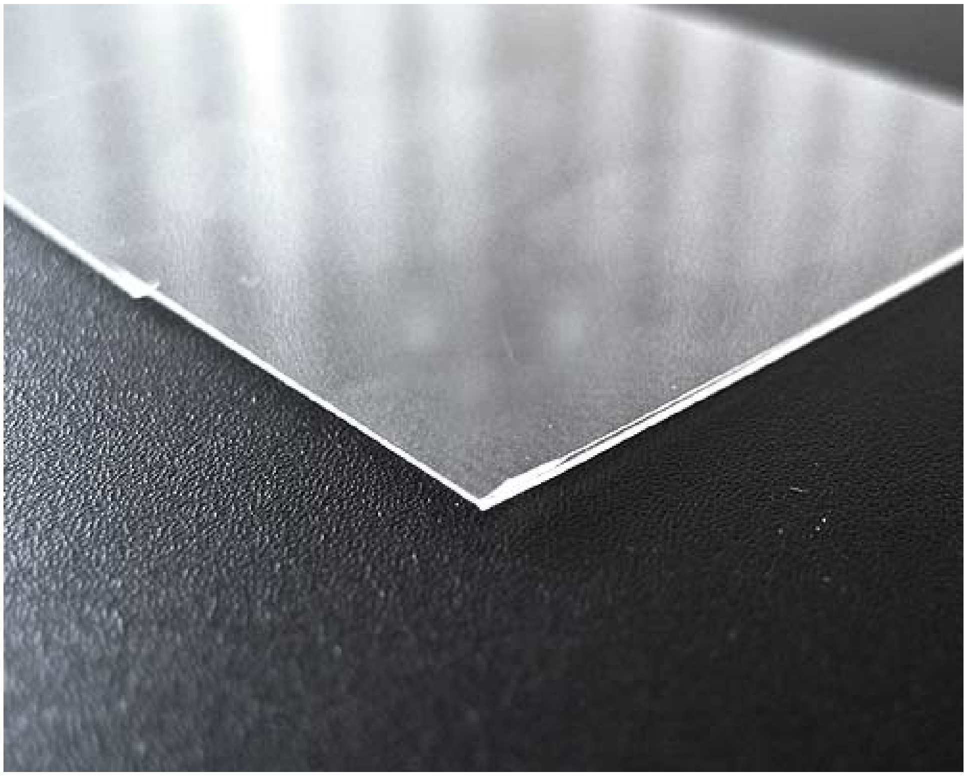
Plastic Film Texture Measurement
With 3D Metrology



Prepared by

Jorge Ramirez

6 Morgan, Ste156, Irvine CA 92618 · P: 949.461.9292 · F: 949.461.9232 · nanovea.com

INTRO:

There are many factors that can contribute to the surface texture of plastics films. During the development processes a plastic film surface can be etched, sprayed, brushed or various other industrial processes. Each process varies widely with different surface parameters that may be random or intended texture patterns. Like virtually all materials industries, Nanotechnology measurement is opening new doors during R&D and ultimately the quality control of plastic film.

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

Because surface texturing of plastic film can be used to control wettability, biocompatibility, friction and others, it will be crucial to monitor the texturing result. Understanding surface texture such as consistency, directional patterns and others can lead to the best selection surface texture and control measures. To insure the quality control of such parameters will heavily rely upon quantifiable, reproducible and reliable inspection of plastic film texture. The Nanovea 3D Non-Contact Profilometers utilize chromatic confocal technology with unmatched capability to measure plastic film. Where other techniques fail to provide reliable data, due to probe contact, surface variation, angle, absorption or reflectivity, Nanovea Profilometers succeed.

MEASUREMENT OBJECTIVE

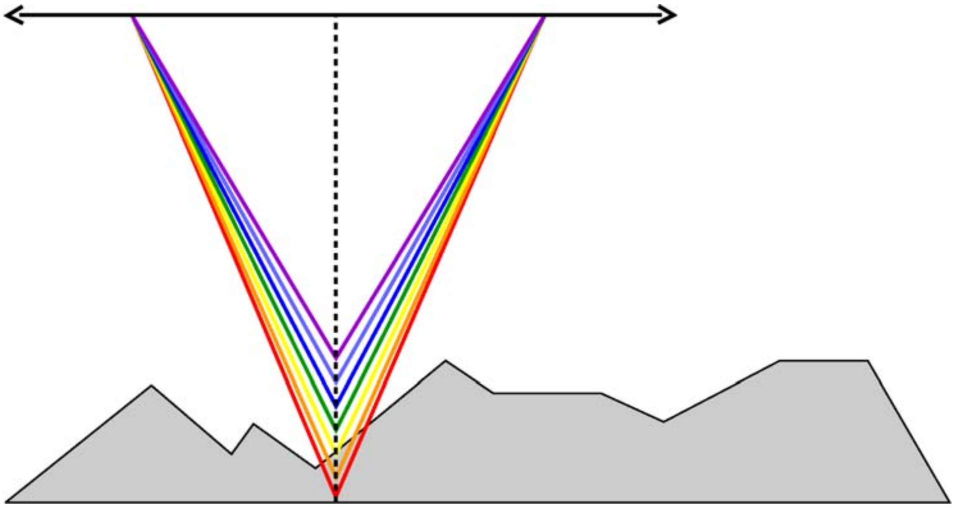
In this application, the Nanovea ST400 is used to measure and compare the surface texture of three plastic film samples. Several surface parameters will be automatically calculated from the thin film profile including the most common, Sa (average surface roughness), shape and form.

MEASUREMENT PARAMETERS:

Probe	300µm
Acquisition rate	2000 Hz
Averaging	10
Measured surface	1.0mm x 1.0mm
Step size	2µm x 2µm
Scanning Mode	Constant speed

MEASUREMENT PRINCIPLE:

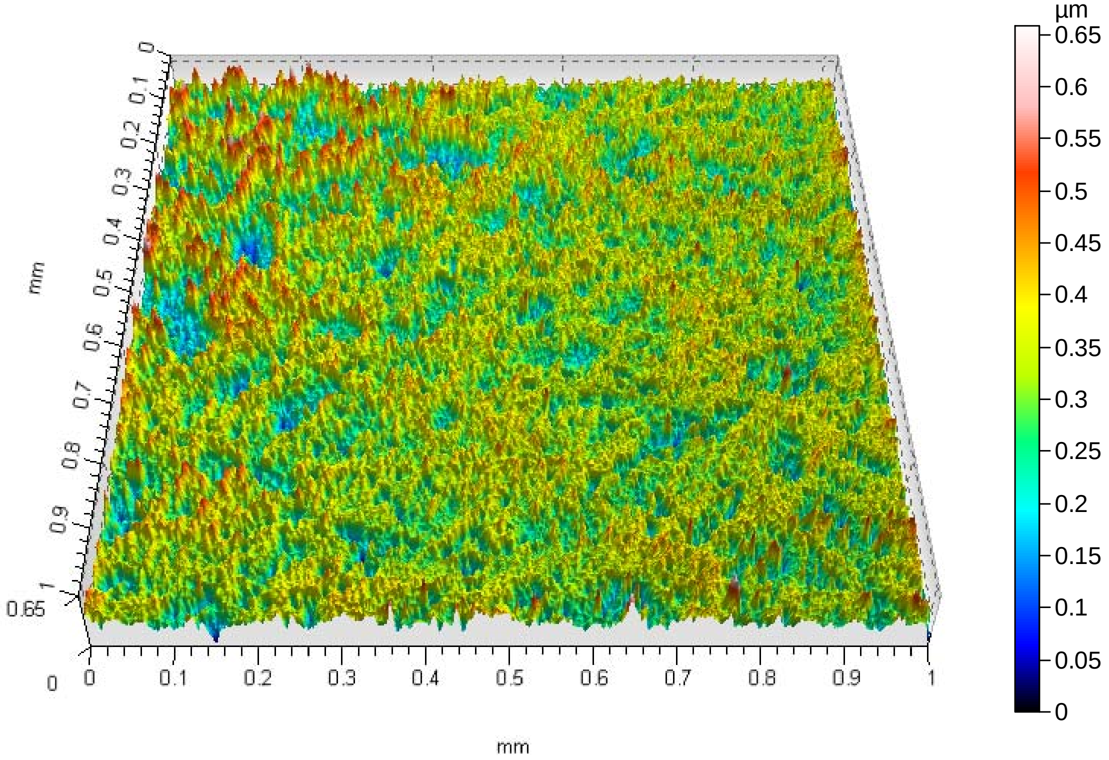
The axial chromatism technique uses a white light source, where light passes through an objective lens with a high degree of chromatic aberration. The refractive index of the objective lens will vary in relation to the wavelength of the light. In effect, each separate wavelength of the incident white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



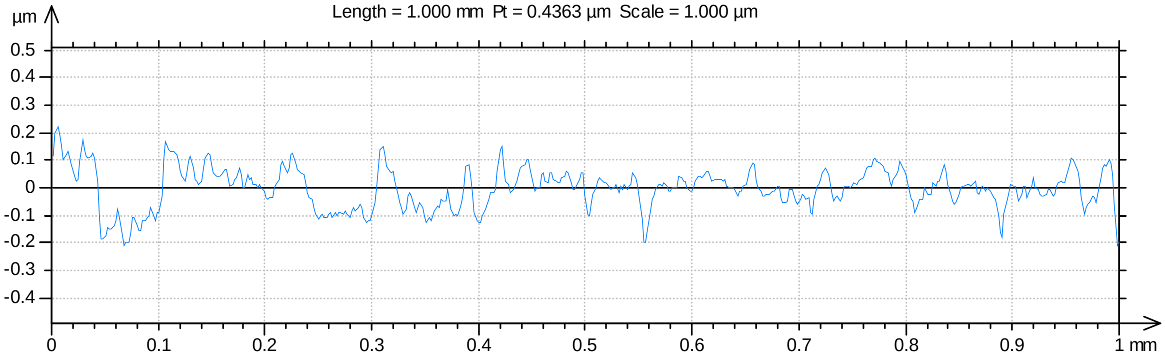
Nanovea optical pens have zero influence from sample reflectivity. Variations require no sample preparation and have advanced ability to measure high surface angles. Capable of large Z measurement ranges. Measure any material: transparent/opaque, specular/diffusive, polished/rough.

RESULTS:

Sample 1



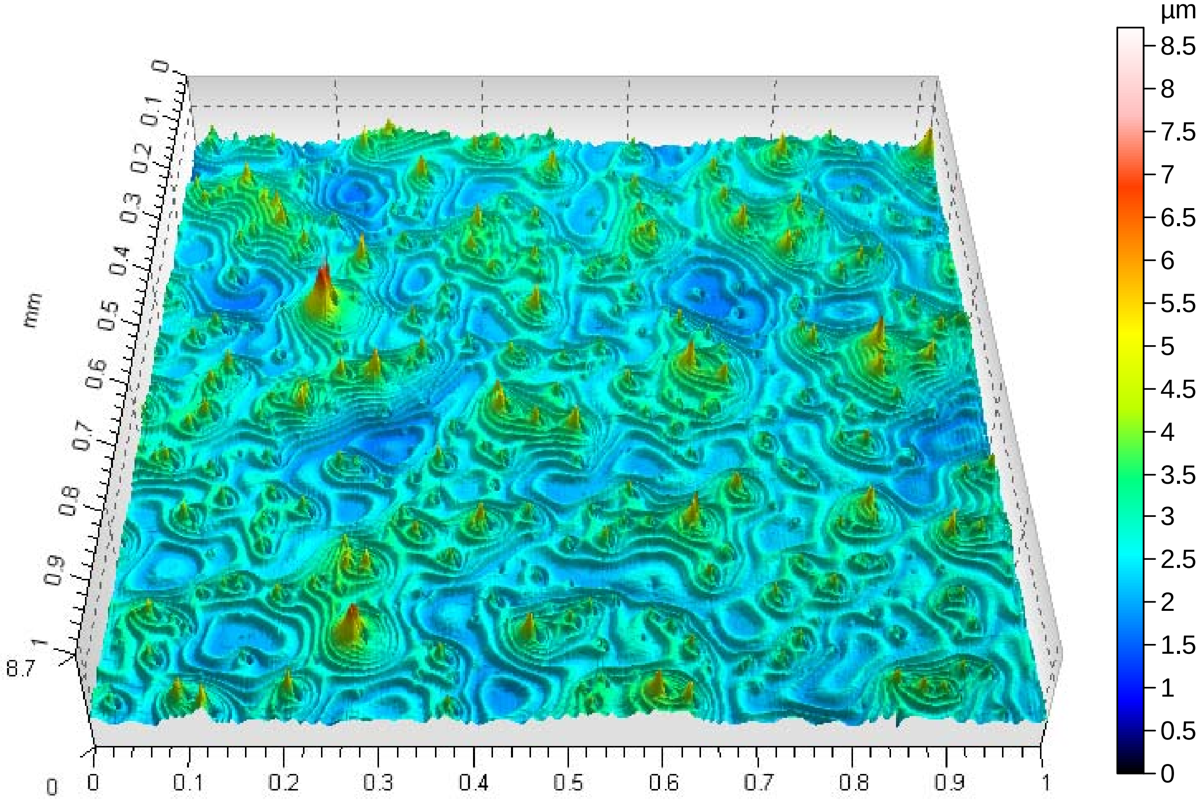
3D image of Sample 1



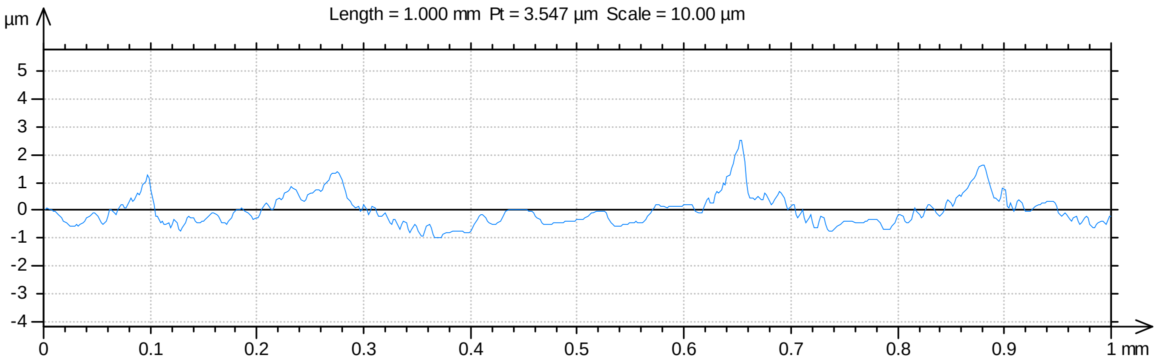
2D Profile extraction of Sample 1

Sa	Sq	Sp	Sv	Sz	Ssk	Sku	Sdar
0.054µm	0.069µm	0.345µm	0.314µm	0.658µm	-0.139	3.647	1.000
Arithmetical Mean Height	Root Mean Square Height	Maximum Peak Height	Maximum Pit Height	Maximum Height	Skewness	Kurtosis	Total Surface Area

Sample 2



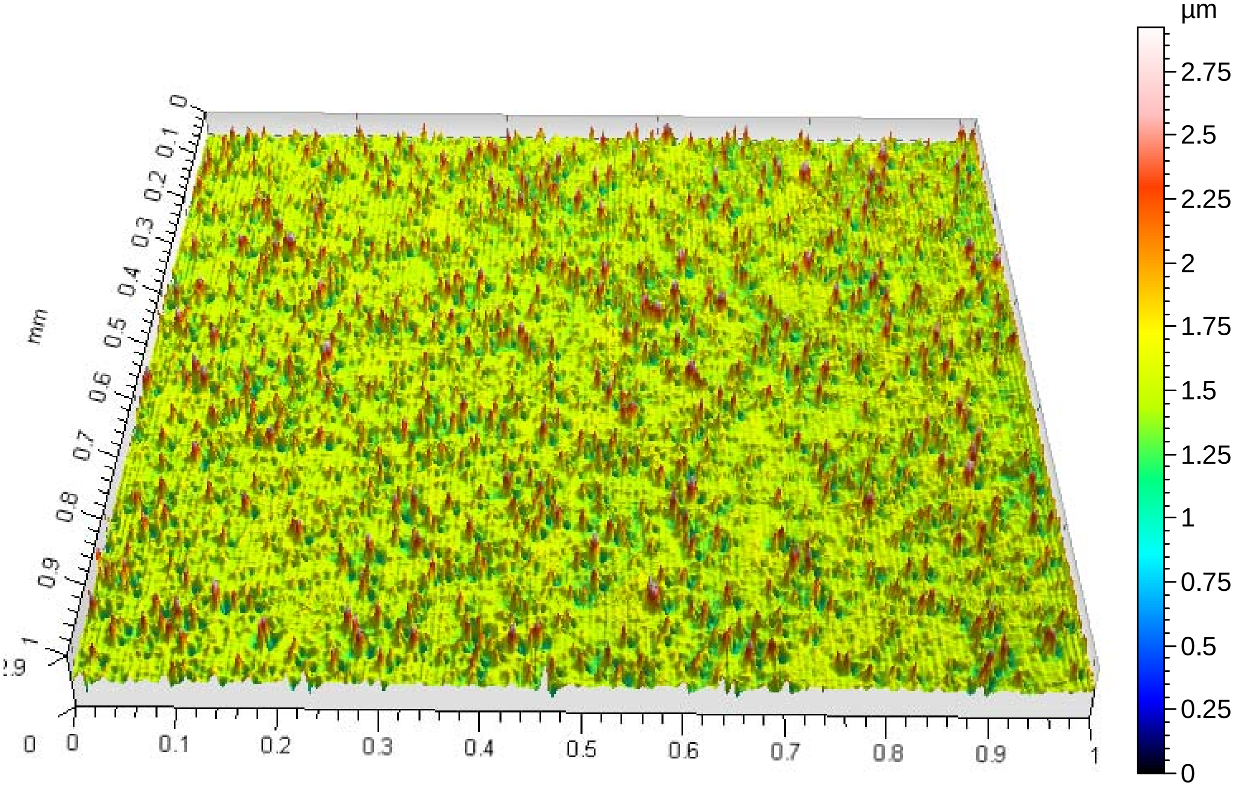
3D image Sample 2



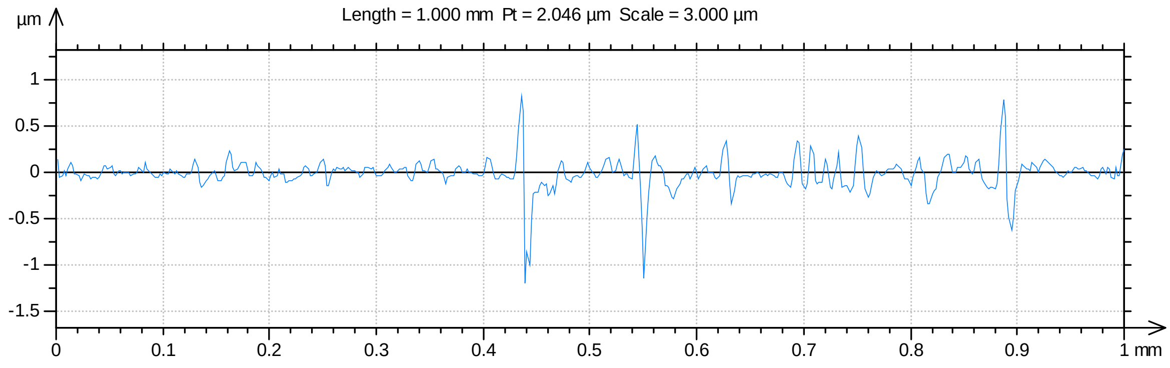
Profile extraction of Sample 2

Sa	Sq	Sp	Sv	Sz	Ssk	Sku	Sdar
0.341µm	0.461µm	6.039µm	2.679µm	8.718µm	1.268	8.052	1.006
Arithmetical Mean Height	Root Mean Square Height	Maximum Peak Height	Maximum Pit Height	Maximum Height	Skewness	Kurtosis	Total Surface Area

Sample 3



3D image of Sample 3



Profile extraction of Sample 3

Sa	Sq	Sp	Sv	Sz	Ssk	Sku	Sdar
0.140µm	0.237µm	1.411µm	1.513µm	2.924µm	0.236	11.56	1.007
Arithmetical Mean Height	Root Mean Square Height	Maximum Peak Height	Maximum Pit Height	Maximum Height	Skewness	Kurtosis	Total Surface Area

Definitions of Roughness Parameters

	Height Parameter	Definition
Sa	Arithmetical Mean Height	Mean surface roughness. $Sa = \frac{1}{A}\int_A \lvert z(x,y) \rvert dxdy$
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.

CONCLUSION:

In this application, we have shown how the Nanovea ST400 3D Profilometer can precisely characterize both the texture and the nanometer details of the plastic film surface. (*Note, many other measurements could have also been made besides those shown here) With this information the plastic films can be investigated for R&D or quality control procedures. To further view in detail a 2D cross section can quickly be chosen to analyze, at nanometer range, special areas of interest. Special areas of interest could have been further analyzed with integrated AFM or Microscope 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.