SCREEN FLATNESS MEASUREMENT
BY FAST 3D NON-CONTACT PROFILOMETRY

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INTRODUCTION

Flatness is an important geometric surface quality in the manufacture of precision parts and assemblies. Flatness of the surface plays a vital role in the end use of the product. For example, the parts that are connected in an air-tight or liquid-tight manner across a surface area require stringent surface conditions of superior flatness at the contact face. Flatness of the screen is critical to the functionality and aesthetics of electronic devices such as cellphones, pads and laptops. Any imperfection of the screen flatness can create negative user impression and experience of the product.

IMPORTANCE OF FAST 3D NON-CONTACT PROFILOMETRY

Mass production is the dominant form of screen manufacturing around the globe. It requires fast and precise measurement of the roughness and flatness on a large screen surface to ensure the narrowest tolerances in quality control. High resolution 3D scan can quickly detect and report any defects or imperfection of the screens created during the fabrication processes. Designed for stable high speed flatness measurement, the Nanovea HS2000 non-contact profilometer with its granite base and air bearing stages provides superior stability at high scanning speeds. In addition to the screens, virtually any kinds of surfaces fabricated from different materials such as metals, ceramics, plastics and glasses can be measured in a timely fashion, making it an ideal tool for surface inspection in production lines.

MEASUREMENT OBJECTIVE

In this application, we showcase that the Nanovea HS2000 High-Speed Profilometer equipped with an optical line sensor finishes a high-precision 3D surface flatness measurement of a large surface (350 mm × 250 mm).
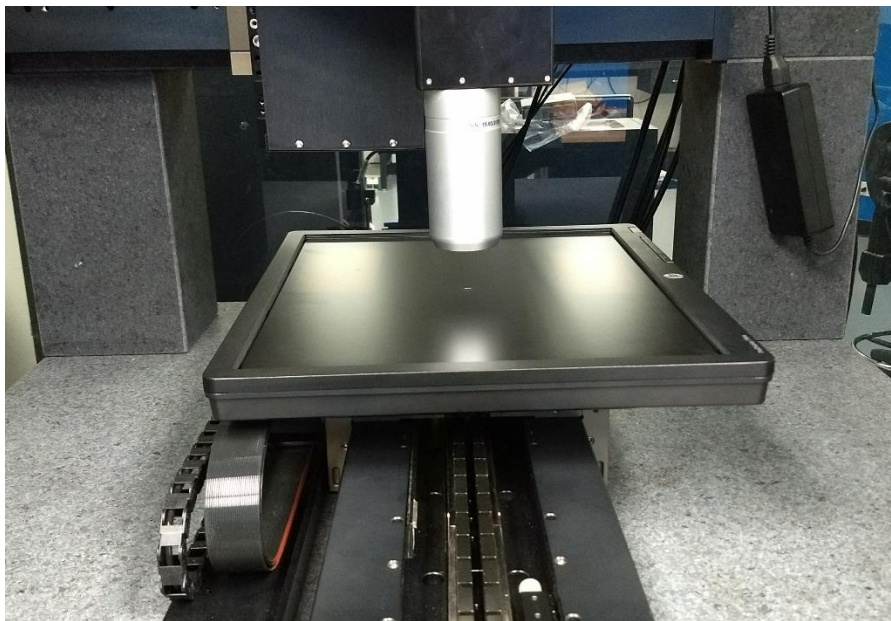

Figure 1: Optical line sensor scanning on the computer screen.

RESULTS AND DISCUSSION

As shown in Figure 1, the Nanovea HS2000 profilometer provides automated surface inspection at high speeds. The optical line sensor generates a bright line composed of 192 light spots that scan the sample surface at the same time. This significantly increases the scan speed and enables rapid 3D scan of a large area up to **400 mm × 700 mm**. Such a fast speed makes it possible to implement the Nanovea HS2000 3D profilometer for quality control of a large quantity of samples.

Figure 2 and Figure 3 show the False Color View and 3D View of the computer screen, respectively. The 3D View provides users an ideal tool to directly observe the surface morphology from different angles in detail and to evaluate the shape, flatness and roughness of the sample for the purpose of quality control. The computer screen possesses a slightly lower center and elevated edges in the diagonal direction. The height variation across the sample surface is as high as 600 μm. Table 1 lists the Roughness and Flatness values calculated by the analysis software based on the ISO 25178 and ISO 12781, respectively. Such values can be applied as reliable thresholds to determine the pass/fail criteria of the screen surface quality during the quality control process.

Using the powerful analysis software, we can easily obtain the 2D profiles at different locations across the screen as shown in Figure 4. It allows further investigation on the shape, flatness, texture and possible defects, e.g. cracks and scratches, of the screen.
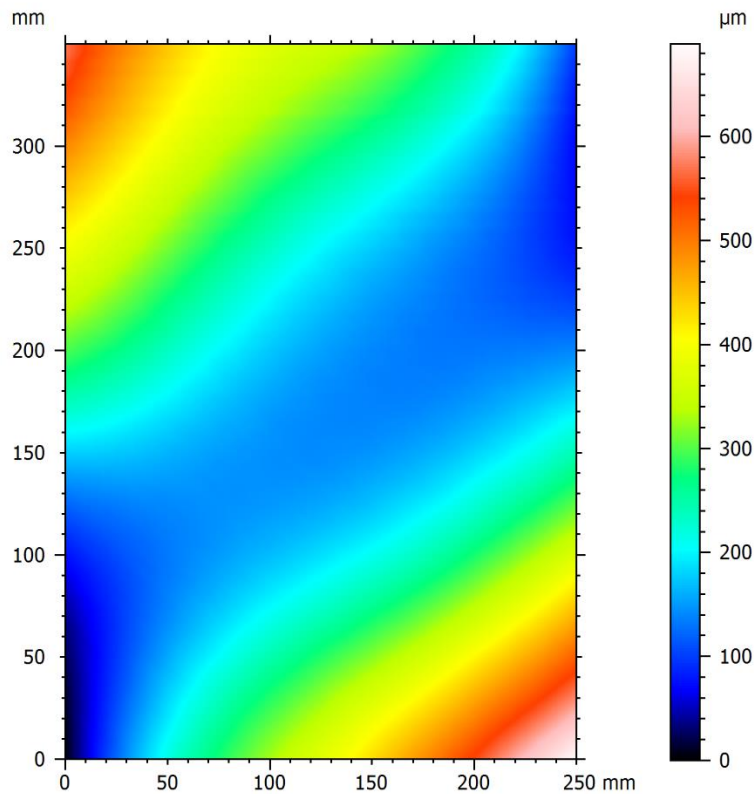

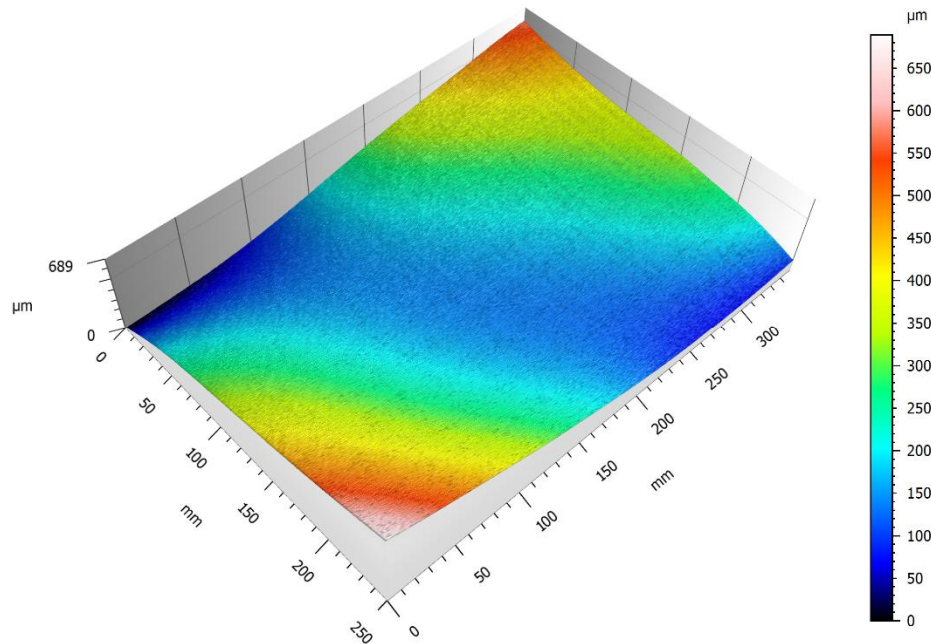**Figure 2: False color view of the computer screen.**

Figure 3: 3D view of the computer screen.

ISO 25178 Roughness			
Sq	1.02	µm	Root-mean-square height
Ssk	-0.102		Skewness
Sku	4.35		Kurtosis
Sa	0.807	µm	Arithmetic mean height
ISO 12781 Flatness			
FLTt	679	µm	Peak-to-valley flatness deviation of the surface
FLTp	444	µm	Peak-to-reference flatness deviation
FLTv	235	µm	Reference-to-valley flatness deviation
FLTq	115	µm	Root-mean-square flatness deviation

Table 1: Roughness and Flatness of the computer screen.
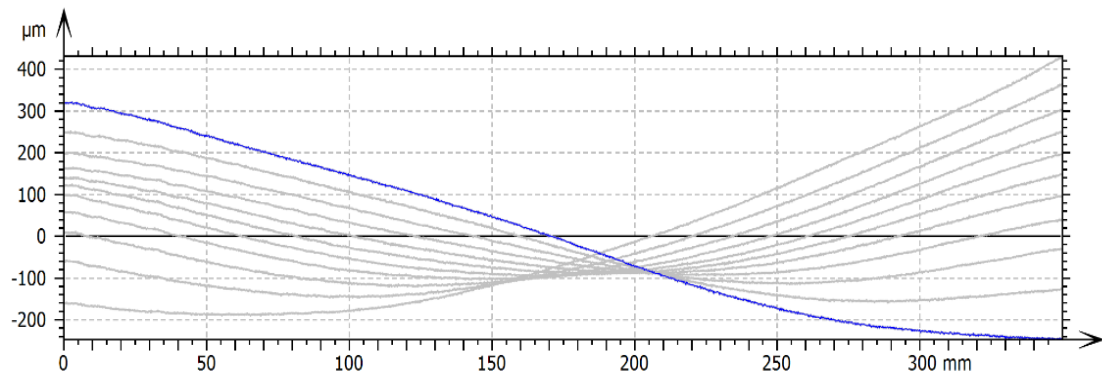

Figure 4: 2D surface profiles across the computer screen.

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CONCLUSION

In this application, we showcase the Nanovea HS2000 3D Non-Contact Profilometer equipped with an optical line sensor. High resolution scan for large surfaces as done in this study provides both roughness and flatness information in a few minutes. Moreover, HS2000 can measure flatness of samples as large as 400mm×700mm in seconds with sub-micro accuracy. The axial chromatism technique allows measuring the sample surface at very high speeds without touching, making it possible and simple to implement the Nanovea profilometer in the production line so as to monitor the surface quality in situ.

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: 3D non-contact profilometer PRINCIPLE

The Chromatic Confocal technique uses a white light source (LED) that passes through a series of lenses, called an optical pen, which has a high degree of chromatic aberration. The refractive index of the lenses will vary the focal distance of each wavelength of the white light. In effect, each separate wavelength of the white light will focus at a different distance from the optical pen, creating the measurement range. When a surface of interest is within the measurement range a single wavelength of the white light will be in focus while all others will be out of focus. The white light is then reflected back through the optical pen, then through a pin hole filter that allows only the focused wavelength to pass through to a CCD spectrometer. The CCD will indicate the wavelength in focus, which corresponds to a specific distance for a single point.

• Physical Wavelength Measured + No Algorithms Needed for Results = Higher Accuracy.
• Level of accuracy independent of form, roughness level, illumination and measurement speed.
• No special leveling procedure required.
• Most claim very high resolutions. Nanovea provides high accuracy.
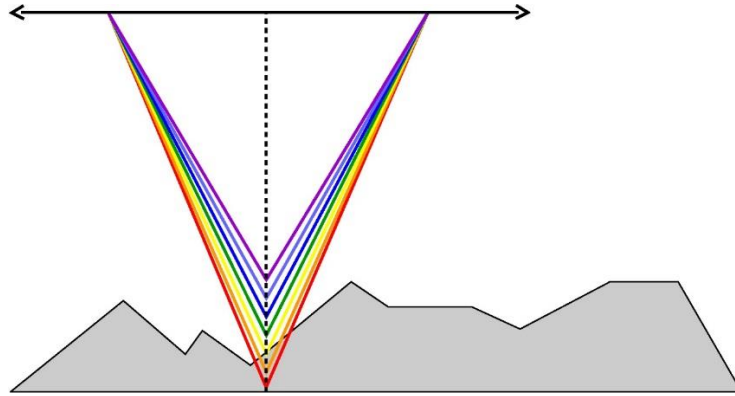
CHROMATIC CONFOCAL MEASUREMENT

Chromatic Confocal by design ensures the highest accuracy of all optical techniques. Specifically when measuring surfaces that are geometrically complex (randomly rough surfaces). Other techniques are subject to many error sources that are simultaneously present and it is not possible to remove or compensate for them or even to estimate their combined influences. The Profilometers offer high accuracy across the widest range of materials and surfaces conditions including tissues, biomaterials, polymers, plastics, metals, composites and ceramics. Examples of particularly demanding applications where Chromatic Confocal performs better than any techniques includes: corrosion pits, textured surfaces such as paper towel and sand paper, scratches and wear tracks, angular tooling parts and many more.