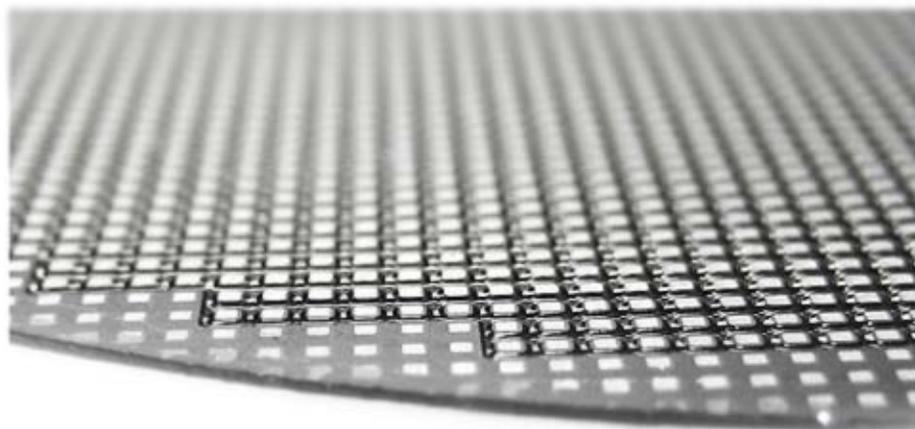


**WAFER ARRAY FLATNESS MEASUREMENT
USING 3D PROFILOMETRY**



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INTRO:

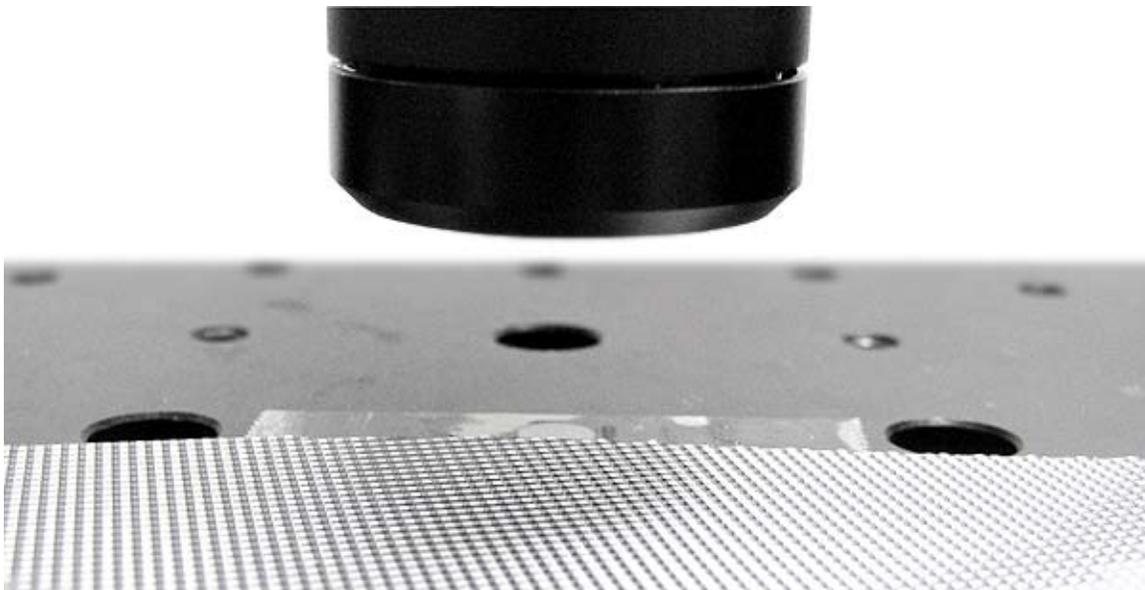
A critical factor which can dramatically affect the quality of wafer arrays is the flatness to adjoining components. The components of the wafer are typically intended to lie in an array pattern. If any component is not flat or planar relative to its neighboring components, it may become overly compressed or stressed, while neighboring components do not make proper contact.

IMPORTANCE OF 3D NON CONTACT PROFILOMETER FOR WAFER ARRAY STUDY

Unlike other techniques such as stylus or interferometry, the 3D Non Contact Profilometer, using axial chromatism, can measure nearly any surface, sample sizes can vary widely due to open staging and there is no sample preparation needed. Nano through macro range is obtained during surface profile measurement with zero influence from sample reflectivity or absorption, has advanced ability to measure high surface angles and there is no software manipulation of results. Measure any material: transparent, opaque, specular, diffusive, polished, rough etc. The technique of the Non Contact Profilometer provides an ideal, broad and user friendly capability to maximize wafer array measurement; with the benefits of combined 2D & 3D capability.

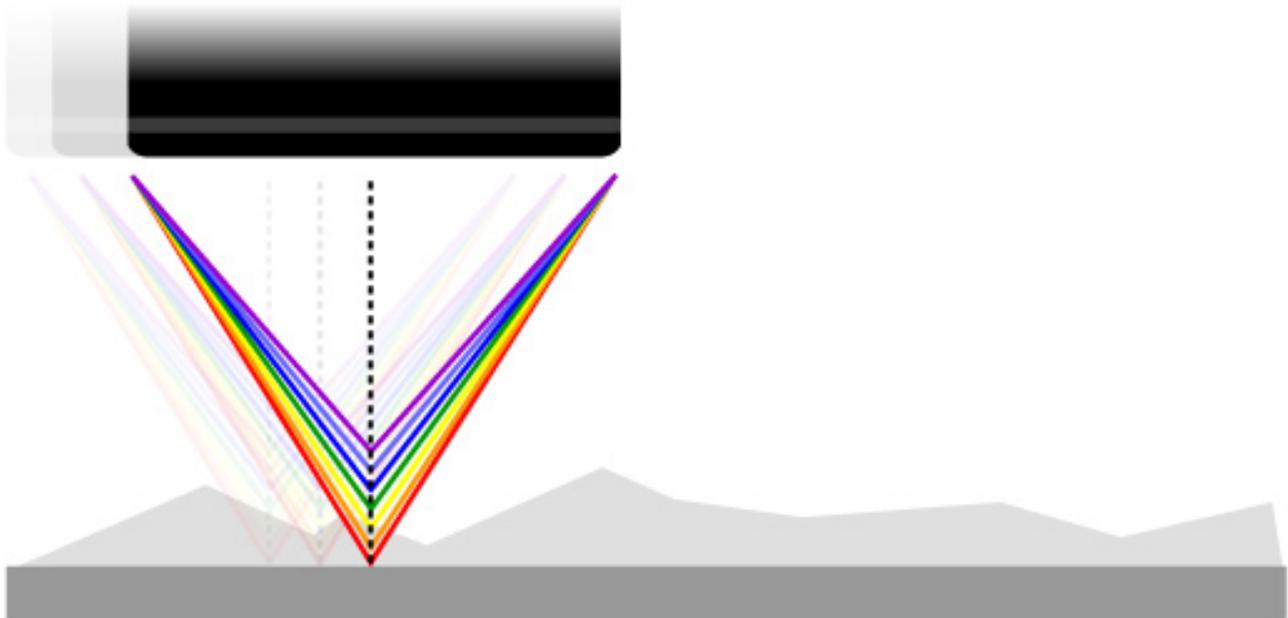
MEASUREMENT OBJECTIVE

In this application the Nanovea ST400 Profilometer is used to measure the section of a wafer array. The area measured was selected at random, and assumed large enough in that it could be extrapolated to make assumptions about a much larger surface. Surface flatness, planarity & other surface parameters are used to analyze the surface.



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.

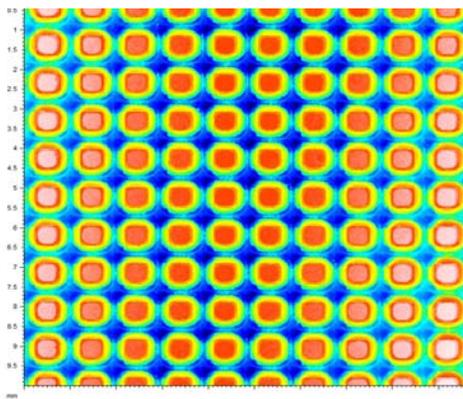
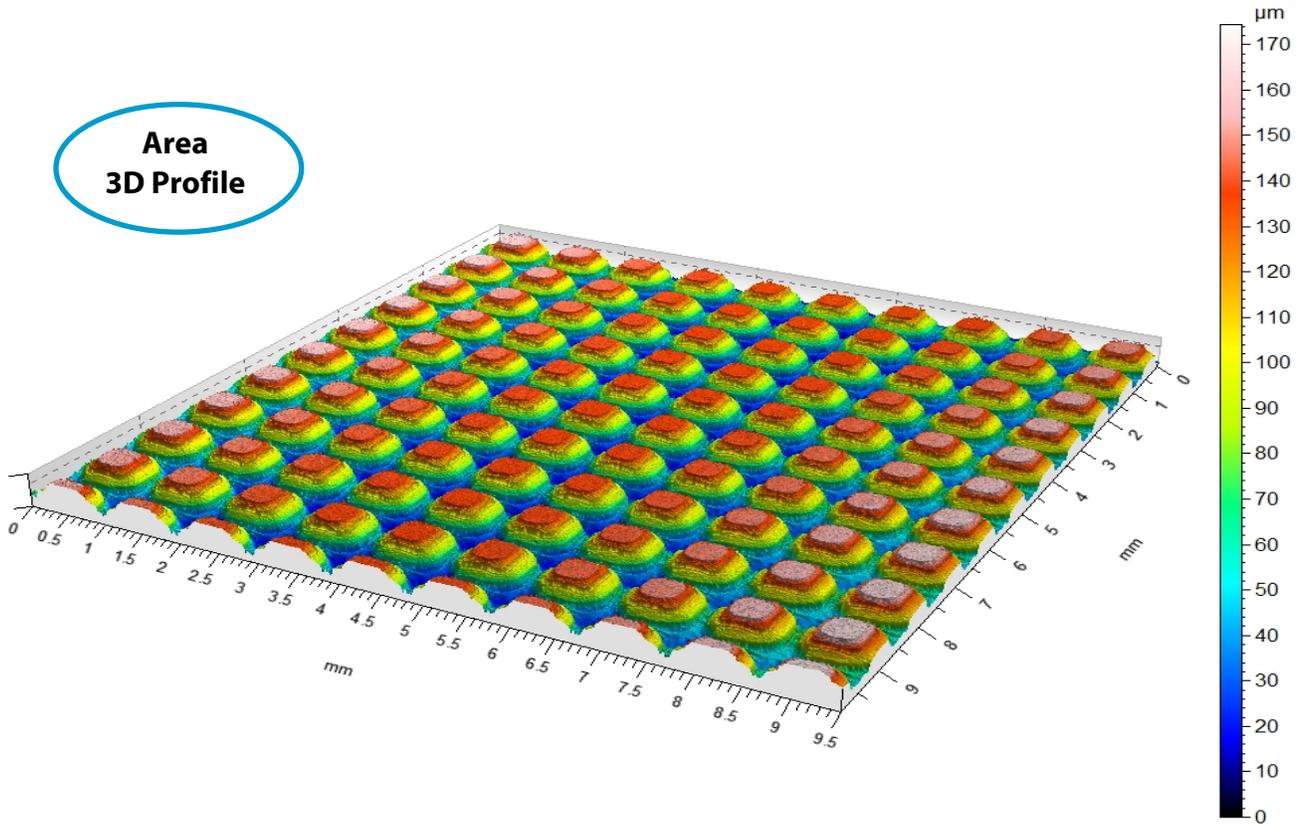


Unlike the errors caused by probe contact or the manipulative Interferometry technique, White light Axial Chromatism technology measures height directly from the detection of the wavelength that hits the surface of the sample in focus. It is a direct measurement with no mathematical software manipulation. 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/opaque, specular/diffusive or polished/rough.

RESULTS: 3D & 2D Profile

3D and 2D views of randomly selected area, showing 100 components assembled in an array and a cross-sectional area. Flatness variation can be seen clearly by color and height changes at the top of the devices.

**Area
3D Profile**

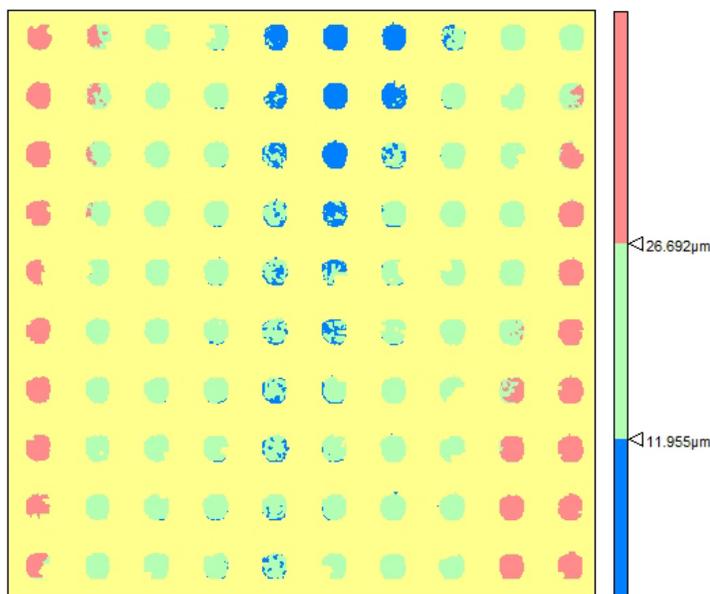
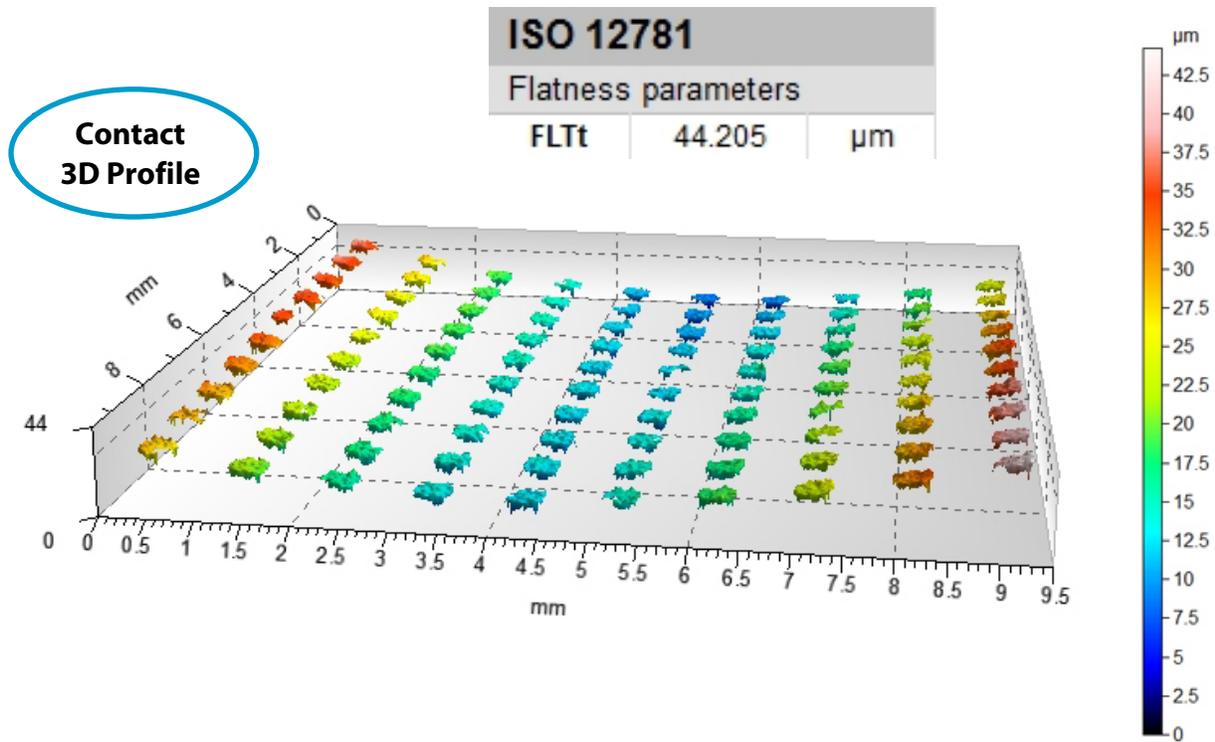


**Area
2D Profile**



RESULTS: 3D Profile of Contact Tips

Using data from previous page, top electrical contact pad was isolated to show flatness and planarity. Image below shows contact area at different depths, highlighting the deviation from flat over this small section of the wafer.



Contact Area

	■	□	■
Projected Area (%)	12.220	65.362	22.418
Volume of void (%)	1.4835	52.123	92.373
Volume of material (%)	98.517	47.877	7.6265
Volume of void ($\mu\text{m} \cdot \text{mm}^2 / \text{mm}^2$)	0.17734	7.6812	16.178
Volume of material ($\mu\text{m} \cdot \text{mm}^2 / \text{mm}^2$)	11.777	7.0555	1.3357
Mean thickness of void (μm)	0.17734	7.6812	16.178
Mean thickness of material (μm)	11.777	7.0555	1.3357

CONCLUSION:

In this application we have shown how the Nanovea 3D Non Contact Profilometer can precisely characterize the flatness and planarity of a wafer array. As seen above the results accurately identify the contact area at different relative depths. With this information it is identified that to make complete contact with all 100 devices shown the wafer must compress from the tallest device 44.205 μm . The planarity of the devices were also calculated on average to be around 0.61° for neighboring devices and 1.05° at maximum for devices with extreme differences. This planarity calculation will be a result of both the overall flatness and individual device flatness. Learn more about the [Nanovea Profilometer](#) or [Lab Services](#)