SEED SURFACE TOPOGRAPHY MEASUREMENT USING 3D PROFILOMETRY

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INTRODUCTION:

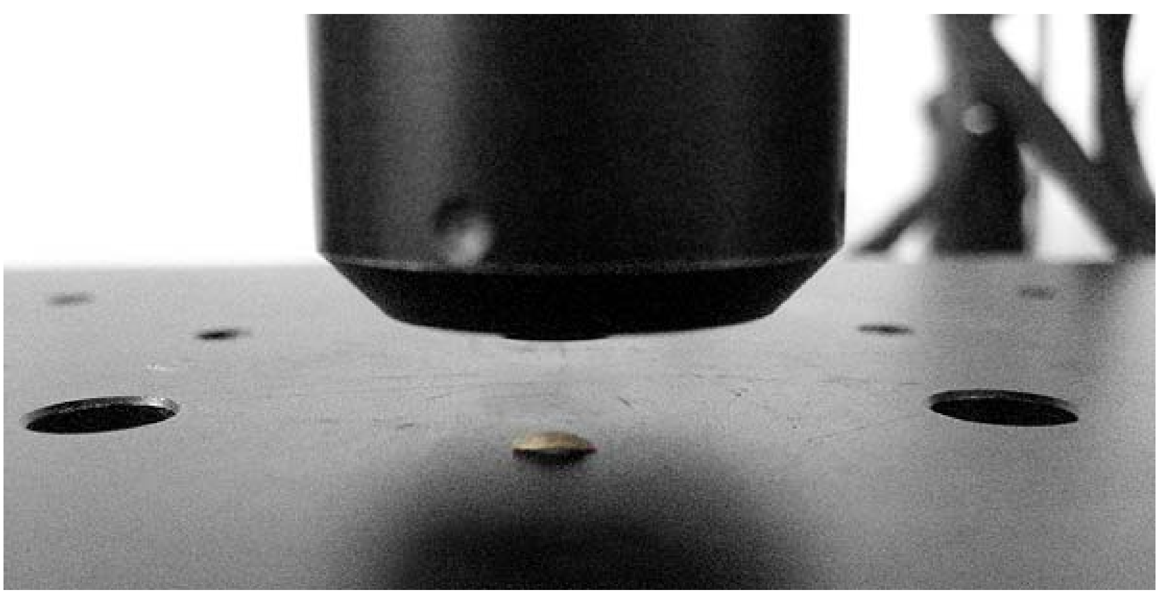
The surface topography and overall surface features present on common seeds provide a great visual example of the capabilities of the Nanovea 3D Non-Contact Profilometer. The small scale of the seeds, most of the intricate surface features are not discernable by eye, are no problem for the resolution and accuracy of the profilometer. The profilometer's analysis software also offers a wide range of studies applicable to these unique surfaces.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR WEAR STUDY

Unlike other techniques such as touch probes or interferometry, the 3D Non-Contact Profilometer, using axial chromatism, can measure nearly any surface, sample sizes can vary widely due to open staging and there is no sample preparation needed. Nano through macro range is obtained during surface profile measurement with zero influence from sample reflectivity or absorption, has advanced ability to measure high surface angles and there is no software manipulation of results. Easily measure any material: transparent, opaque, specular, diffusive, polished, rough etc. The technique of the Non Contact Profilometer provides an ideal, broad and user friendly capability to maximize surface studies; along with the benefits of combined 2D & 3D capability.

MEASUREMENT OBJECTIVE

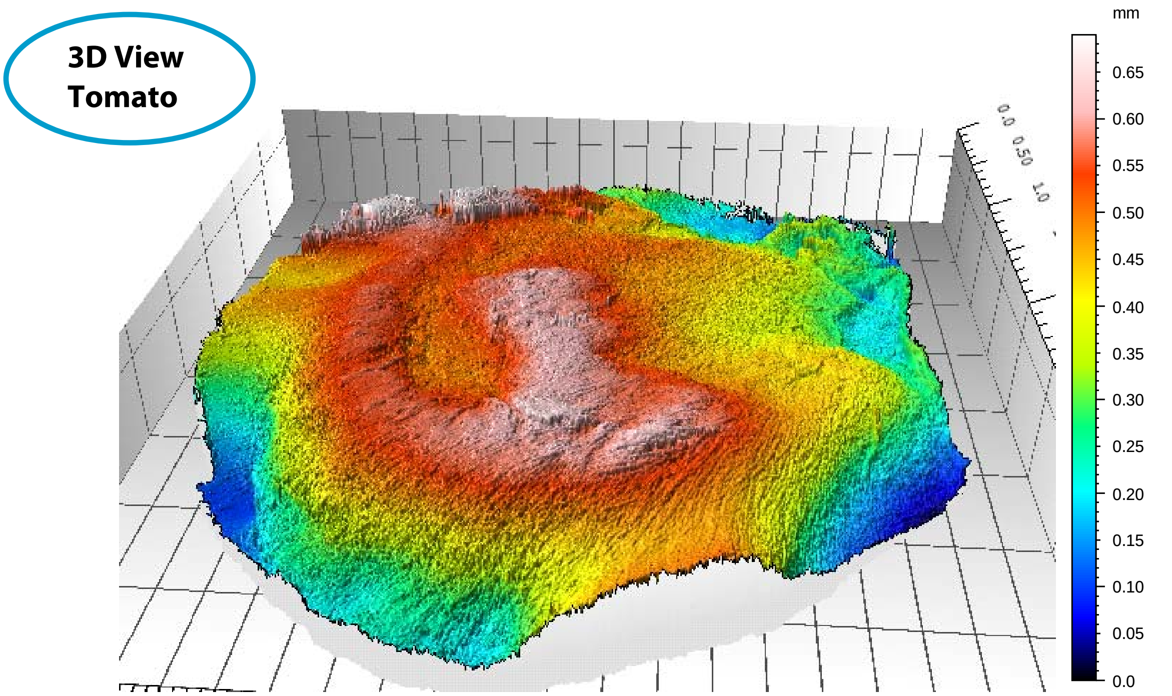
In this application the Nanovea ST400 Profilometer is used to measure the surface of a tomato seed and romaine lettuce seed. The entire surface of each seed was scanned with a high resolution. Various analyses will be used to characterize the surfaces including surface roughness, contour analysis, and texture direction.

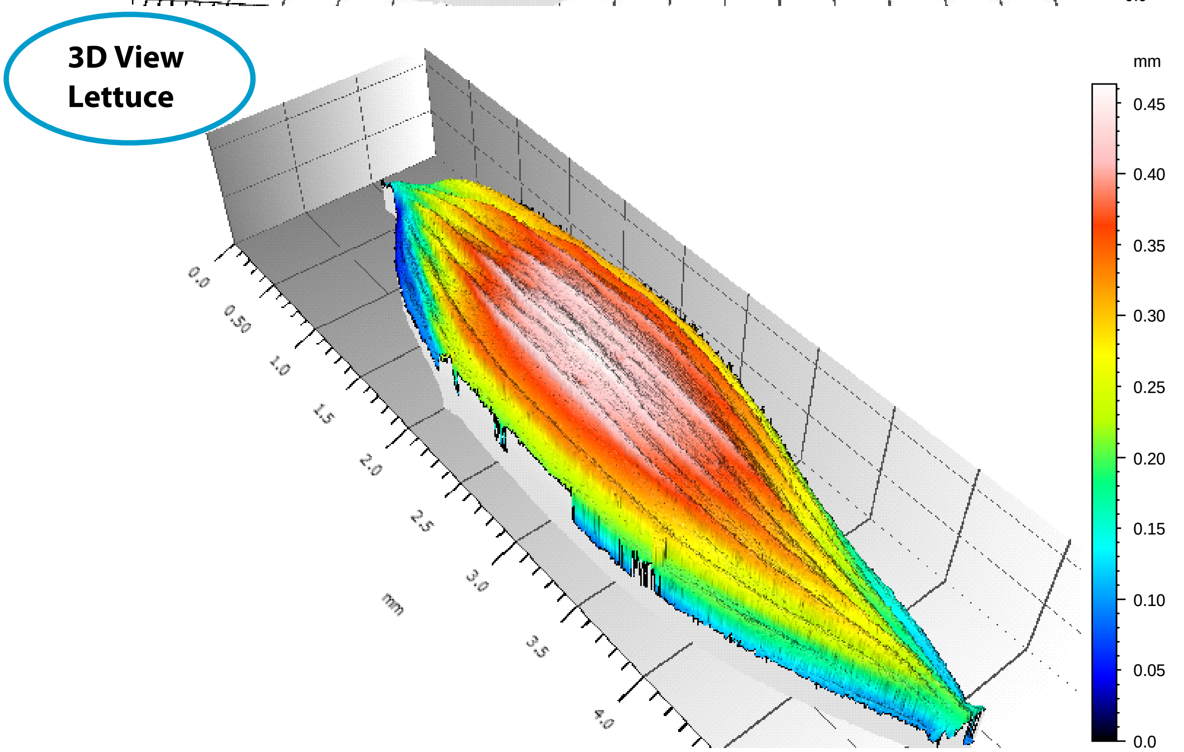


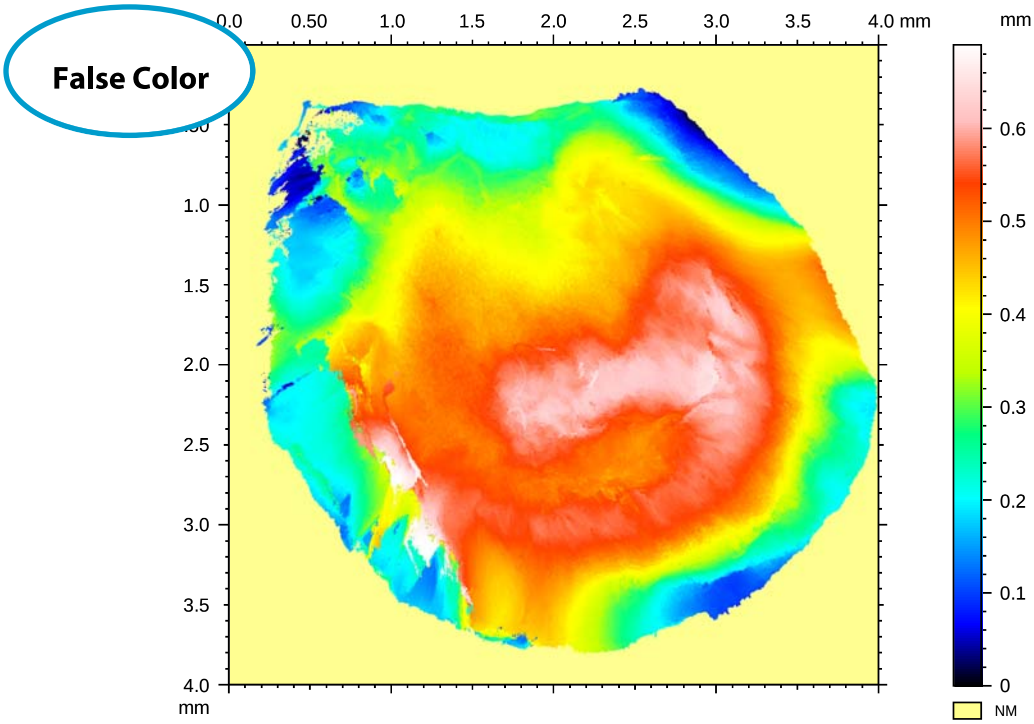
RESULTS:

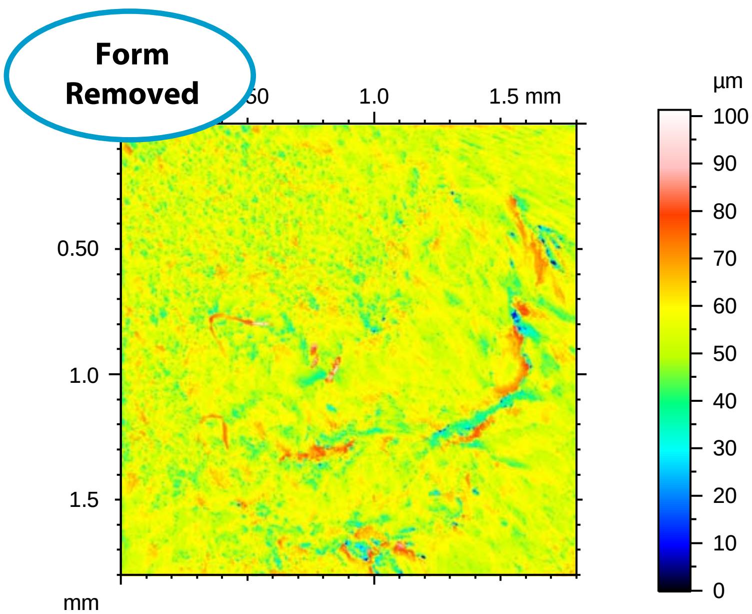
3D Surface

The 3D View and False Color View of the seeds show a complex surface structure. It provides users a straightforward tool to directly observe the morphology of the surface from different angles. The overall form was then removed from the surface in order to calculate the local surface roughness of the seeds, and the texture direction of the lettuce seed.

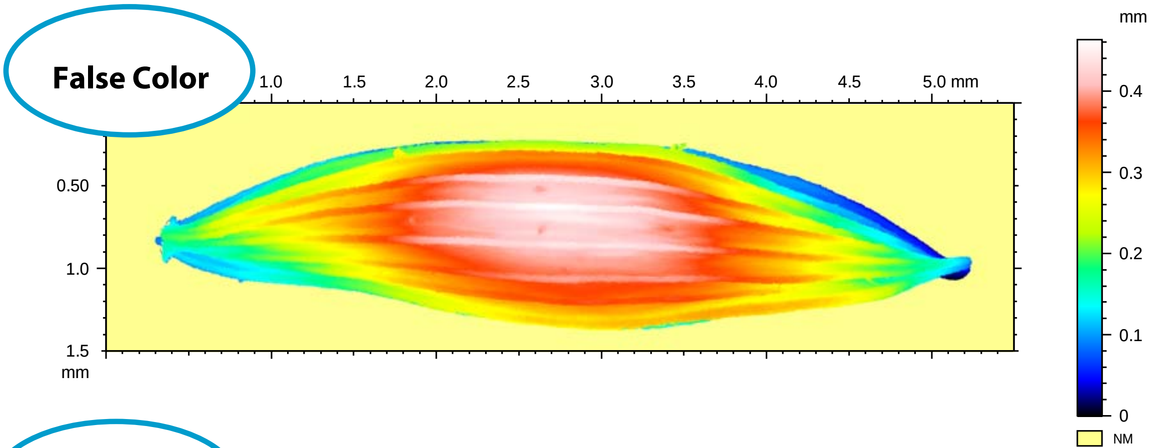


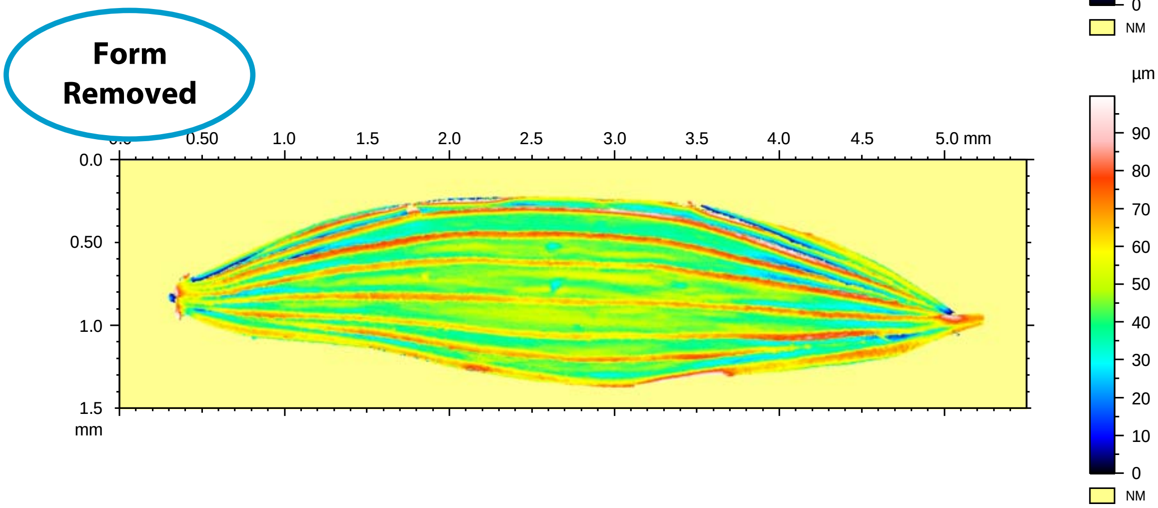




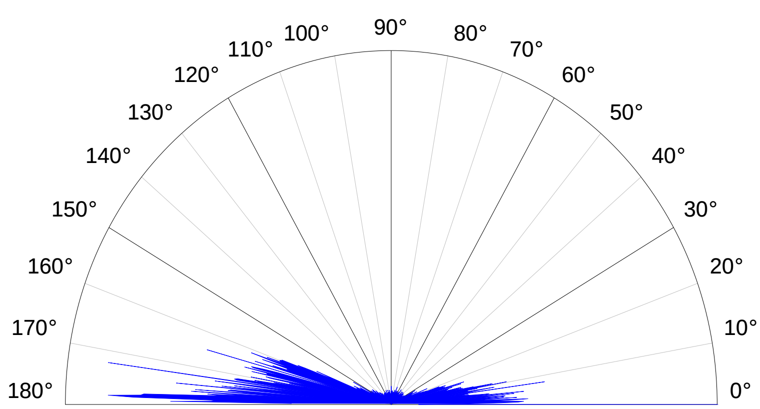


ISO 25178		
Height Parameters		
Sa	4.858	µm
Sq	6.605	µm
Sp	46.50	µm
Sv	54.83	µm
Sz	101.3	µm
Ssk	-0.4595	
Sku	6.628	





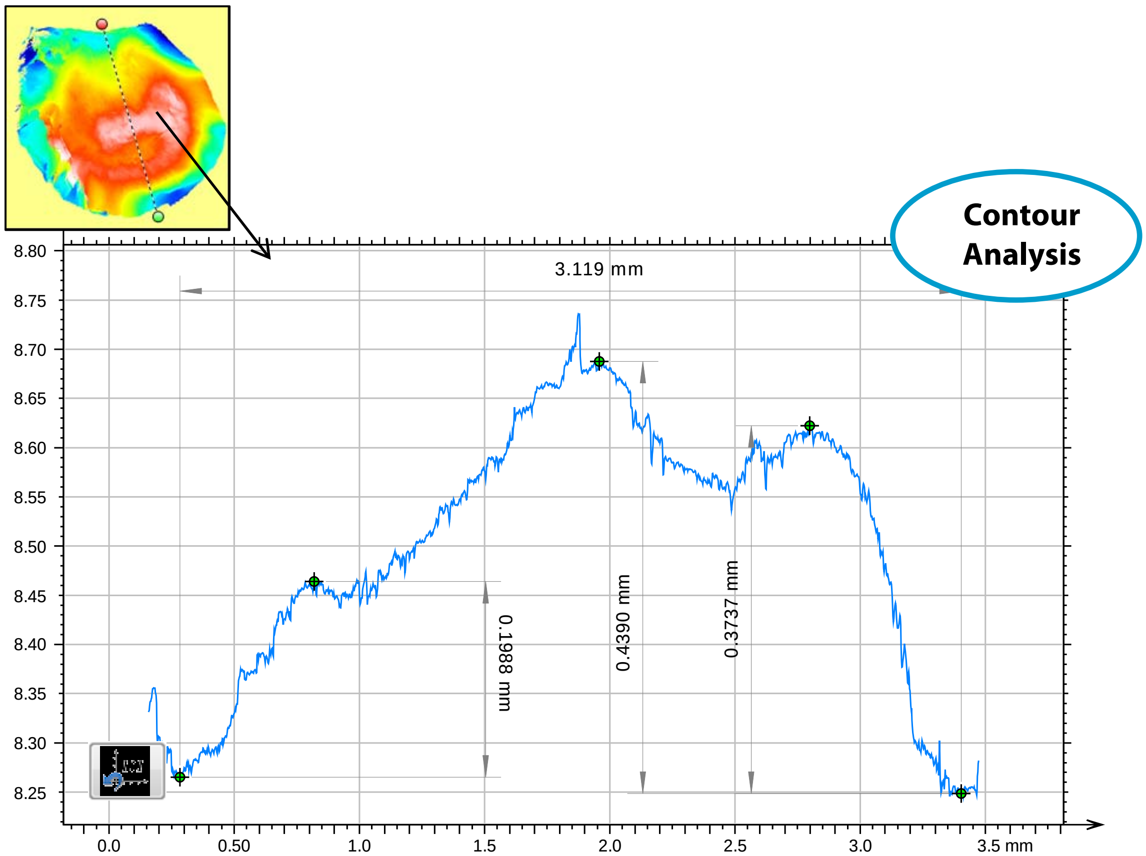
ISO 25178		
Height Parameters		
Sa	11.03	µm
Sq	13.71	µm
Sp	49.63	µm
Sv	50.10	µm
Sz	99.73	µm
Ssk	0.3684	
Sku	3.132	

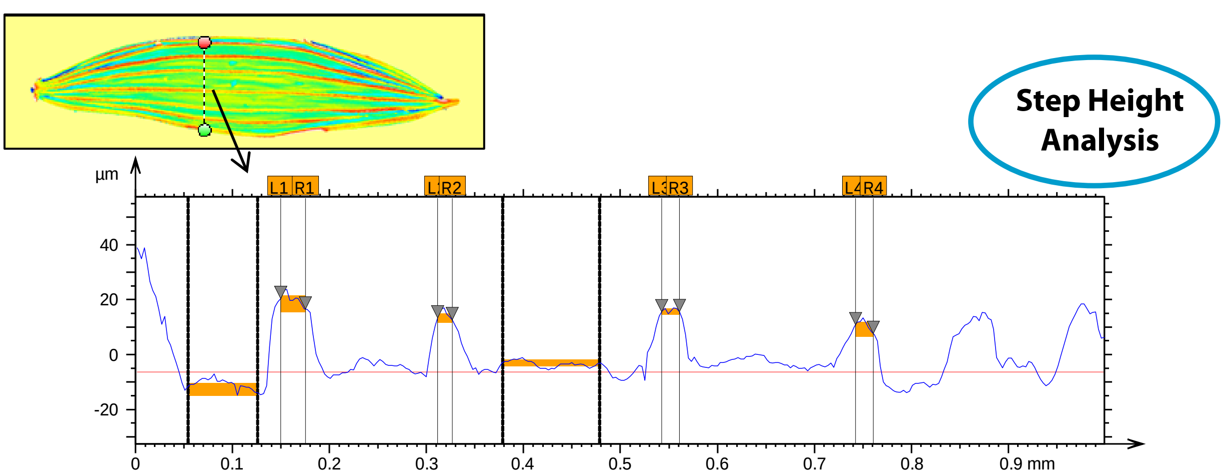


Parameters	Value	Unit	
Isotropy	15.63	%	
First Direction	0.2342	°	
Second Direction	172.3	°	

2D Surface Analysis

Line profiles can also be extracted from the surface to show a crossectional view of the seed surface. The Countour Analysis and Step Height studies were used to measure precise dimensions of the seeds' surface features.





Parameters	Unit	Step 1	Step 2	Step 3	Step 4
Maximum height	µm	30.12	23.34	23.31	19.79
Mean height	µm	26.66	20.84	22.27	17.37

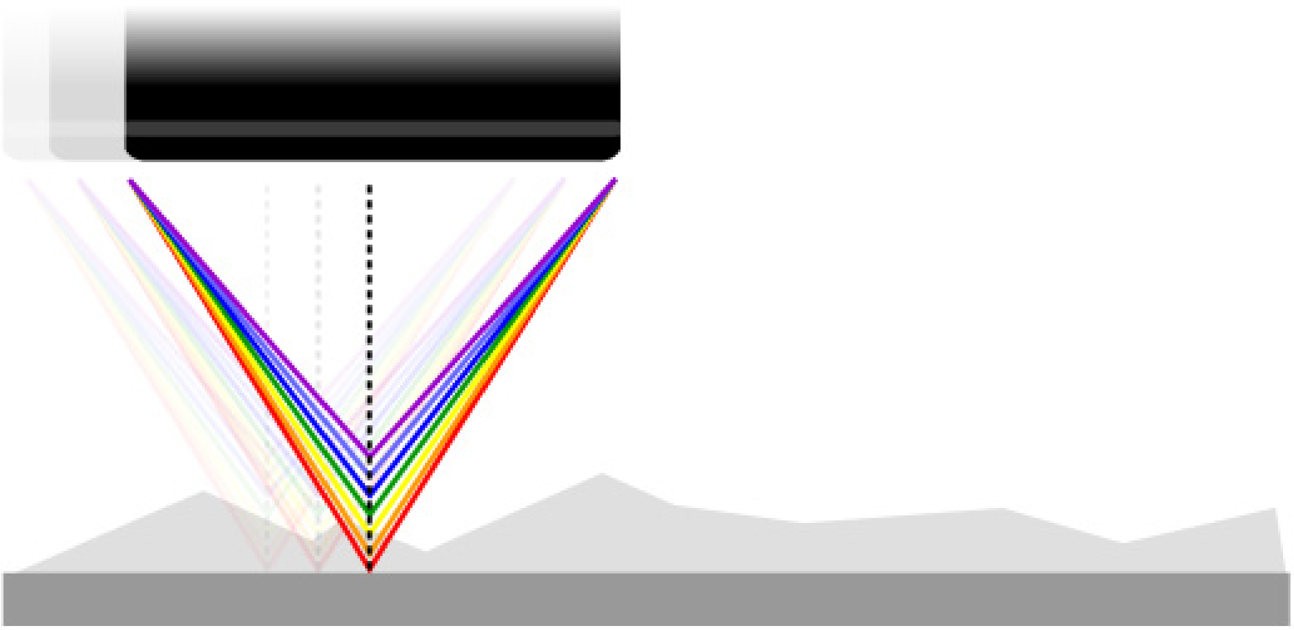
CONCLUSION:

In this application, we have shown how the Nanovea 3D Non Contact Profilometer can precisely characterize a wide range of surface features. The tomato and lettuce seed had a local surface roughness of 4.858μm and 11.03μm, respectively. The texture direction analysis was also used to determine the most significant angle of the lettuce seed grooves, 0.234°. From the profile view, the lettuce seed grooves were found to be between 19 and 30μm high. The data shown here represents only a portion of the calculations available in the analysis software.

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.



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.