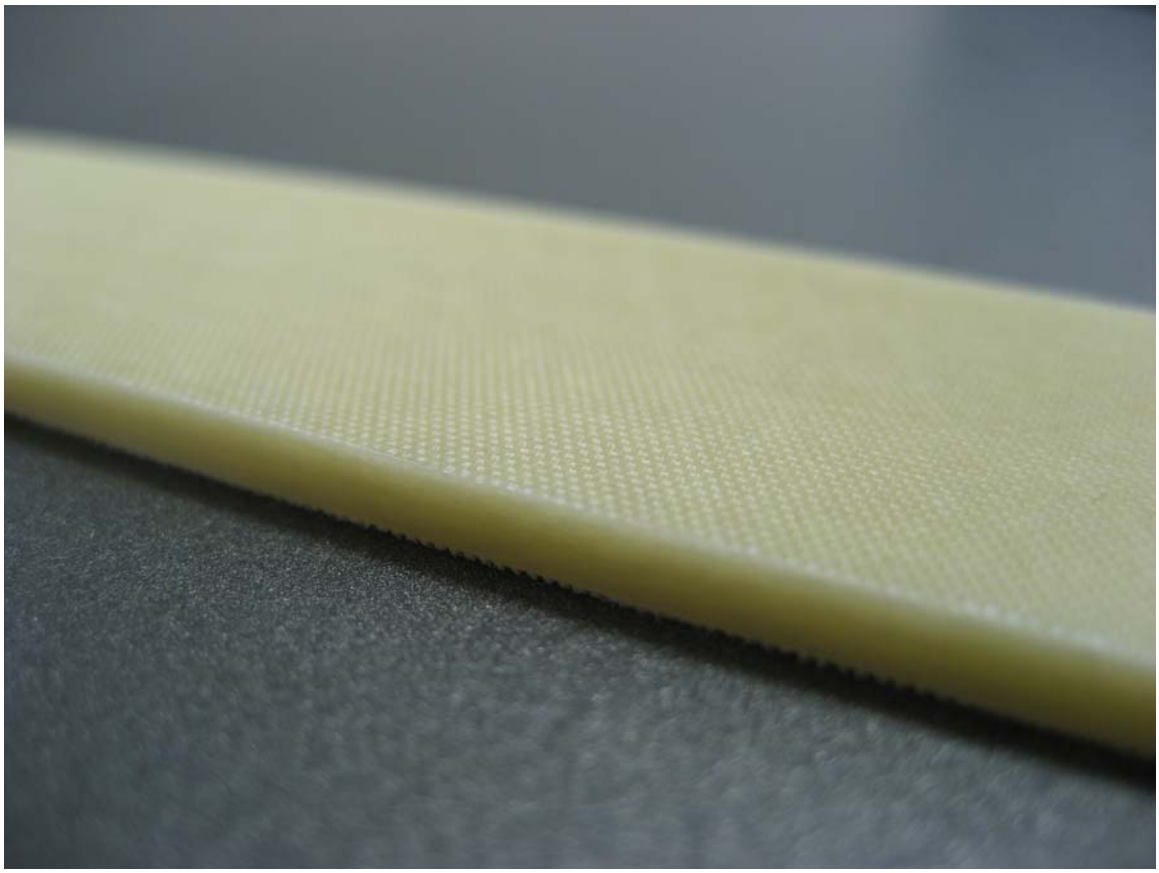
NANOVEA®
A Better Measure.

FIBERGLASS SURFACE TOPOGRAPHY USING 3D PROFILOMETRY



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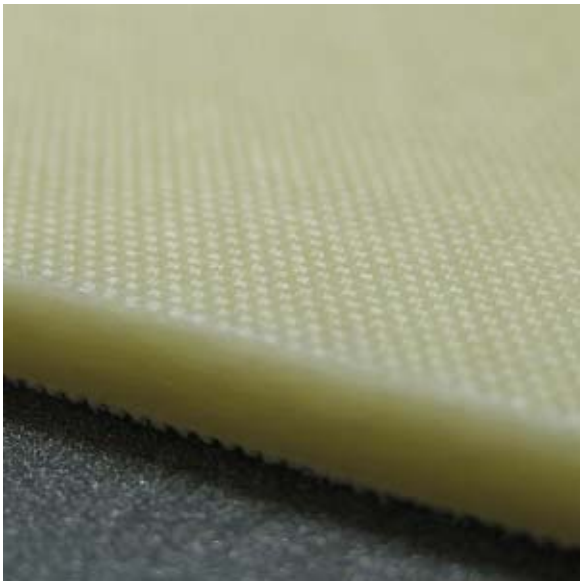
INTRO:

Fiberglass, (also called fibreglass and glass fibre), is material made from extremely fine fibers of glass. It is used as a reinforcing agent for many polymer products; the resulting composite material, properly known as fiber-reinforced polymer (FRP) or glass-reinforced plastic (GRP), is called "fiberglass" in popular usage.

IMPORTANCE OF SURFACE METROLOGY INSPECTION FOR QUALITY CONTROL

Although there are many uses for Fiberglass reinforcement, in most applications it is crucial that they are as strong as possible. Fiberglass composites have one of the highest strength to weight ratios available and in some cases, pound for pound it is stronger than steel. It is also important to have as little of exposed surface area as possible. Increased surface can make them more vulnerable to chemical attack and possibly material expansion. Therefore, surface inspection is critical to quality control production.

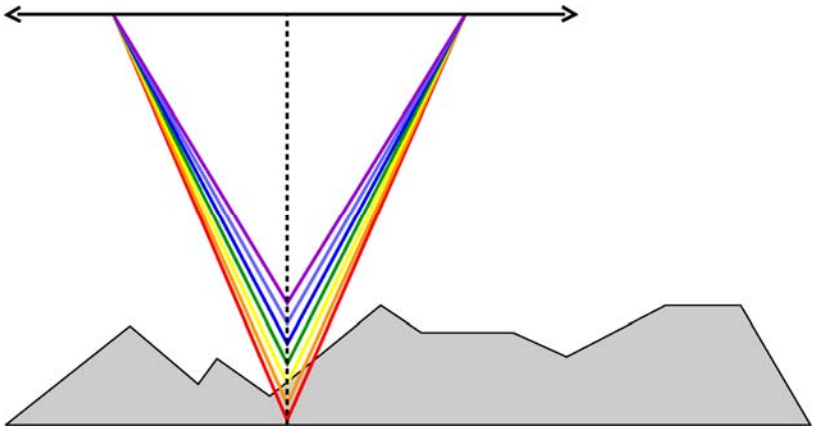


MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure a Fiberglass Composite surface for roughness and flatness. With improved roughness and flatness, it is possible to create and insure a stronger, longer lasting fiberglass composite material.

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.

If the sample is composed of several transparent or semitransparent thin layers, each interface between adjacent layers will reflect the light of a different wavelength, and the spectrum of detected lights will be composed of a series of spectral peaks. The chromatic aberration technique allows all interfaces to be detected and their positions to be measured simultaneously.

Probe Specifications

Measurement Range	1.2mm
Z Resolution (nm)	25
Z Accuracy (nm)	200
Lateral Resolution (µm)	2

Measurement Parameters

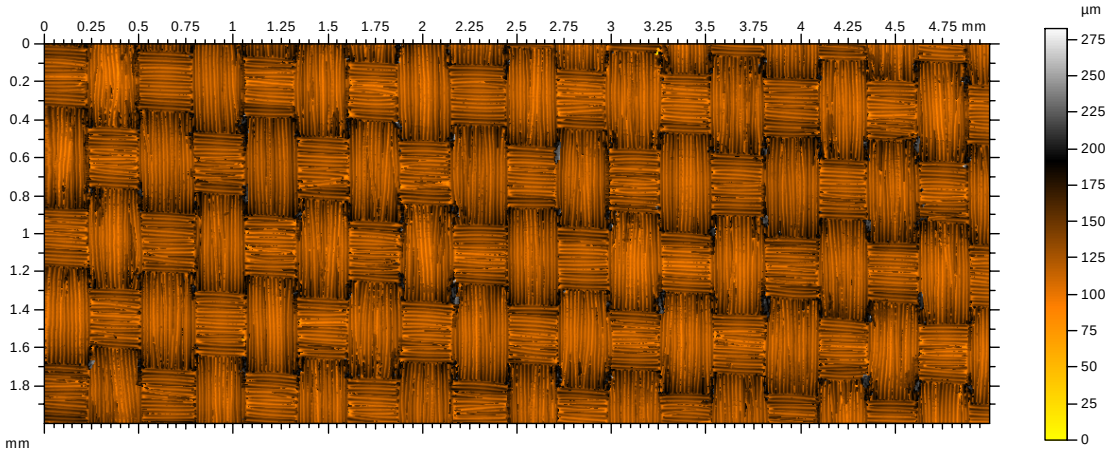
Probe	1.2mm
Acquisition rate	30 Hz
Averaging	1
Measured surface	5mm x 2mm
Step size	5µm x 5µm
Scanning Mode	Constant speed

Procedures

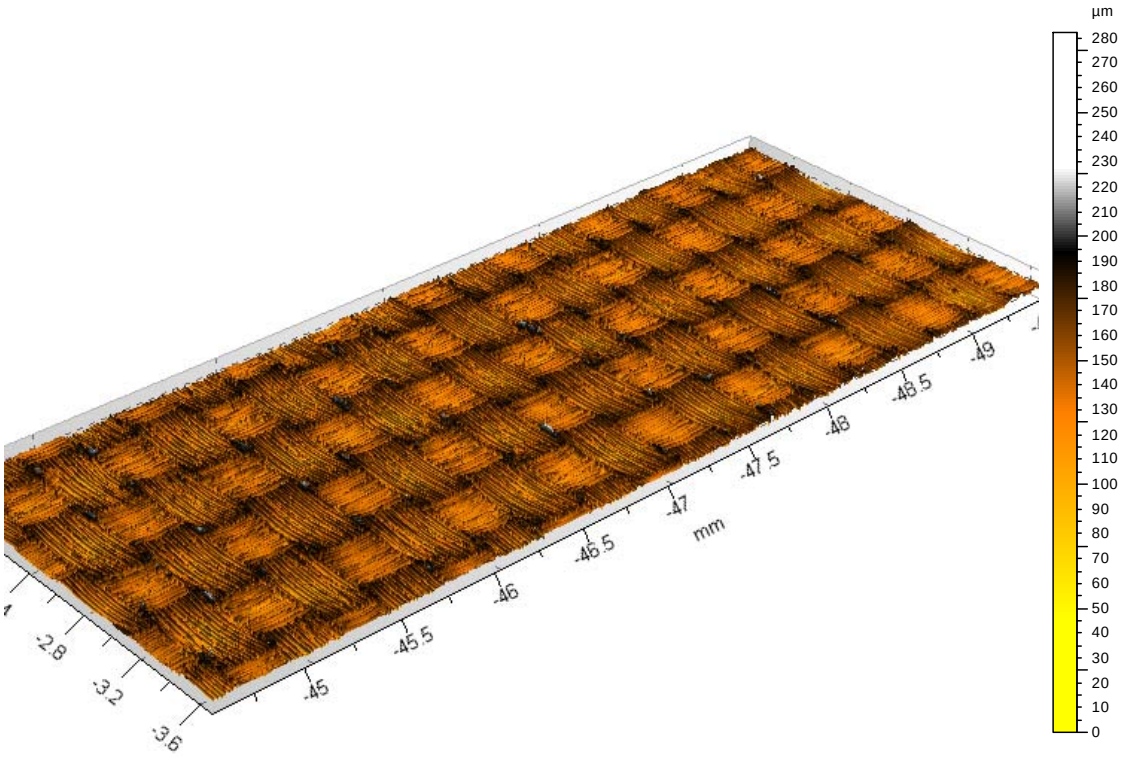
> Surface threshold
> Surface points filled in
> Surface leveled
> Roughness calculated
> 3D surface generated

Results

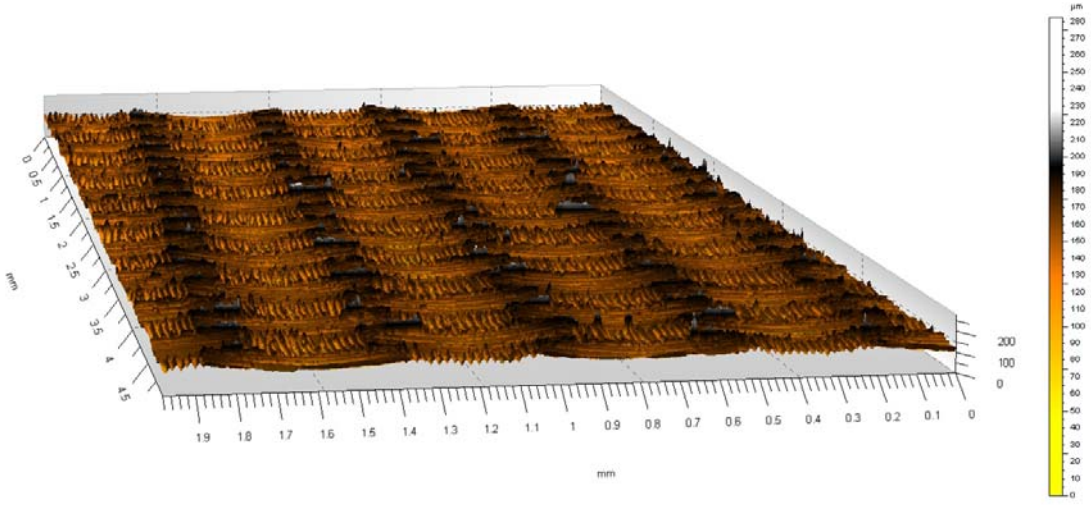
False Color Height Representation



3D Surface Roughness



3D Surface Flatness



Roughness Results

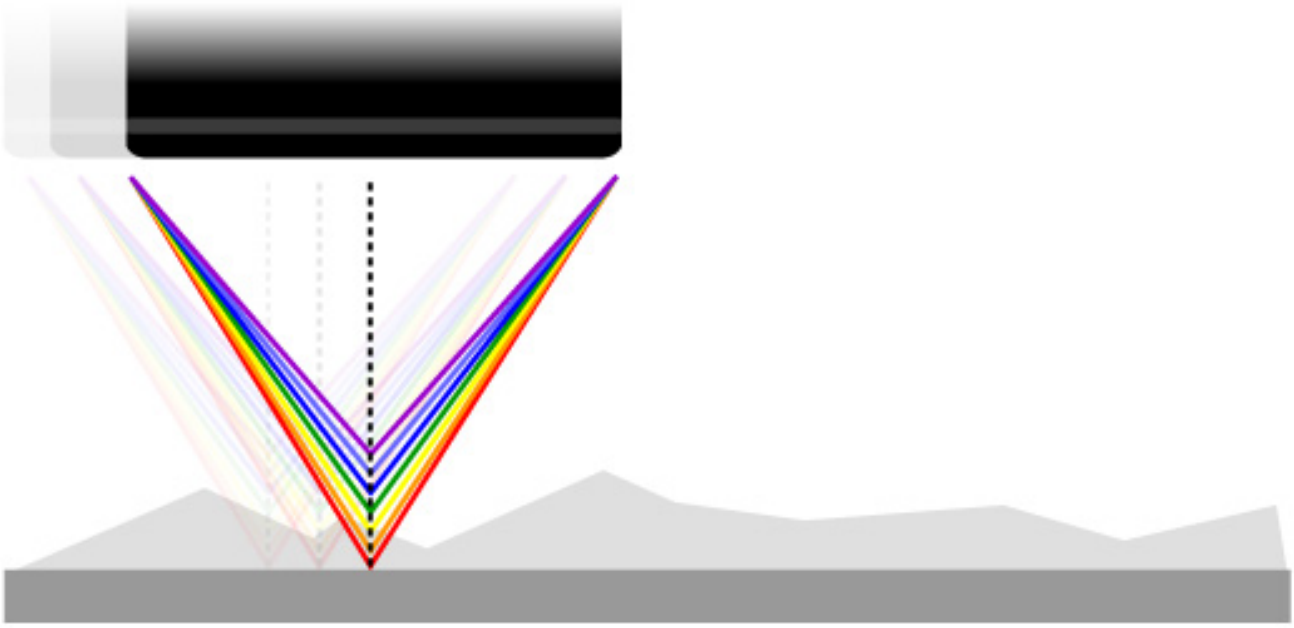
Sa	15.716 µm	*Arithmetical Mean Height*
Sq	19.905 µm	*Root Mean Square Height*
Sp	116.74 µm	*Maximum Peak Height*
Sv	136.09 µm	*Maximum Pit Height*
Sz	252.83 µm	*Maximum Height*
Ssk	0.556	*Skewness*
Sku	3.654	*Kurtosis*

CONCLUSION:

As shown in the data above, is it clear that the ST400 Profilometer was able to accurately measure the roughness and flatness of the fiberglass composite surface. Data can measured over multiple batches of fiber composites and or a given time period to provide crucial information about the different manufacturing processes and how they react over time. Thus, the ST400 is a viable option for strengthening the quality control process of fiberglass composite materials.

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.