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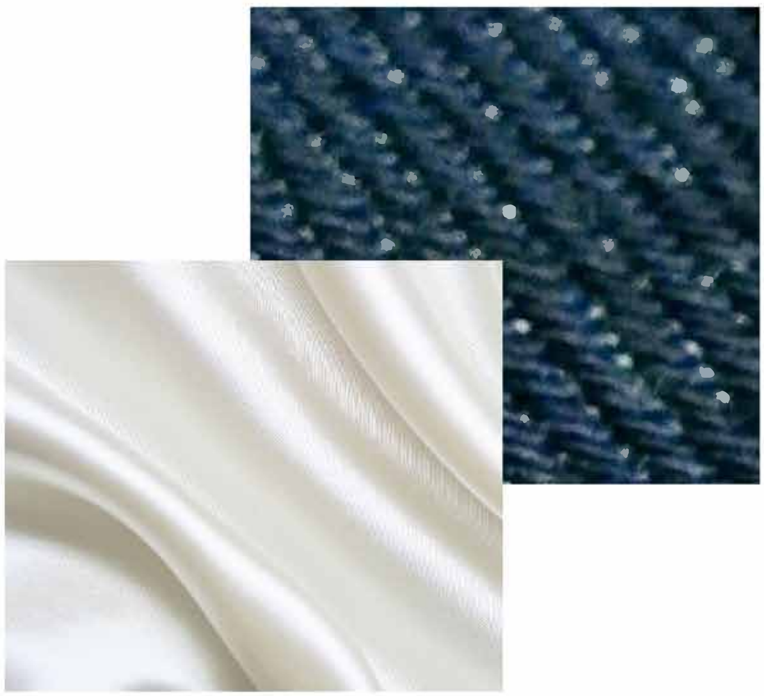
A Better Measure.

TEXTILE TEXTURE MEASUREMENT USING 3D PROFILOMETRY



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INTRODUCTION

Textiles go through a series of manufacturing process and physical and chemical treatments to obtain desired functional properties. For example, cotton experiences purification, preliminary process, coloration, and mechanical/chemical finishing to develop its full textile potential. Roughness and texture of the fabric surface play an important role in its end use, such as the appearance, performance and feel. Special functional fabrics for outdoor clothing are treated to be waterproof and yet breathable.

IMPORTANCE OF SURFACE TEXTURE MEASUREMENT FOR FABRICS

A better understanding of the surface texture, consistency, patterns of the fabrics allows the best selection of processing and control measures. Traditional stylus-based profilometers determine the surface morphology of the coatings by sliding in contact across the measured surface, which may deform the soft fabric and induce inaccurate measurement. The Nanovea 3D Non-Contact Profilometers utilize chromatic confocal technology with unmatched capability to provide a comprehensive analysis of the surface feature of fabrics, making it an ideal tool for reliable product inspection and quality control.

MEASUREMENT OBJECTIVE

The surface texture of two fabrics, namely silk and denim, were measured and compared using Nanovea ST400 optical profilometer. We would like to showcase the capability of Nanovea optical profilometer in the comprehensive study of the textiles for different applications.

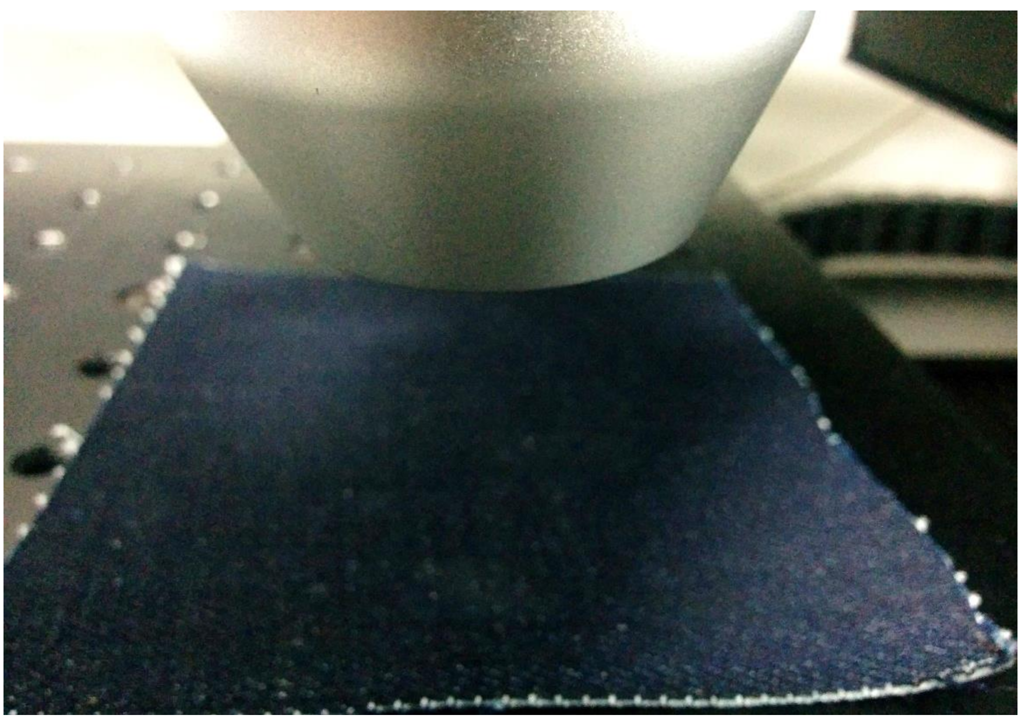


Fig. 1: Non-contact optical pen on the denim sample.

RESULTS AND DISCUSSION

Silk fibers have a thickness of 5 to 10 µm and a smooth soft texture. Being one of the strongest natural fibers, silk is an ideal material for lightweight fabrics that provides a smooth and luxurious finish. In comparison, denim jeans were originally designed for cowboys and miners due to the durability and strength of the denim fabric. It is woven in a twill manner to form a slanting textured fabric surface.

The 2D and 3D View of the silk and denim samples are compared in Fig. 2 and Fig. 3, respectively. Fig. 4 shows the false color view and statistics of the silk and denim samples. The silk fabric sample shows a much smoother surface with fine threads. The Abbott-Firestone curve shows that the height variation of the silk sample is around 70 µm, leading to a low surface roughness S_a of ~17 µm. In comparison, the denim sample exhibits a much coarser texture. The directional floating set of thick yarns are designed to absorb the abrasion. Even if wear and tear takes place on the floating yarns, there are more yarns underneath that keep the strength of the fabric. The surface height variation of the denim sample is ~350 µm and the roughness S_a is 58 µm.

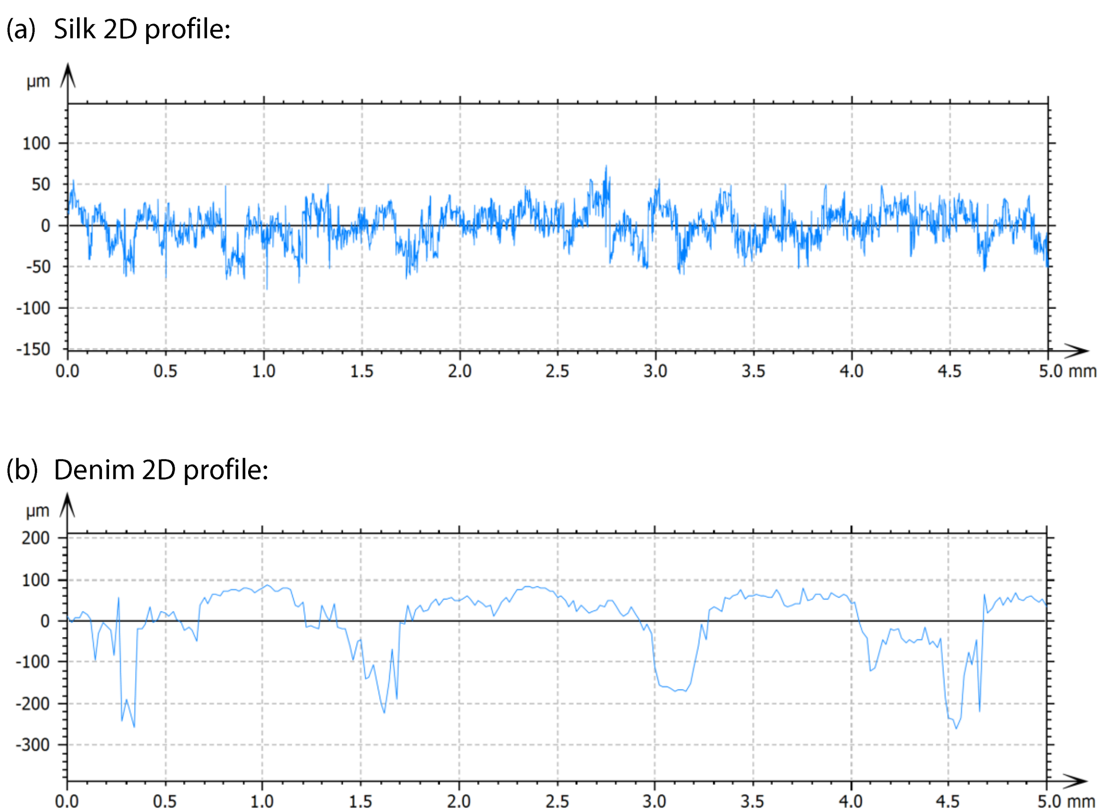
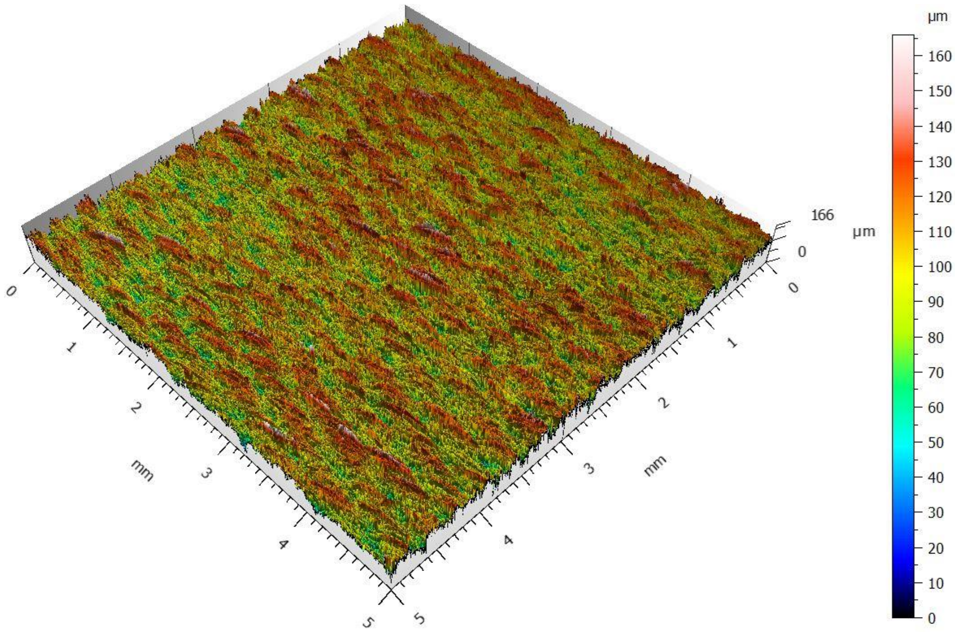


Fig. 2: 2D profiles of the silk and denim samples.

(a) 3D View of the silk sample:



(b) 3D View of the denim sample:

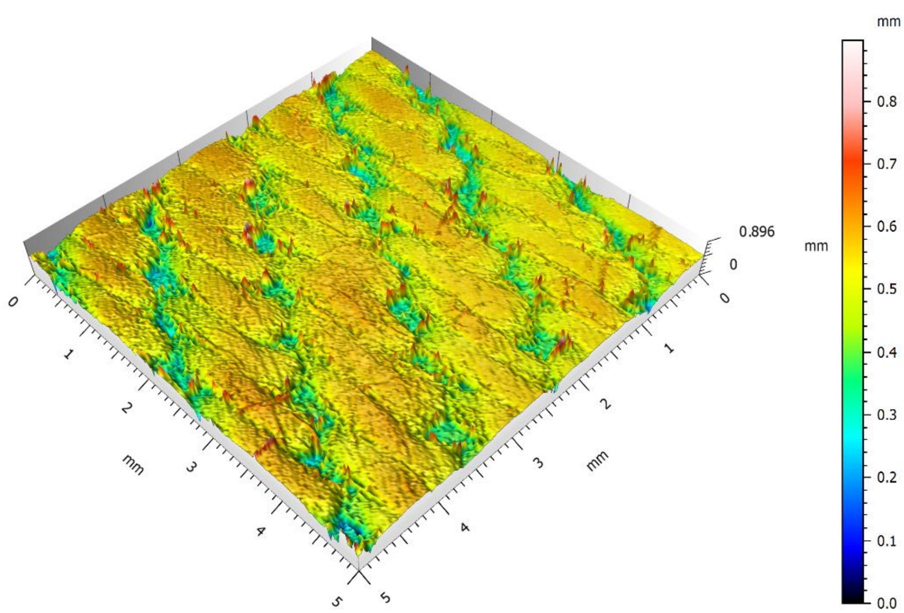
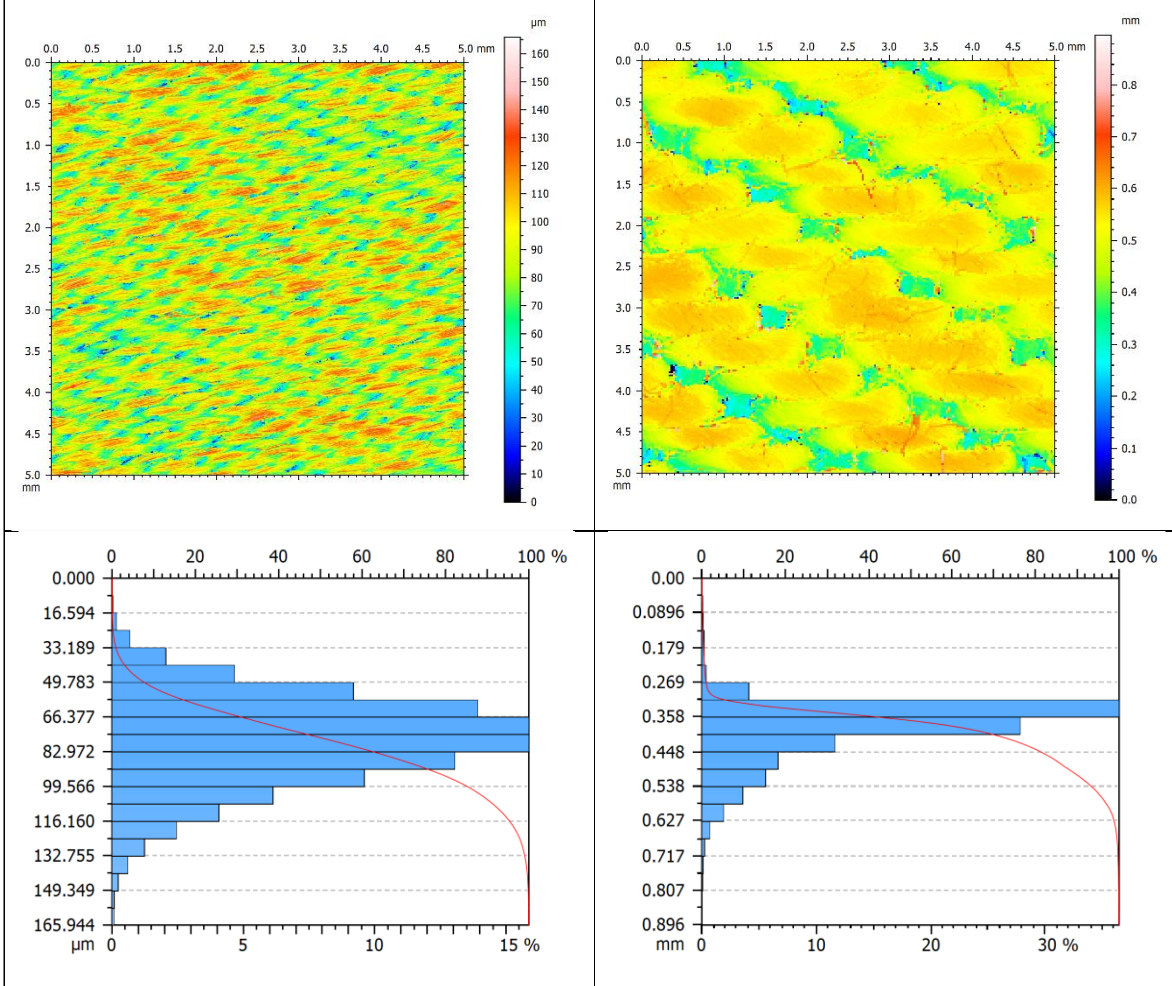


Fig. 3: 3D views of the silk and denim samples.

(a) Silk: **(b) Denim:**



(a) Silk:

ISO 25178			
Height Parameters			
Sq	21.1	µm	*Root-mean-square height*
Ssk	-0.382		*Skewness*
Sku	3.27		*Kurtosis*
Sp	77.9	µm	*Maximum peak height*
Sv	88.1	µm	*Maximum pit height*
Sz	166	µm	*Maximum height*
Sa	16.7	µm	*Arithmetic mean height*

(b) Denim:

ISO 25178			
Height Parameters			
Sq	0.0793	mm	*Root-mean-square height*
Ssk	-1.26		*Skewness*
Sku	6.12		*Kurtosis*
Sp	0.392	mm	*Maximum peak height*
Sv	0.504	mm	*Maximum pit height*
Sz	0.896	mm	*Maximum height*
Sa	0.0587	mm	*Arithmetic mean height*

Fig. 4: False color view and statistics of the silk and denim samples.

CONCLUSION

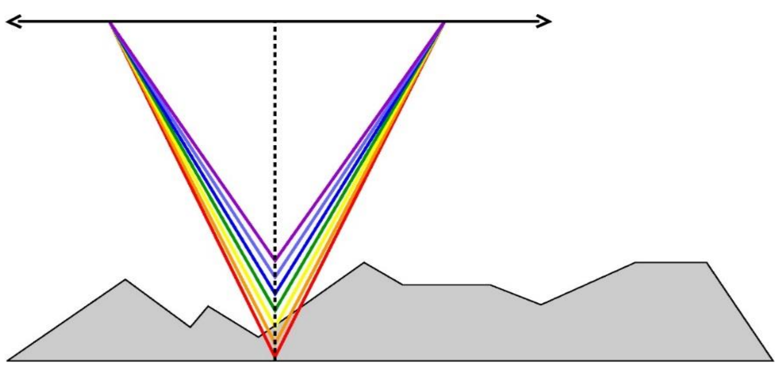
The surface texture of the silk and denim samples are compared using Nanovea ST400 non-contact profilometer. We would like to showcase that this measurement provides a useful tool in both development phases and quality control of the fabrics to improve the look, performance, or feel of the finish textile or clothing. The analysis software provides measurements such as 3D view, roughness, directional texture and many other options, enabling users to have a comprehensive understanding of the fabric surface texture.

The data shown here represents only a portion of the calculations available in the analysis software. Nanovea Profilometers measure virtually any surface in fields including Semiconductor, Microelectronics, Solar, Fiber Optics, Automotive, Aerospace, Metallurgy, Machining, Coatings, Pharmaceutical, Biomedical, Environmental and many others.

Learn more about the Nanovea Profilometer or Lab Services

APPENDIX: 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.



Chromatic Confocal White Light Measurement

Unlike the errors caused by probe contact or the manipulative Interferometry technique, White light Axial Chromatism 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.