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A Better Measure.

SURFACE FINISH OF PLASTIC TUBING USING 3D PROFILOMETRY

Prepared by
Craig Leising

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

INTRO:

The appearance and performance of a plastic component is highly contributed to surface finish. Monitoring surface finish for the intended parameters is crucial to the success of a plastic component both molded and machined. Insuring surface finish allows for the vast uses of plastic components and the environments they are found, ranging from medical to consumer goods, to electronics and cosmetics. For every use of a plastic component a specific surface finish parameter can be set to control its appearance and performance during environmental conditions. It is this parameter that is assured with the use of 3D non-contact metrology.

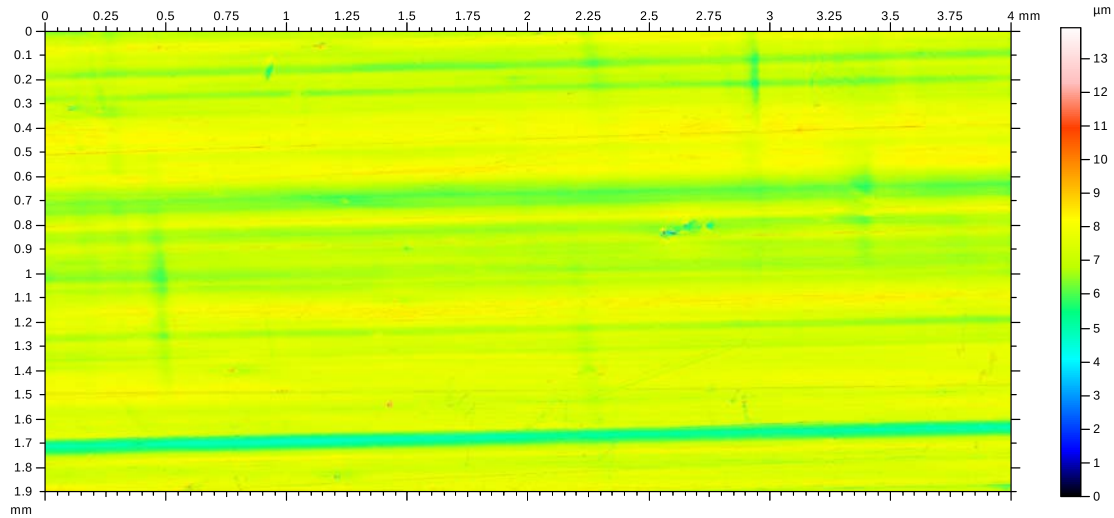
IMPORTANCE OF SURFACE METROLOGY INSPECTION FOR QUALITY CONTROL

Because surface finish is vital to both appearance and performance it is crucial to control the intended result. Appearance is highly crucial to applications requiring a brilliant shine, such as car components and consumer goods, where as performance related applications may call for a dull and rough surface to conversely meet frictional needs.

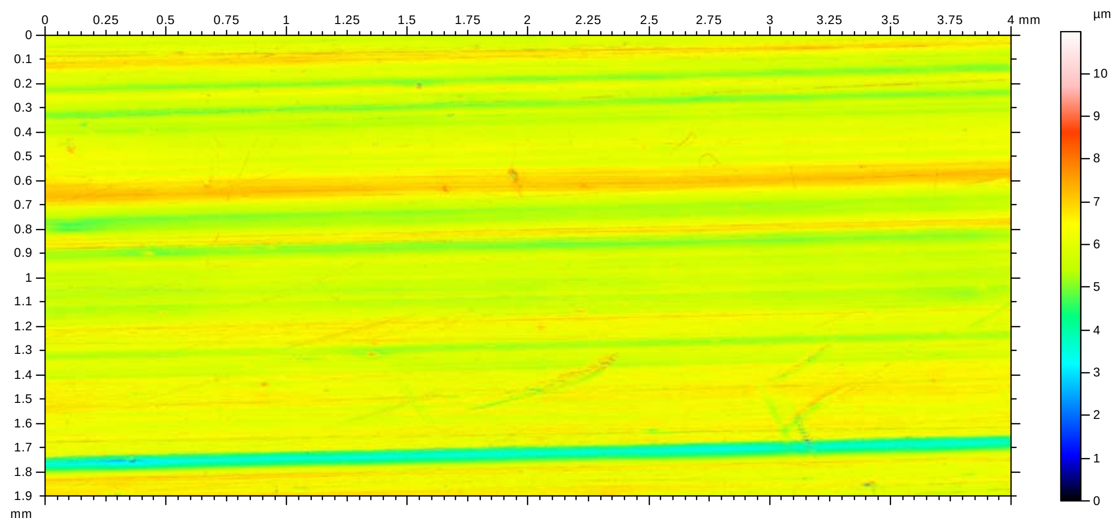
MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the surface of a plastic tube in two locations to measure and compare the surface roughness. Several surface parameters will automatically be calculated including the most common, Sa (average surface roughness).

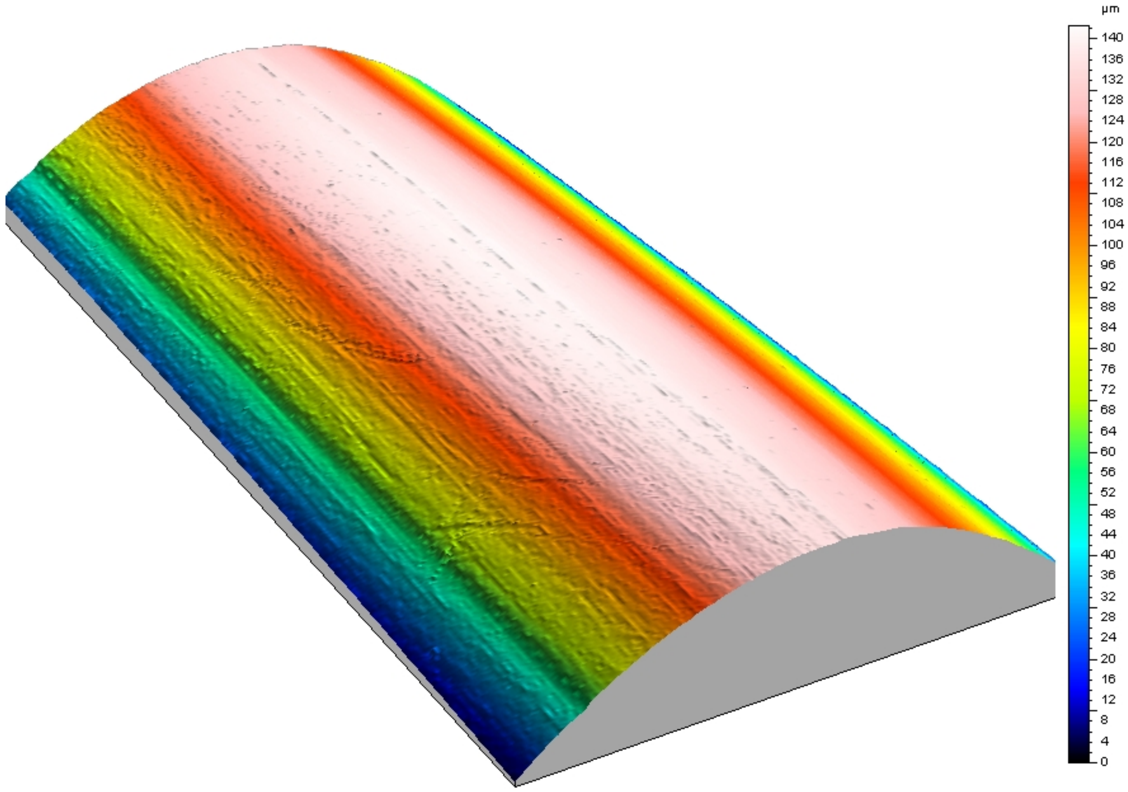
RESULTS:



False color representations of flattened Area 1 (above) and flattened Area 2 (below)



	Area 1	Area 2	
Sa	0.508 µm	0.471 µm	*Arithmetical Mean Height*
Sq	0.659 µm	0.636 µm	*Root Mean Square Height*
Sp	6.581 µm	4.978 µm	*Maximum Peak Height*
Sv	7.334 µm	6.005 µm	*Maximum Pit Height*
Sz	13.915 µm	10.983 µm	*Maximum Height*
Ssk	-0.6348	-0.6263	*Skewness*
Sku	4.643	5.478	*Kurtosis*



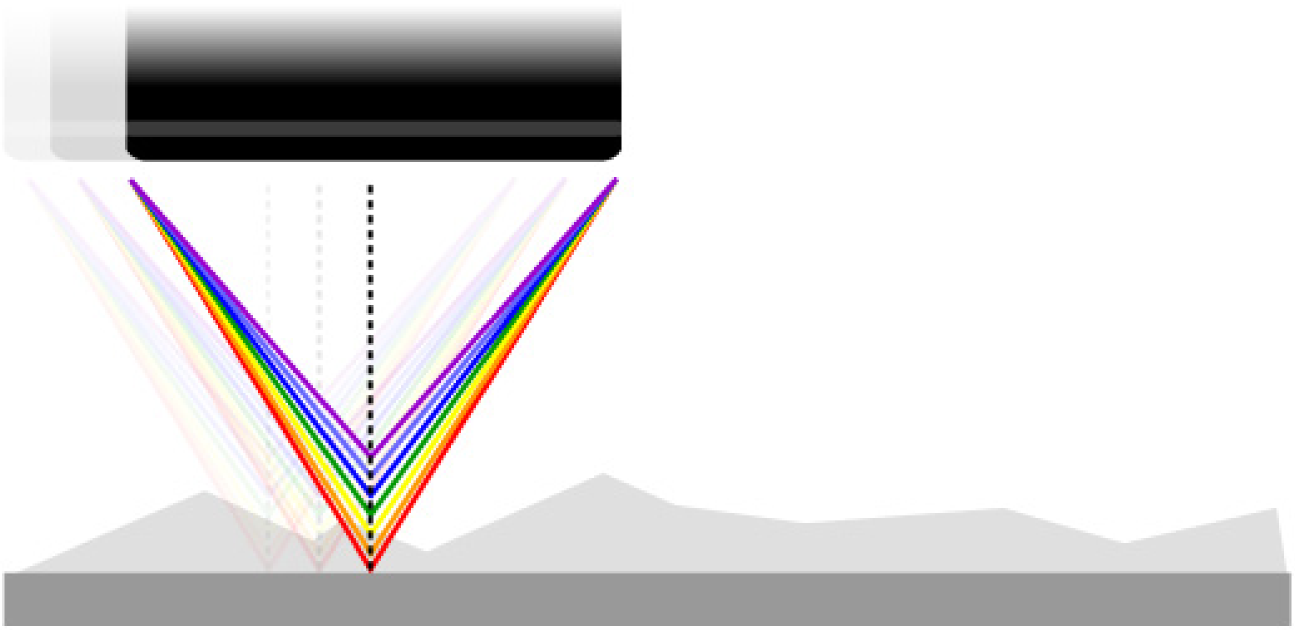
CONCLUSION:

From the two areas measured it has been shown that the surface texture is relatively consistent, especially when comparing average and rms roughness, skewness, and kurtosis. The average and rms values suggest a consistent smooth surface, while the skewness and kurtosis suggest that the flatness and height distributions are similar. This vital information may prove otherwise when compared to intended parameters. It is for this very reason that such information is crucial to quality control. Additionally, this information would be beneficial when conversely studying wear and coefficient of friction parameters.

The high angle measurement ability by the Nanovea ST400 is highlighted with this particular application. Several modifications can be made based on the intended use: a 360° rational stage, AFM, larger and or faster stages and online or inline capability.

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.