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A Better Measure.

Nature Inspired Surface Characterization Using 3D Metrology

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INTRO:

Nature has become a vital pool of inspiration for the development of improved surface structure. Understanding the surface structures found in nature has led to adhesion studies based on gecko's feet, resistance studies based on a sea cucumbers textural change and repellency studies based from leaves, among many others. These surfaces have a number of potential applications from biomedical to clothing and automotive. For any of these surface breakthroughs to be successful, fabrication techniques must be developed so surface characteristics can be mimicked and reproduced. It is this process that will require identification and control.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR NATURES SURFACES

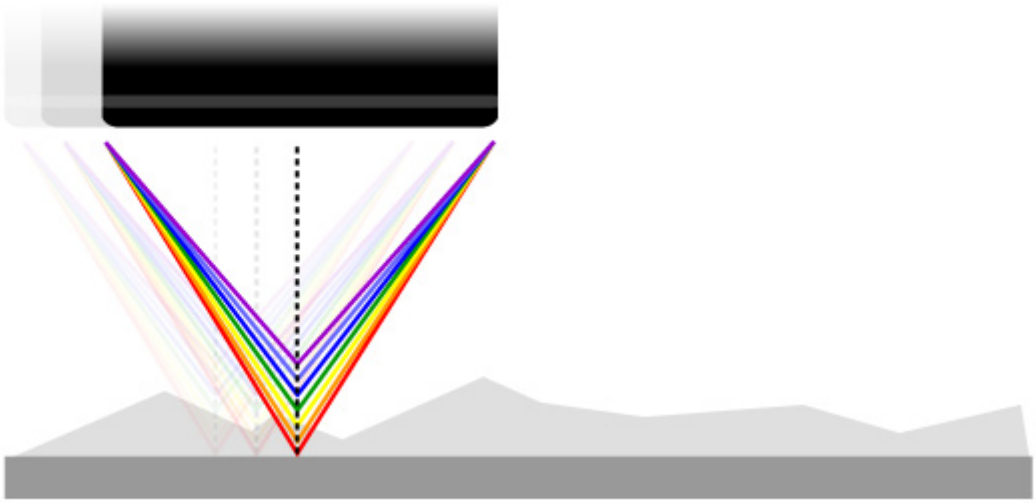
Utilizing chromatic confocal technology, the Nanovea Profilometer has superior capability to measure nearly any material. That includes the unique and steep angles, reflective and absorbing surfaces found within natures broad range of surface characteristics. 3D non contact measurement provides a full 3D image to give a more complete understanding of surface features. Without 3D capabilities, identification of nature's surfaces would be solely relying on 2D information or microscope imaging, which does not provide sufficient information to properly mimic the surface studied. Understanding the full range of the surface characteristics including texture, form, dimension, among many others, will be critical to successful fabrication.

MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the surface of a leaf. There is an endless list of surface parameters that can be automatically calculated after the 3D surface scan. Here we will review the 3D surface and select areas of interest to further analyze, including quantifying and investigating the surface roughness, channels and topography.

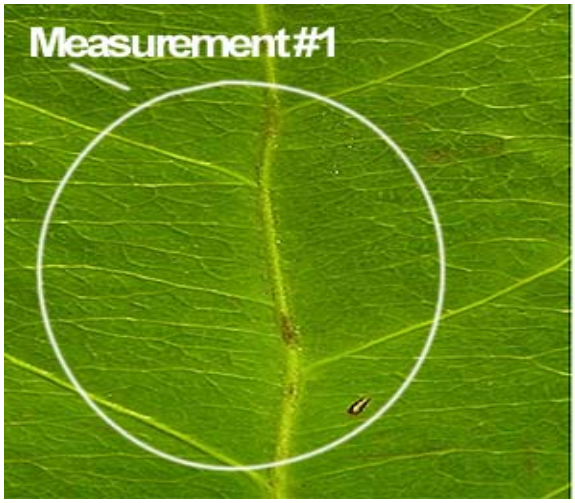
MEASUREMENT PRINCIPLE:

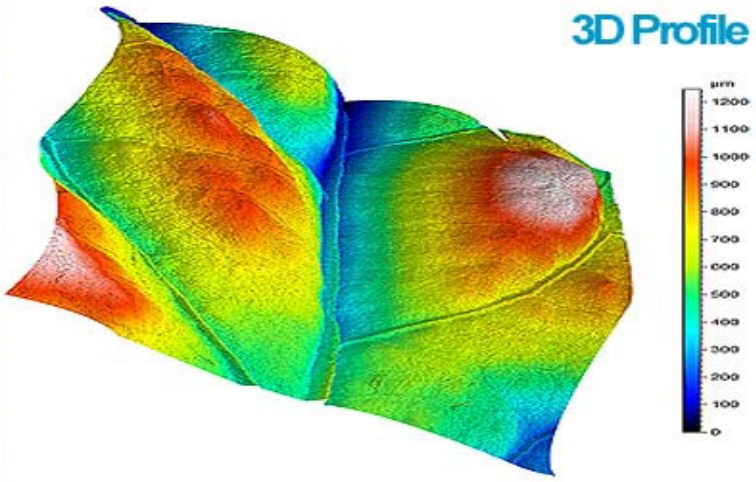
The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white 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.

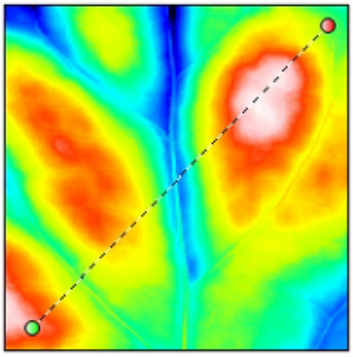


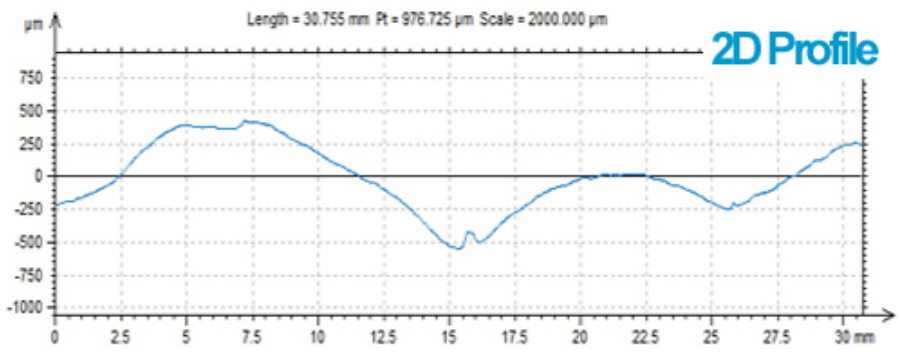
Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive, polished/rough. Measurement includes: Profile Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height Depth Thickness and many others.

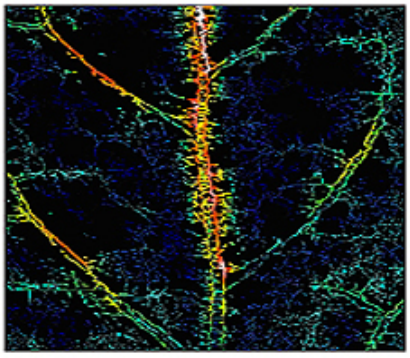
RESULTS:







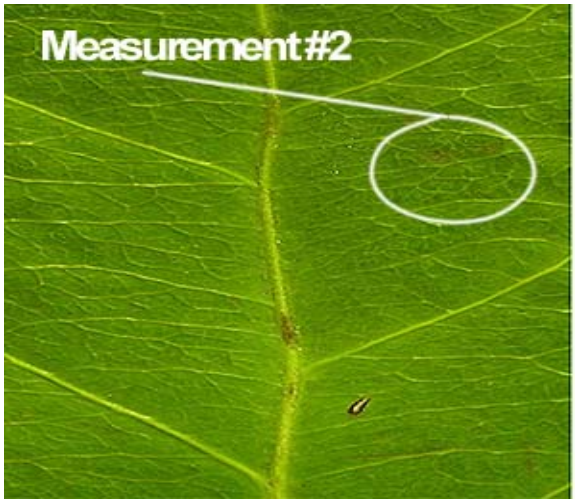


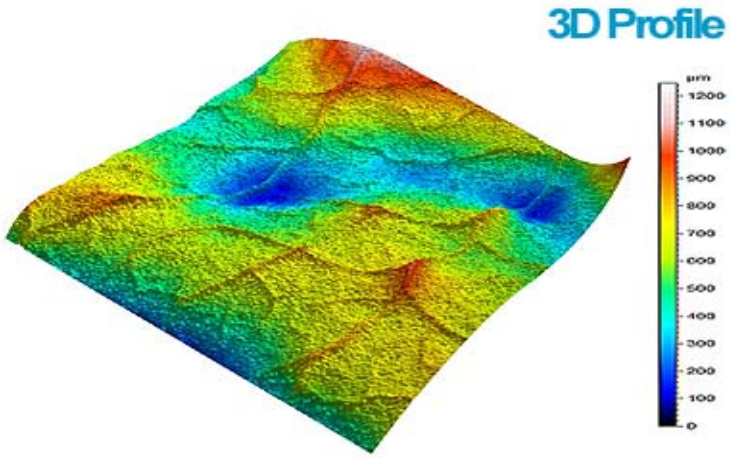


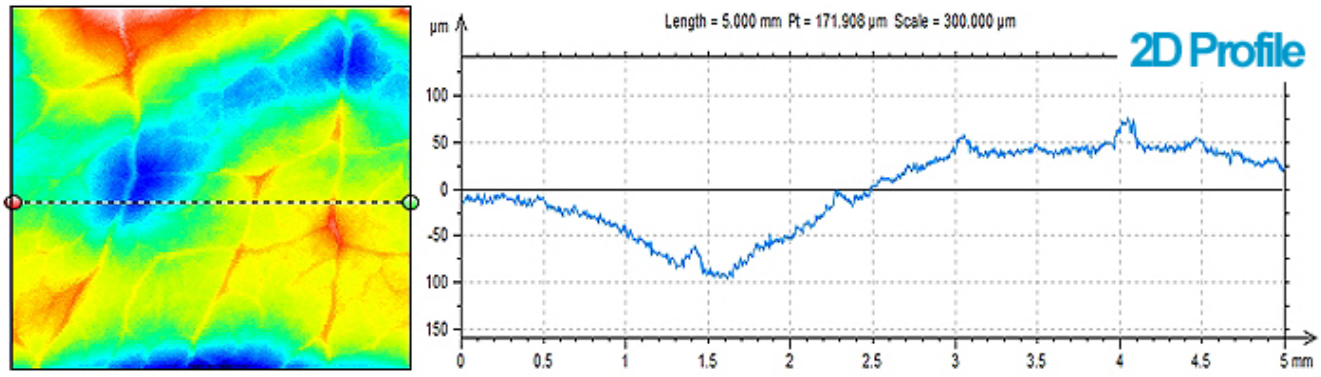
Furrow Depth

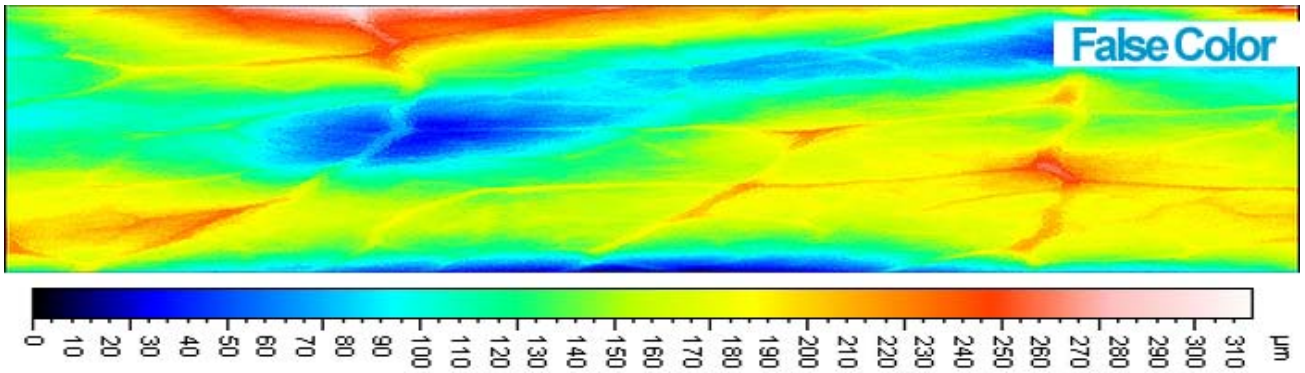
Maximum depth of furrows : 359.769 µm
Mean depth of furrows : 97.428 µm
Mean density of furrows : 16.471 cm/cm2

RESULTS:

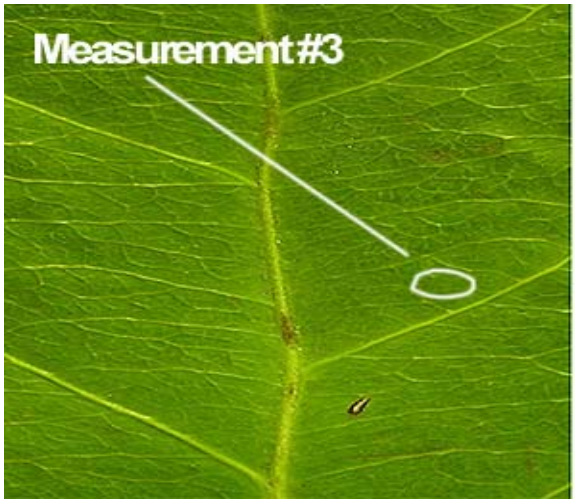

Measurement #2

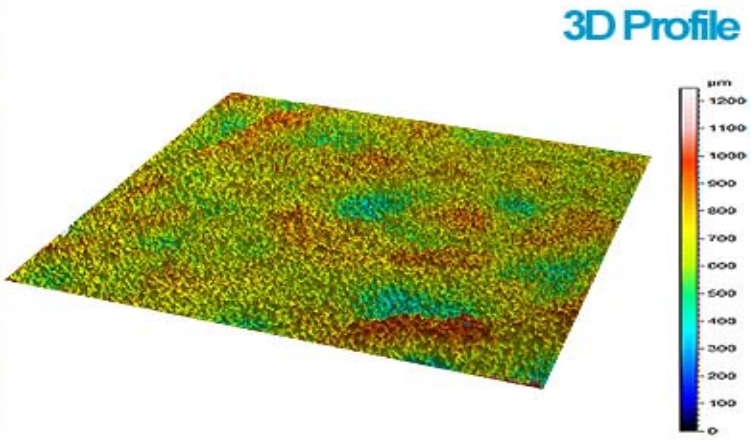

3D Profile
µm
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

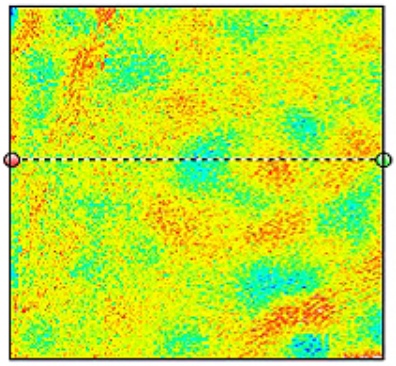

Length = 5.000 mm Pt = 171.908 µm Scale = 300.000 µm
2D Profile
µm
100
50
0
-50
100
150
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
5 mm

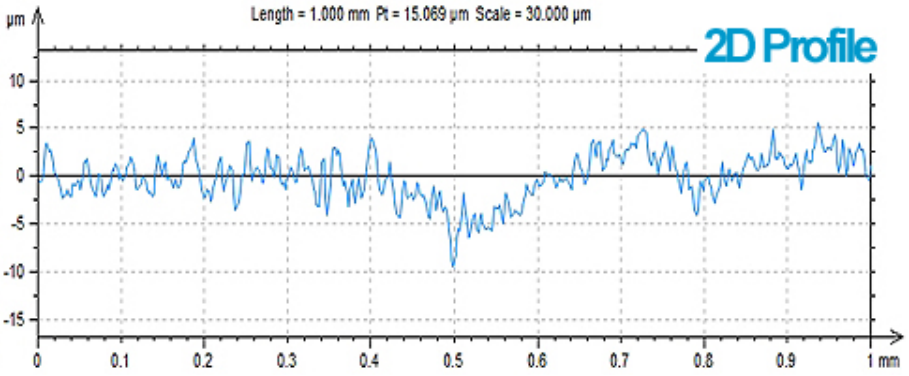

False Color
0
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290
300
310
µm

RESULTS:

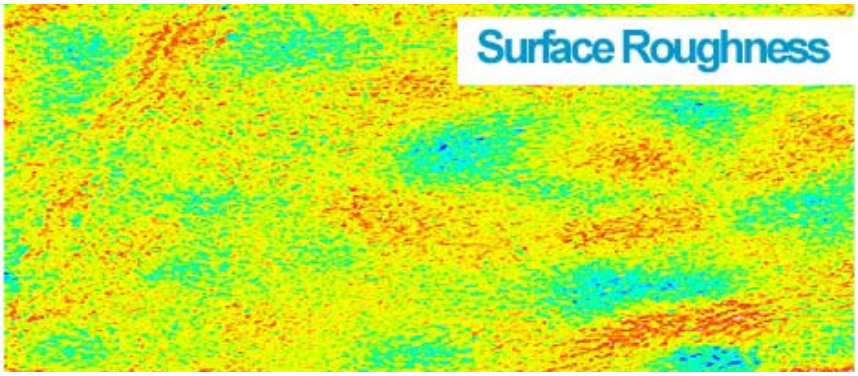








ISO 25178		
Height Parameters		
Sq	2.161	µm
Ssk	-0.163	
Sku	3.371	
Sp	10.729	µm
Sv	12.372	µm
Sz	23.100	µm
Sa	1.700	µm



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 leaf surface. Here we have shown the broad capability to study nature's surfaces. From these 3D surface measurements, areas of interest can quickly be identified and then analyzed with a list of endless measurements (Dimension, Roughness Finish Texture, Shape Form Topography, Flatness Warpage Planarity, Volume Area, Step-Height and others). A 2D cross section can quickly be chosen to analyze further details. With this information nature's surfaces 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 on table top models. Nanovea also provides a fully portable model for field research.