

SENSOFAR®

PIμ 2300 Optical Imaging Profiler

Flat Panel Display
RGB Color Filter Inspection



Introduction

Sensofar's PL μ 2300 is an Optical Imaging Profiler for three-dimensional measurements of surfaces. The optical technology is based on Confocal profiling and Interferometry, covering a wide range of spectrum, from very low magnification and large field of view, to the highest available microscope magnification. Interferometry allows to measure with low magnification with PSI, achieving 0.1 nm resolution and 0.01 nm repeatability, while confocal is capable to use high numerical aperture objectives, being capable to measure optical surfaces with local slopes up to 70.

One of the key elements of Flat Panel Display industry is the RGB color filter array. Such arrays are manufactured on glass and used to filter the color information present on the image of the display. Many non-contact measurements on the surface of the glass are needed: filter height characterization, photo-spacer characterization and defect analysis. PL μ 2300 is able to perform measures on the RGB color filter array in manual, semiautomatic and totally automatic modes. For manual and semiautomatic measurements, the SensoMAP software is used for analysis, while for completely automatic working, the system is equipped with SensoPRO.

Step Height RGB filter characterization

Height of the filters is characterized with a low magnification objective. The field of view is up to 5 mm with 1 nm z resolution and measuring time of few seconds. The height is characterized statistically over hundreds of individual filters.

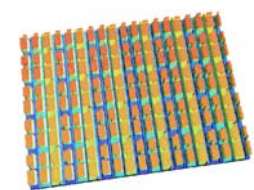
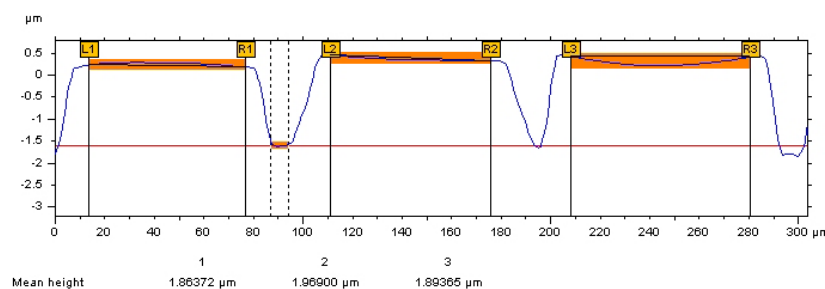
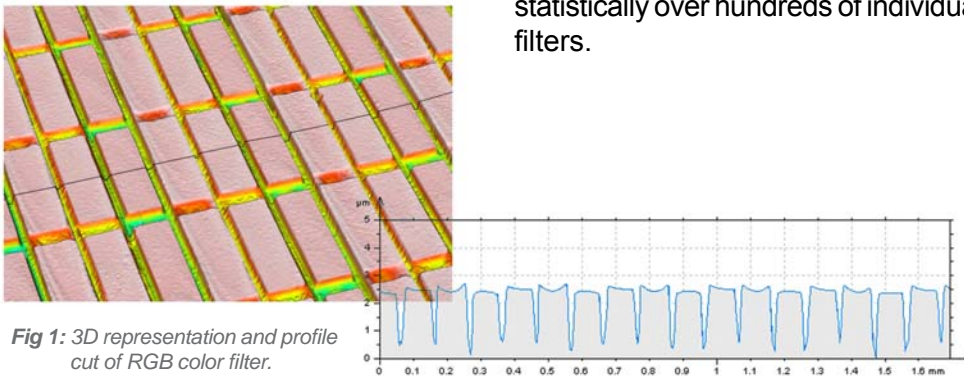


Photo-spacers

Photo-spacers are used to align and separate the RGB color filter glass and the light modulation device (LCD, TFT...). With the SensoMAP or

from the rest of the surface.

In comparison to single point scanning profilers (like chromatic confocal,

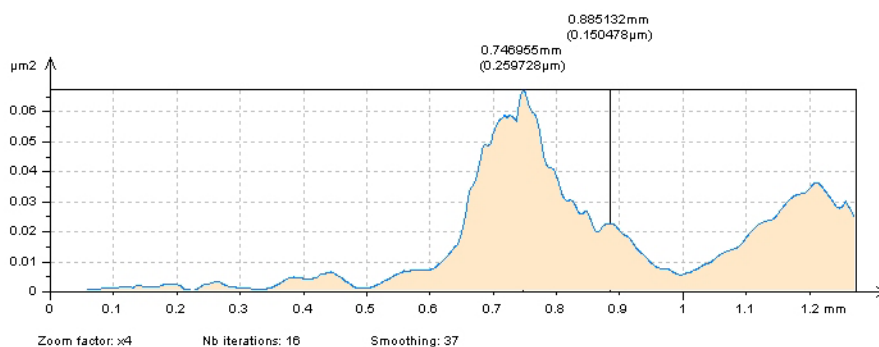


Fig 3: Power spectrum density of the bump isolated 3D topography. Mean photo-spacer distance: 0.745 mm.

SensoPRO software it is possible to characterize the XY position, presence or absence, height and diameter of each photo-spacer.

For the photo-spacer recognition, an advanced analysis based on thresholding and 3D binarization is used to isolate each one of the bumps

triangulation, or AFM), Confocal and Interferential Optical profilers are based on imaging technology. This means that measurements are performed in few seconds for all pixels of the CCD camera. For photo-spacers presence and position determination, a 5X or 10X objective is used, with FOV of several mm. VSI

technology allows the measurement of such large FOV with nm repeatability and less than 5 seconds measuring time.

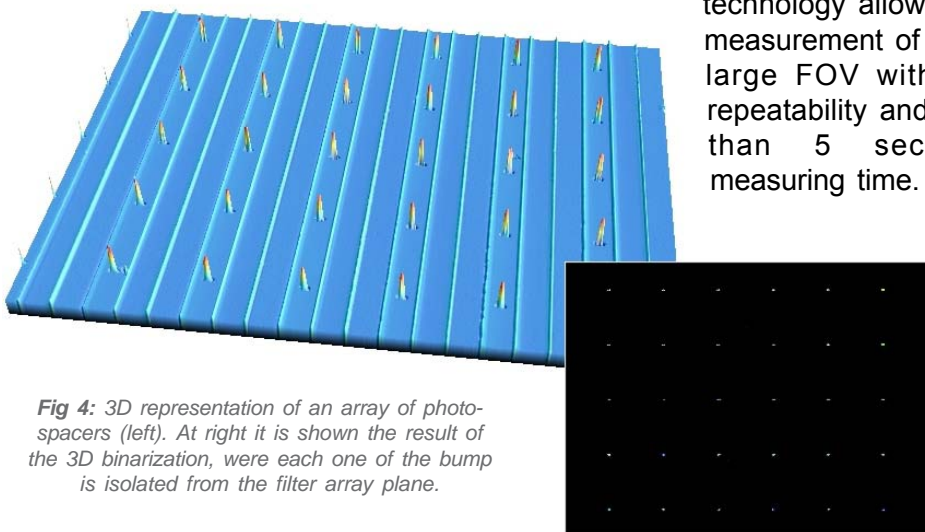


Fig 4: 3D representation of an array of photo-spacers (left). At right it is shown the result of the 3D binarization, where each one of the bump is isolated from the filter array plane.

Photo-spacer tip shape and roughness can also be characterized.

For high resolution profiling of the tip, a high magnification objective is used (usually a 50X objective, but a 100X and 150X can give an extremely close image of the tip).

The most relevant shape parameters that are evaluated are the radius of curvature, aspheric components on the tip, height, roundness, perimeter, area, form factor, aspect ratio, compacticity and orientation.

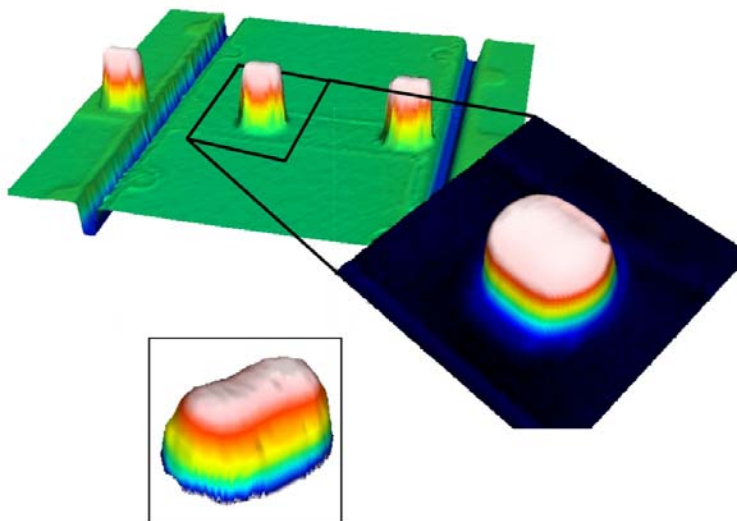


Fig 5: 3D representation of a photo-spacer measured with a high magnification objective.

Roughness evaluation is achieved through a filtering process that isolates the shape components of the tip from the high frequency details. This is done through a standard filtering process described by the ISO 11562. All roughness, Area and Volume, spatial parameters, flatness and Hybrid parameters are calculated according to the ISO, DIN, CNOMO or JIS normatives.

Area	0.1218 mm ²
Perimeter	1.3635 mm
Diameter	0.3938 mm
Form Factor	0.8235
Aspect Ratio	1.8075
Roughness	0.5669
Orientation	0.47 °

Sa	16.2 nm
Sq	22.9 nm
Sz	300.3 nm

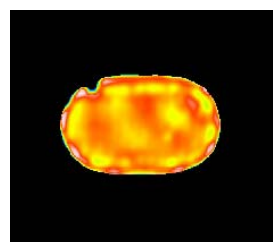


Fig 6: Tip of the photo-spacer after roughness filtering.

Defect analysis

High and low magnification optics are used to identify and subsequently measure defects on the surface of the RGB color filter array. During the manufacturing process, a 2D imaging system inspects the surface at high speed looking for defects. Such defects (called MURA) can lower the transmission of the light, and even make the filter not to work properly. The 2D machine is not able to recognize a simple dust particle, and refuse an expensive component that could be easily repaired. The addition of a 3D non-contact profiler after 2D inspection gives the information about the shape of the defect. If the defect is just above the surface, it can be repaired. If the defect is under the surface, or even modifying the shape

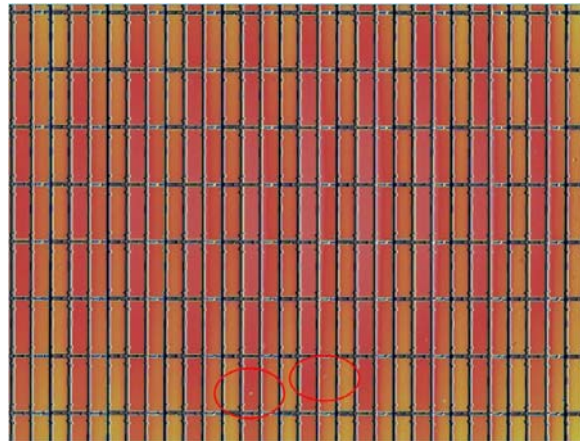


Fig 7: 3D measurement for defect analysis inspection. Area: 3.4 x 2.5 mm². Note the two red encircled details. The left is a MURA defect consisting of a hole, while the right is a deposited particle.

of the filter, it could mean that the filter is destroyed, and thus is not usable. Appropriate 3D information on height, area and volume of a defect can be used assess whether this is affecting the overall performance of the filter.

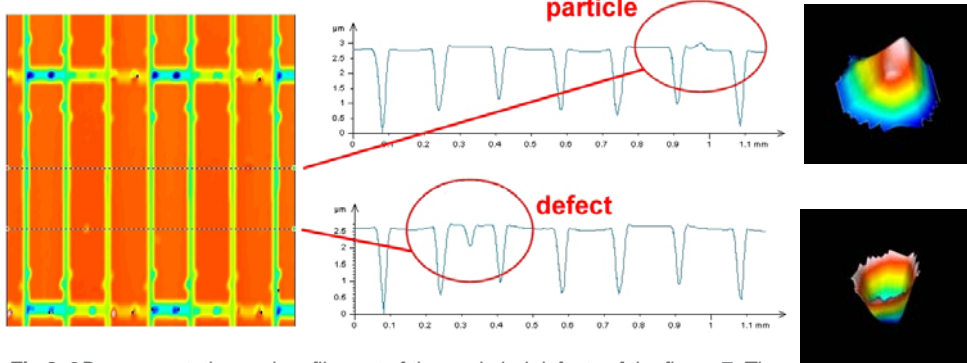


Fig 8: 2D representation and profiles cut of the encircled defects of the figure 7. The top defect is a deposited particle, while the bottom defect is a hole. Both defects were subtracted and isolated from the 3D information through an advanced thresholding and 3D binarization and subsequent feature sorting. The 3D representation of the particle and the hole are shown at right.

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