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Measurements with 3D Non-contact optical profilometry

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Abstract

The simple method to 3D mapping of micro surfaces, without any question we use a 3D Optical Profiler. Quite aside from the -fashioned stylus-profilers (a competent 3D Optical Profiler, for instance, typically acquires a full 3D image in about 30seconds and is very fast and easy to set up for each run) there is a host of other serious benefits, such as true colour imaging and the ability to cover height measurement ranges from subnanometre to millimetres .

Keywords: 3D Non contact optical Profiler, Z-Dot Technology

1. Introduction

In Traditional microscopes have a very limited depth of focus. Test surfaces and features are clearly visible only when they are within the focal depth**.** Finally, a form of optical microscope which turns the depth of focus, formerly a limitation, into an advantage and uses it to determine the height of the sample at each and every x,y position on the sample surface (figure 1). This method and the simplicity of microscope optics lends itself to extraordinary versatility. For instance, it is possible to integrate functionality such as Thin Film Measurement by means of reflectometry. It is also possible to integrate Nomarski Differential Interference Contrast to map roughness on scales muchsmaller than 1 nm (figure 2). Furthermore, it is possible to integrate interferometry in some 3D Optical Profilers in order to push the height resolution even further (figure 3).Images of adjacent areas of sample can be automatically and sequentially acquired and stitched together to 3D-map large areas of sample with extremely high resolution. Additionally, an AFM can also be integrated into the system such that the benefits of the 3D Optical Profiling can be seamlessly coupled to AFM profiling (where the tip is locatable within the optical Field of View).

2. Experimental technique

Fig.1 Zeta 20 Optical Profiler

We used Zeta Instruments Inc., USA, Zeta-20 optical profilometer for measurements of various surfaces.Zeta has come up with an invention which enables a focal variation instrument (sometimes known as 'infinite focus') to measure hitherto impossible surfaces. Up until this innovation, a fundamental flaw of the focal variation class of instrument (despite its great advantages) had been that it requires 'something to focus on': that is, the surface under examination required features on which the optics could 'autofocus'. Without such 'native contrast', a focal variation instrument was unable to determine the height of the surface at each and every point.

3. Results and Discussion

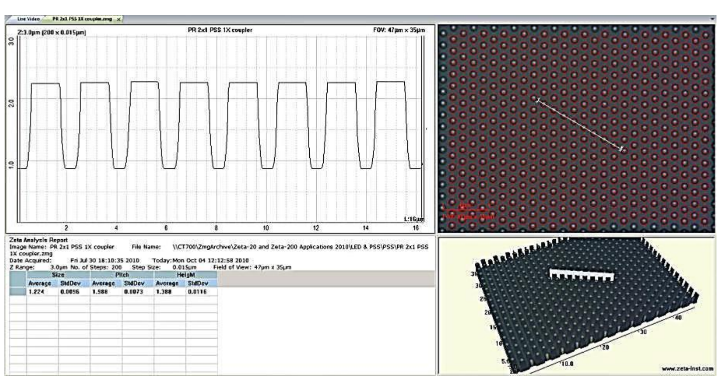


Fig.2.Measurement of PSS Bumps using AFM+Zeta Optical Profiler

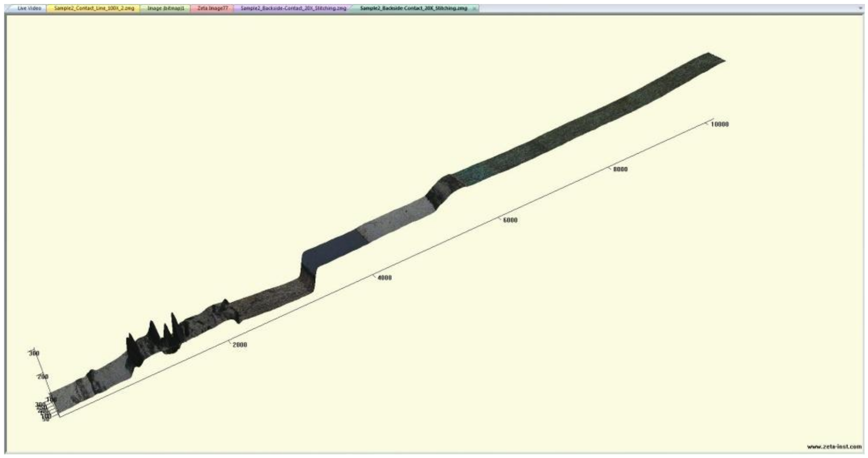
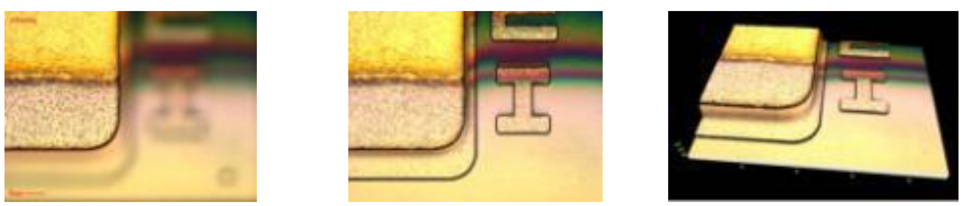


Fig.3.Measurement of backside contact

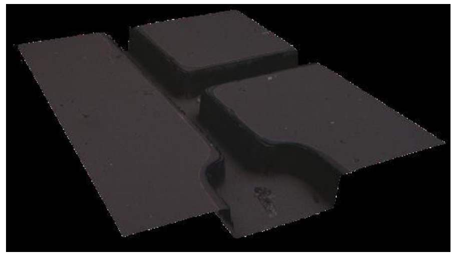
Typical examples of very common samples which presented this difficulty include optically polished surfaces, or fractured metal surfaces. The method patented by the Zeta Instruments Inc. (for which they coin the term ‘Z-Dot’) actually generates local contrast on the surface where no native sample contrast exists. In this way,it is trivially easy to accurately measure hitherto impossible surfaces, Figure 4, optical flats and metals which have areas of high polish. The most featureless smooth and polished surfaces are 3D mapped unambiguously.



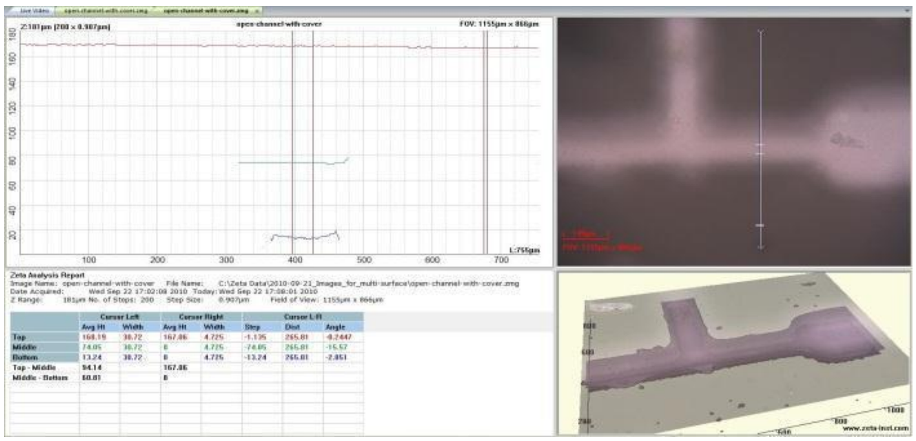
(a) **(b)** **(c)**

Fig.4 (a) Conventional Microscope Image (b) Zeta Digital Image (c) Zeta 3D View

Perhaps one of the most impressive examples of the utility of this feature is the ability of the ZDots to measure the internal dimensions of different surfaces of a sealed micro fluidics device.The instrument is now able to measure each of the transparent surfaces by selecting it and differentiating it from the others (seefigure 5). Of course, given that the internal dimensions of microfluidics cells change upon sealing, that ability to measure the internal dimensions of a sealed cell is proving of critical interest to companies such as IntegenX and others which develop microfluidics devices. Another example of a measurement which is enabled by the use of ZDots is the ability to measure microneedles (see for instance the paper on 3D maps of micro needlearrays by Prof. Y. Makino et al).



(a)



(b)

Fig.5 **(a) 3D-mapping an open micro fluidics ,(b) 3D mapping a sealed micro fluidics cell**

Once it is required to 3D map features of only a few nanometers height then a piezo stage can be used to enhance the Ztranslation capability: yet the optics can still map down to this level with no problem. For instance it is always required toaccurately check the 3D profiles of LED PSS bumps (as in “Light Emitting Diode Patterned Sapphire Substrate”), where arrays of these bumps are manufactured on exactly such a demanding (figure.5)

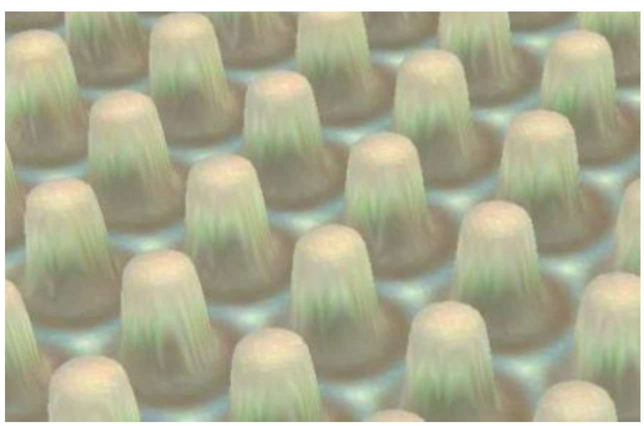


Fig.5. Measurement of PSS Bumps Using Zeta 20 3D Optical Profiler

In summary, 3D Optical Profiling, Imaging and Metrology functionalities, which have so far been mutually exclusive in an instrument can now be combined in one instrument, and recent innovations enable the measurement of hitherto difficult or impossible surfaces.

4. Conclusions

Zeta-20 non contactr Profiler integrates **five powerful optical metrology technologies in one configurable and easy-to-use system**. It images and analyzes different size features on samples of all types: **smooth to rough, very low to very high reflectivity, transparent to opaque, single layer to multilayer, sub-nm to mm**

Acknowledgement

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