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HONEYCOMB PANEL SURFACE FINISH

USING

HIGH SPEED 3D PROFILOMETRY

Prepared by

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Introduction

The honeycomb structure is widely used in the aerospace industry due to its minimal density and relative high strength. It can be made of various types of materials such as aluminum, fiber glass and advanced composites for aircraft and rocket applications. The surface texture, roughness, and porosity of the honeycomb panel plays an important role in its quality and paintability. Honeycomb panel surfaces, with optimal homogeneous textures, provide improved strength and adhesive failure resistance for protective paints. They also enhance corrosion and wear resistance and mitigate the cosmetic effects of the honeycomb panel layer.

Importance of 3D Profilometry for Honeycomb Panel Inspection

Roughness, porosity, and texture of the honeycomb panel surface are critical to quantify for the final panel design. These surface qualities can directly correlate to the aesthetics and functional characteristics of the panel surface. A better understanding of the surface texture and porosity can help optimize the panel surface processing and manufacturability. A quantitative, precise, and reliable surface measurement of the honeycomb panel is needed to control surface parameters for application and painting requirements. The Nanovea 3D Non-Contact sensors utilize unique chromatic confocal technology capable of precisely measuring these panel surfaces.

MEASUREMENT OBJECTIVE

In this study, the Nanovea HS2000 platform equipped with a high-speed Line Sensor were used to measure and compare two honeycomb panels with different surface finishes. We showcase the Nanovea non-contact profilometer's ability to provide fast and precise 3D profiling measurements and comprehensive in-depth analysis of the surface finish.

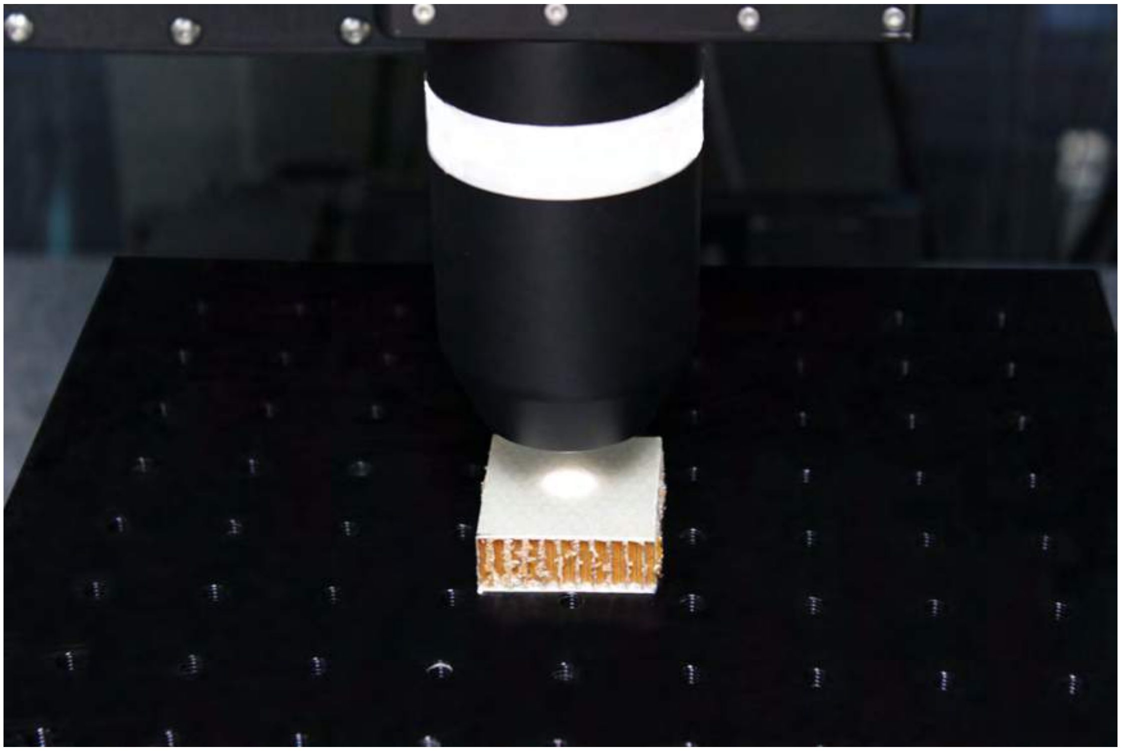


Figure 1: High-speed line sensor above a honeycomb panel sample.

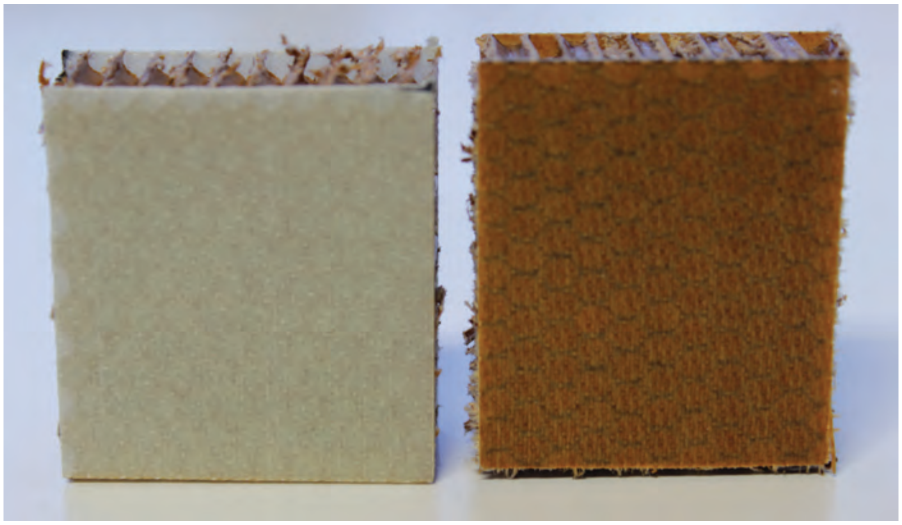


Figure 2: Honeycomb panel samples.

RESULTS AND DISCUSSION

The surface of two honeycomb panel samples with varied surface finishes, namely Sample 1 and Sample 2, were measured. The false color and 3D view of the Samples 1 and 2 surfaces are shown in **Figure 3** and **Figure 4**, respectively. The roughness and flatness values were calculated by advanced analysis software and are compared in **Table 1**. Sample 2 exhibits a more porous surface compared to Sample 1. As a result, Sample 2 possesses a higher roughness Sa of 14.7 µm, compared to an Sa value of 4.27 µm for Sample 1.

(a) (b)

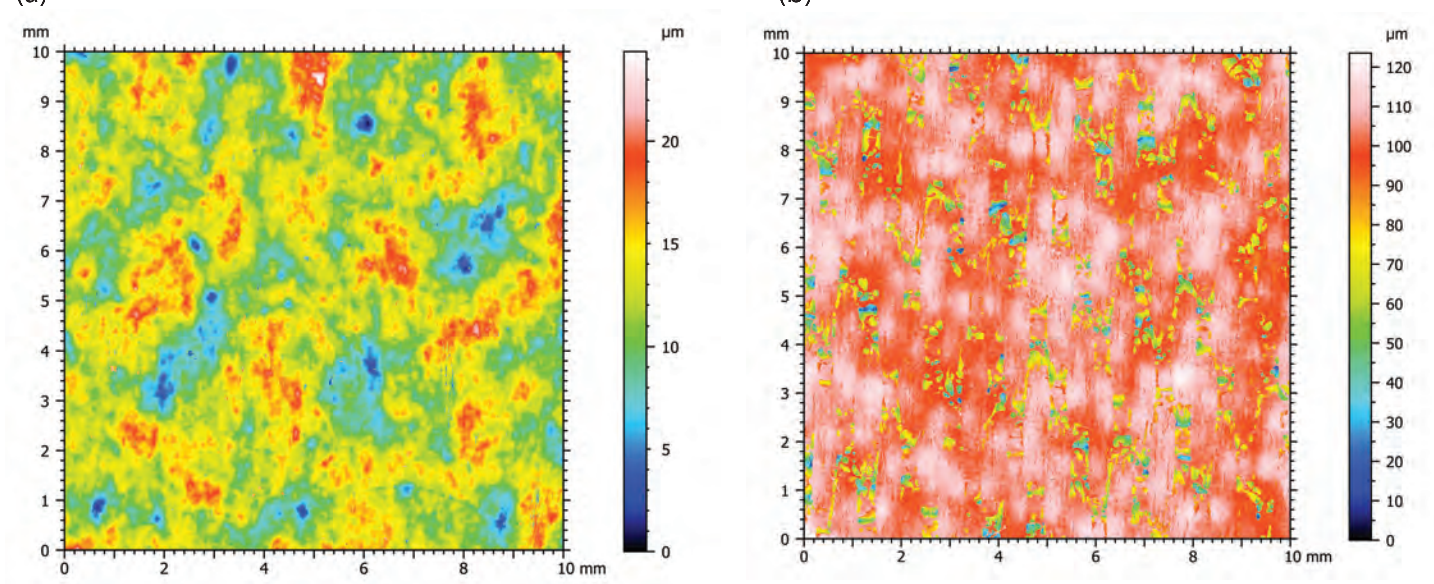
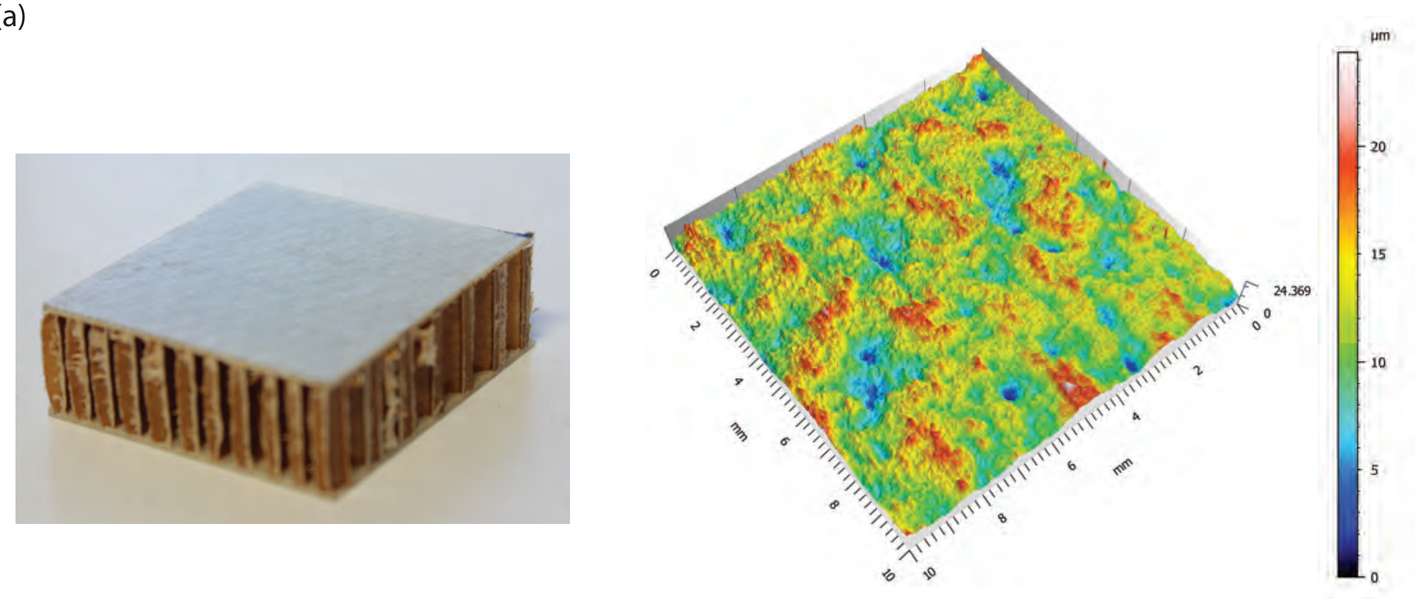


Figure 3: False color view of the honeycomb panel surfaces (a) Sample 1 and (b) Sample 2.

(a)



(b)

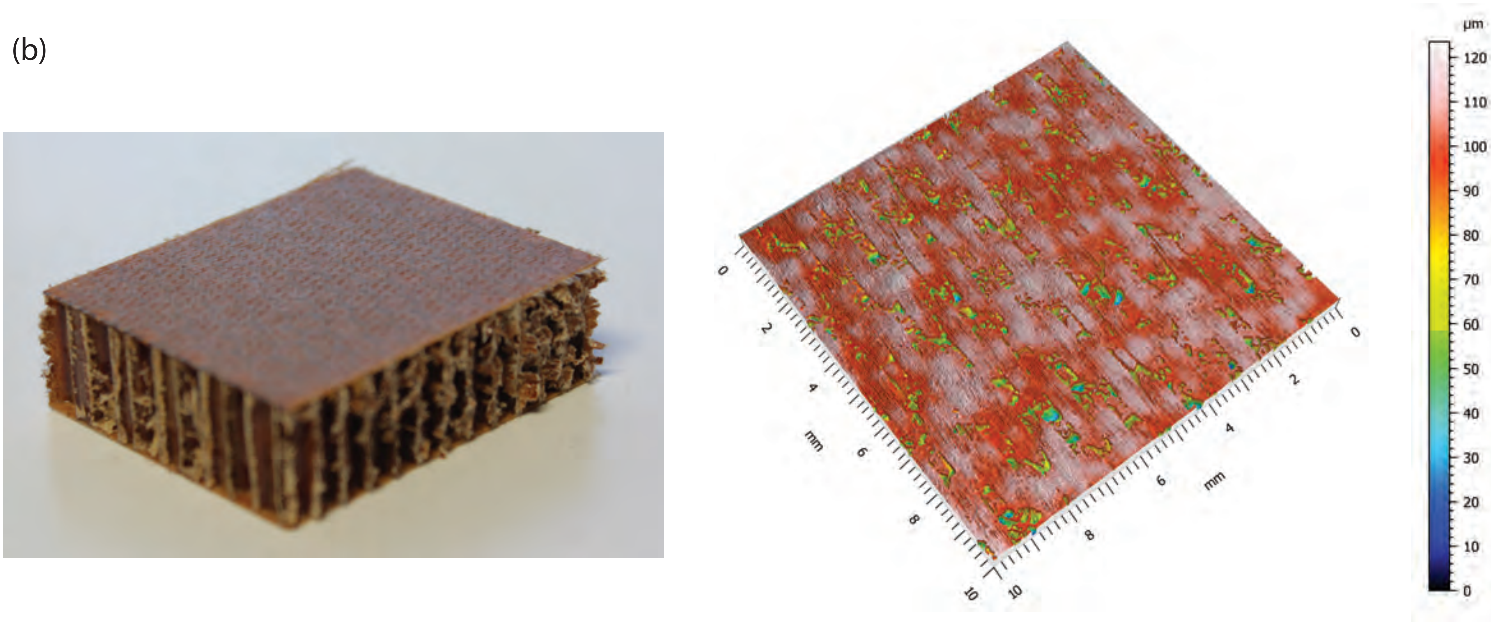


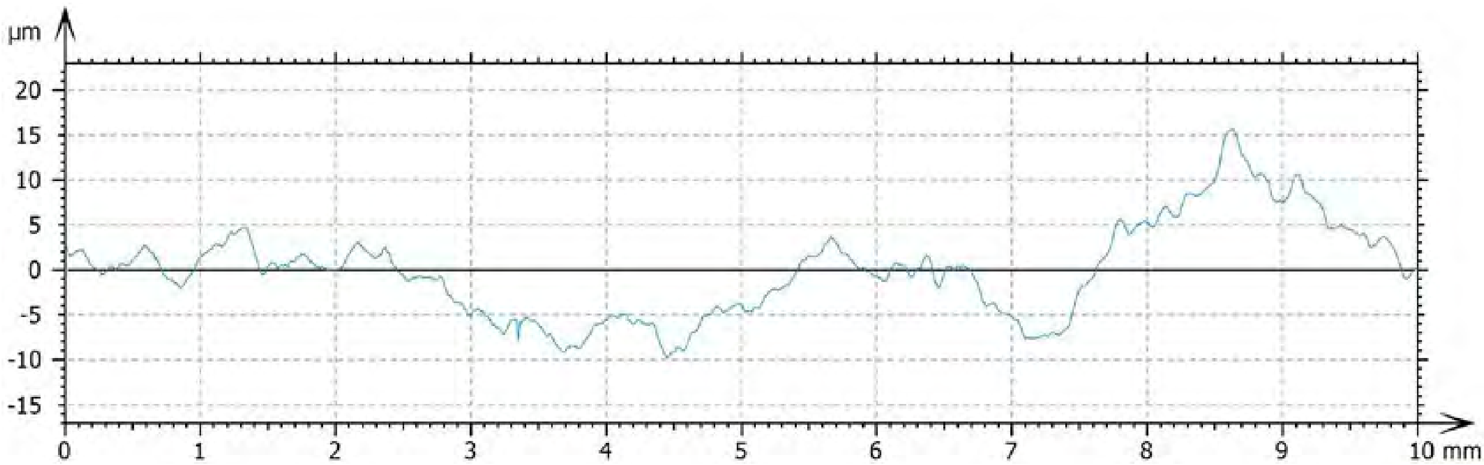
Figure 4: 3D view of the honeycomb panel surfaces (a) Sample 1 and (b) Sample 2.

		Sample 1	Sample 2	
ISO 25178: Roughness				
Sq	µm	4.96	21	Root-mean-square height
Sz	µm	0.288	230	Maximum height
Sa	µm	4.27	14.7	Arithmetic mean height
ISO 12781: Flatness				
FLTt	µm	28.1	73.5	Peak-to-valley flatness deviation of the surface
FLTp	µm	16.3	16.9	Peak-to-reference flatness deviation
FLTv	µm	11.8	56.6	Reference-to-valley flatness deviation
FLTq	µm	4.43	9.66	Root-mean-square flatness deviation

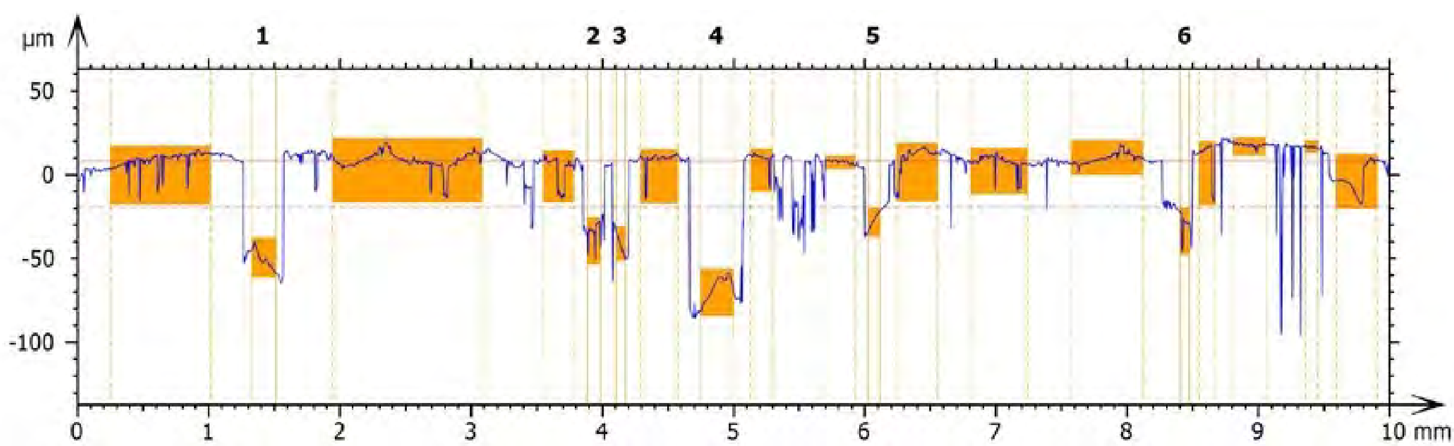
Table 1: The Roughness and Flatness values of the honeycomb panel surfaces.

The 2D profiles of the honeycomb panel surfaces were compared in **Figure 5**, allowing users to have a visual comparison of the height change at different locations of the sample surface. We can observe that Sample 1 has a height variation of ~25 µm between the highest peak and lowest valley location. On the other hand, Sample 2 shows several deep pores across the 2D profile. The advanced analysis software has the ability to automatically locate and measure the depth of six relatively deep pores as shown in the table of **Figure 4.b** Sample 2. The deepest pore amongst the six possesses a maximum depth of nearly 90 µm (Step 4).

(a) Sample 1



(a) Sample 2



Parameters	Unit	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6
Width	mm	0.185	0.100	0.070	0.255	0.090	0.075
Maximum depth	µm	67.1	59.3	57.2	89.9	42.7	53.8
Mean depth	µm	58.3	41.6	49.8	75.7	35.9	38.7

Figure 5: Cross section view of the honeycomb panel surfaces.

To further investigate the pore size and distribution of Sample 2, a porosity evaluation was performed and discussed in the following section. The sliced view is displayed in **Figure 6** and the results are summarized in **Table 2**. We can observe that the pores, marked in blue in **Figure 6**, have a relatively homogeneous distribution on the sample surface. The pores' projected area constitutes 18.9% of the whole sample surface. A cumulative pore volume of 0.06 mm^3 per mm^2, 42.2 μm average depth and 108.1 μm maximum depth were calculated.

Parameters	Unit	Void
Projected area	mm^2	18.9
Volume	$\mu m^3/mm^2$	6313393
Mean Depth	μm	42.2
Maximum Depth	μm	108.1

Table 2: Results summary of the porosity analysis.

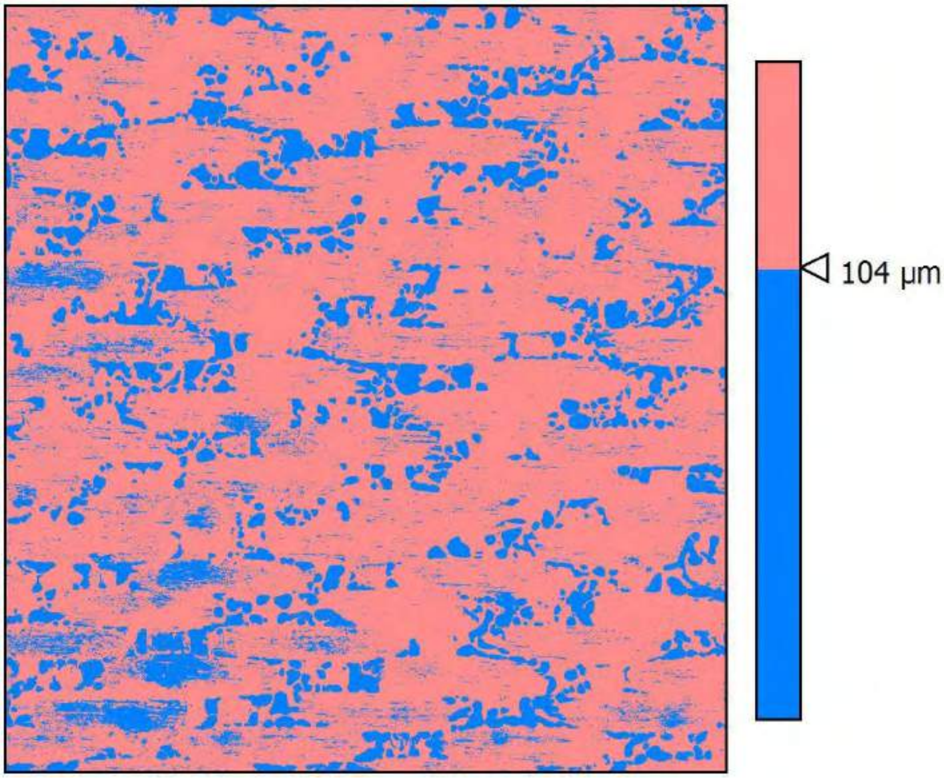


Figure 6: Porosity analysis.

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Conclusion

In this application, we have showcased that the Nanovea HS2000 platform equipped with a high-speed Line Sensor is an ideal tool for analyzing and comparing the surface finish of honeycomb panel samples in a fast and accurate manner. The high-resolution profilometry scans paired with an advanced analysis software allow for a comprehensive and quantitative evaluation of the surface finish of honeycomb panel samples.

The data shown here represents only a small portion of the calculations available in the analysis software. Nanovea Profilometers measure virtually any surface for a wide range of applications in the Semiconductor, Microelectronic, Solar, Fiber Optics, Automotive, Aerospace, Metallurgy, Machining, Coatings, Pharmaceutical, Biomedical, Environmental and many other industries.

Learn more about all the applications our Nanovea Profilometer offers.

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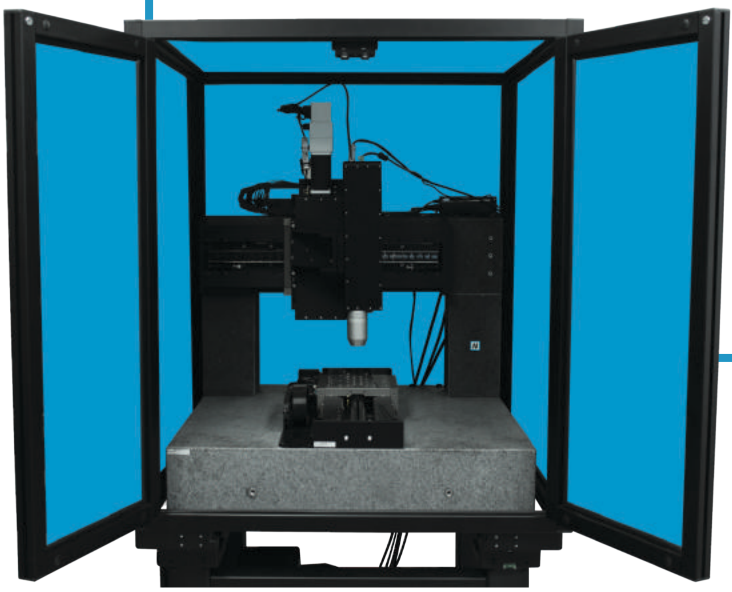
HS2000 Profiler



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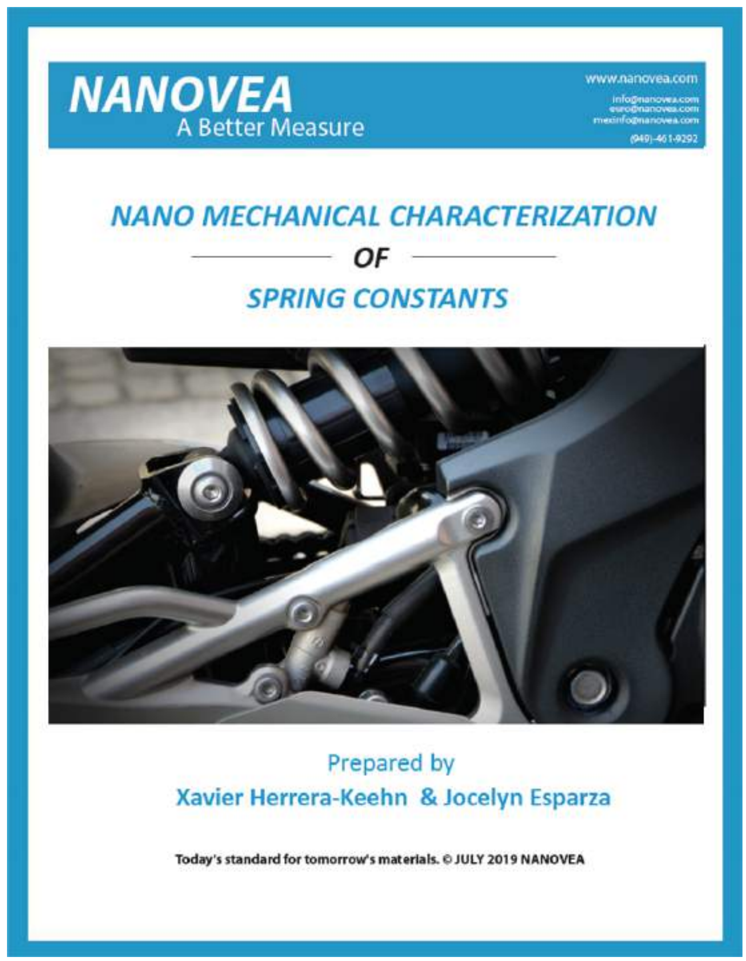
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