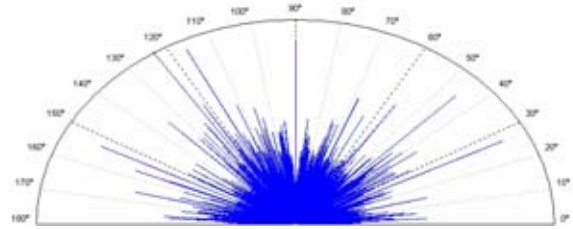


3D Profile of Top Surface.

2D Surface Extraction

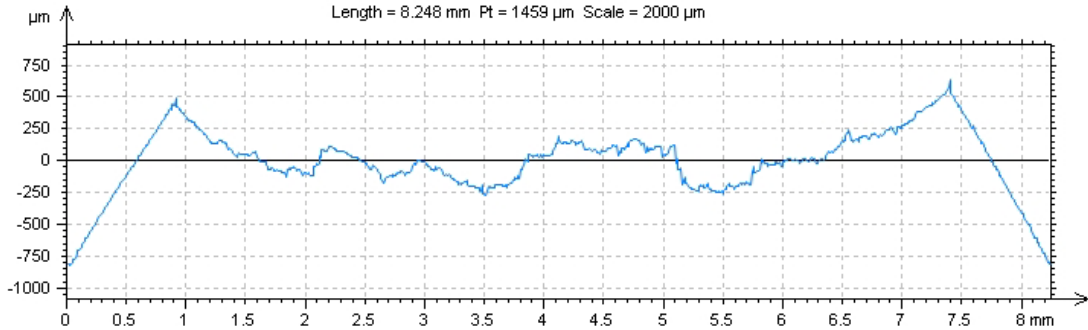


3D Surface Direction Mapping



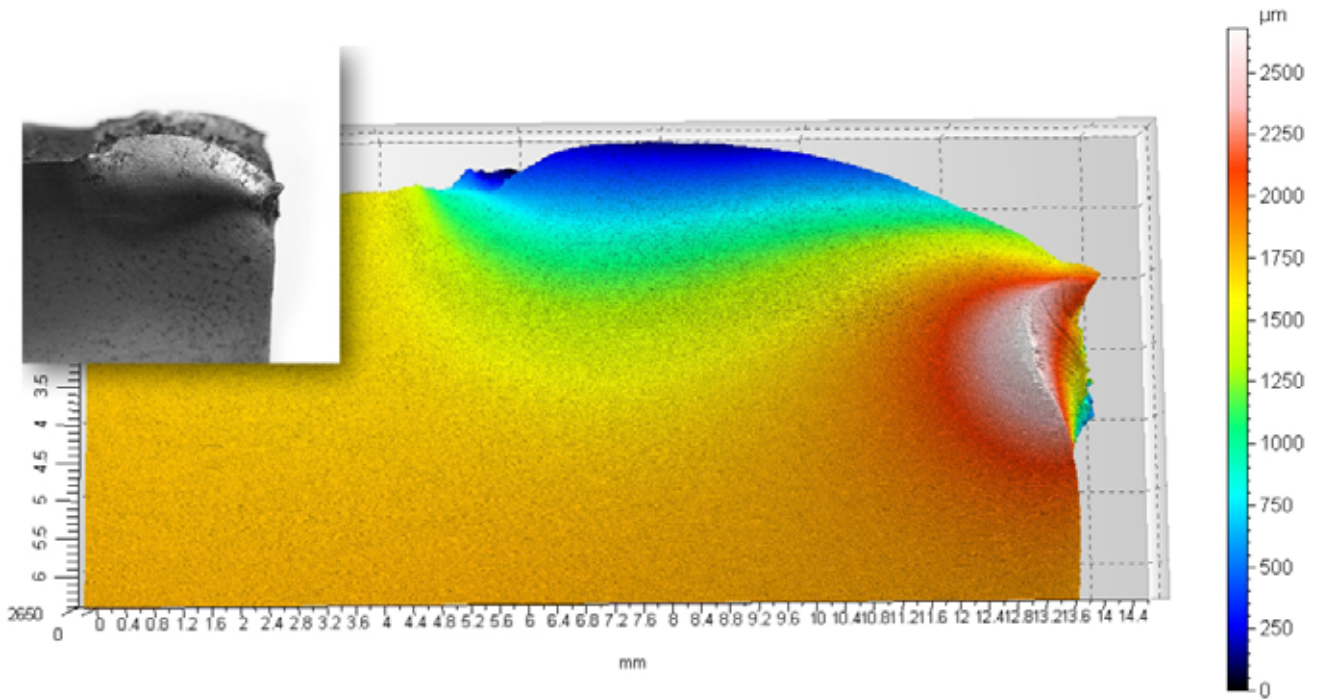
• Isotropy: 51.26% • First Direction: 123.2°
• Second Direction: 116.3° • Third Direction: 0.1725°

2D Surface Extraction Results
Length = 8.248 mm Pt = 1459 μm Scale = 2000 μm



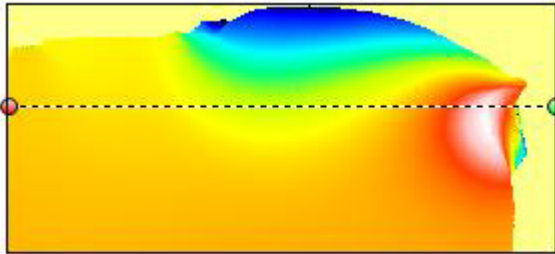
From this extraction Surface Area, Volume, Roughness and many others can be automatically calculated

**RESULTS:
SIDE SURFACE**

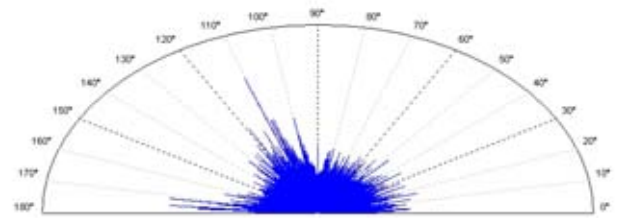


3D Profile of Side Surface

2D Surface Extraction

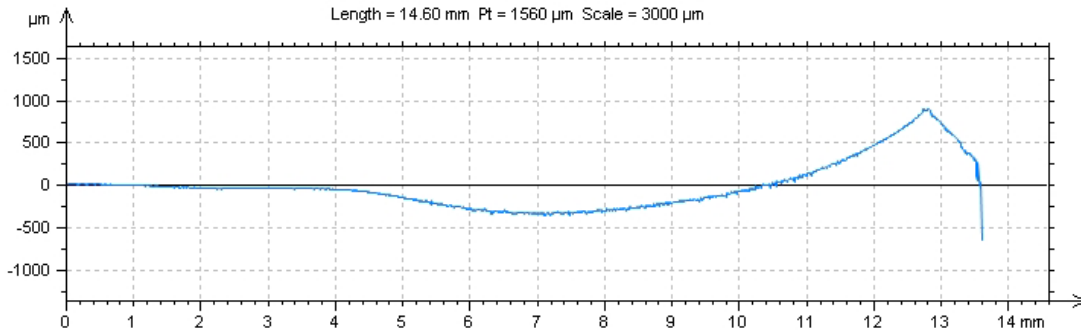


3D Surface Direction Mapping



- Isotropy: 15.55%
- First Direction: 0.1617°
- Second Direction: 110.5°
- Third Direction: 171.5°

2D Surface Extraction Results



From this extraction Surface Area, Volume, 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 fracture surface. From the 3D profile the surface can be clearly identified and areas of interest can then be quickly analyzed with an endless list of surface calculations. To further view in detail a 2D cross section can quickly be chosen to analyze, at nanometer range. With this information surface fracture 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. Additionally, Nanovea has included a portable version to their Profilometer line-up, especially critical for field studies where a fracture surface is immovable. With this broad list of surface measurement capability, fracture surface analysis has never been easier, friendlier or as thorough with a single instrument.