

Warpage Measurement of PCB  
With 3D Metrology



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## INTRO:

In manufacturing and mechanical engineering, flatness is a vital measurement crucial to the quality control of endless applications. Particularly, the manufacturing of precision electronic parts and assemblies are especially vulnerable to warpage and planarity defects. Here, part contact across surface area and part bonding are highly reliant on flatness and must be accurately insured for intended use. It is this very surface measurement that is an ideal match for non-contact profilometry and is a key in such manufacturing processes.

## IMPORTANCE OF FLATNESS MEASUREMENT INSPECTION FOR QUALITY CONTROL

Flatness measurement of electronic parts and assemblies, or PCB's, has become increasingly critical as geometries become smaller: finer pitches, smaller solder ball volumes, thinner substrates, etc. Additionally, processing temperatures vary and can play a major role in PCB warpage and or planarity defects. As a result, accurate flatness measurement has become vitally important to warpage characterization and planarity measurement.

## MEASUREMENT OBJECTIVE

In this application, the Nanovea ST400 is used to measure the surface of a PCB shown below. The Nanovea ST400 provided non-contact measurement with superior accuracies while obtaining flatness, planarity and step-height measurements. Although the ST400 is used here for research and analysis, the Nanovea HS100 could provide high speed automated inspection in quality control environments.

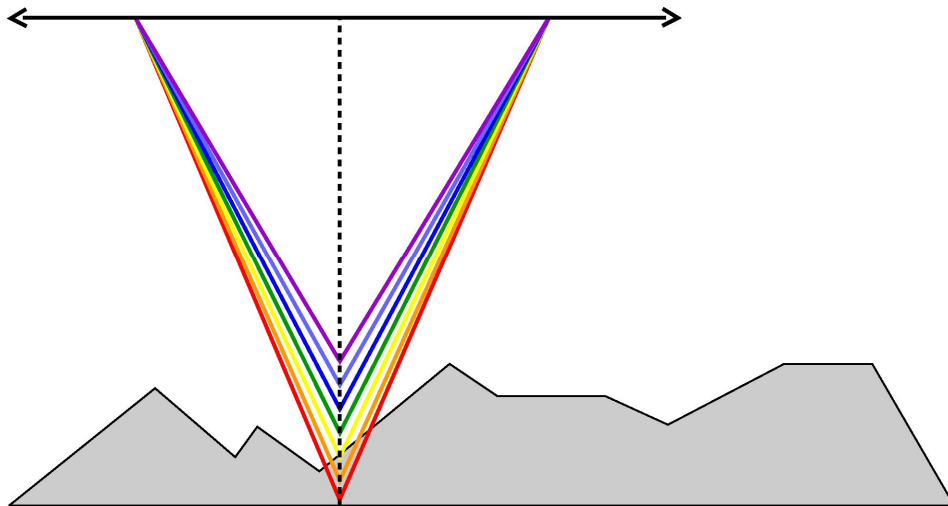


## MEASUREMENT SET-UP & TIPS:

In this particular application, we have used a 12mm optical pen to obtain nanometer resolution of an assembled electronic board. We have used spatial resolution of 50microns, which will be sufficient to give details of the patterns.

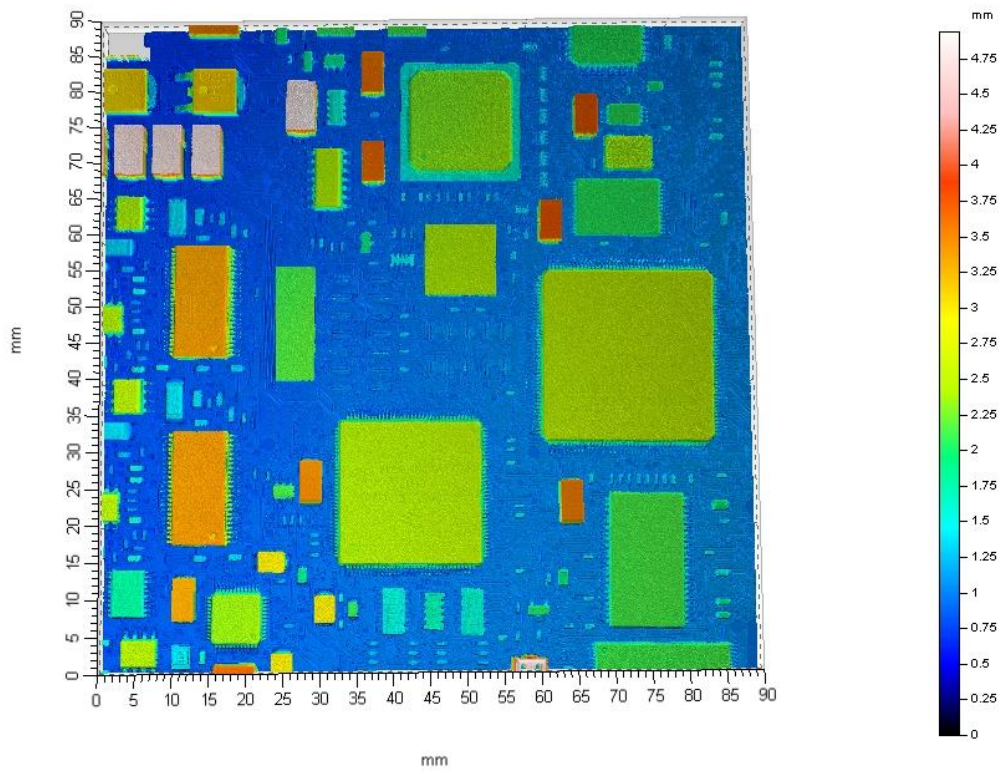
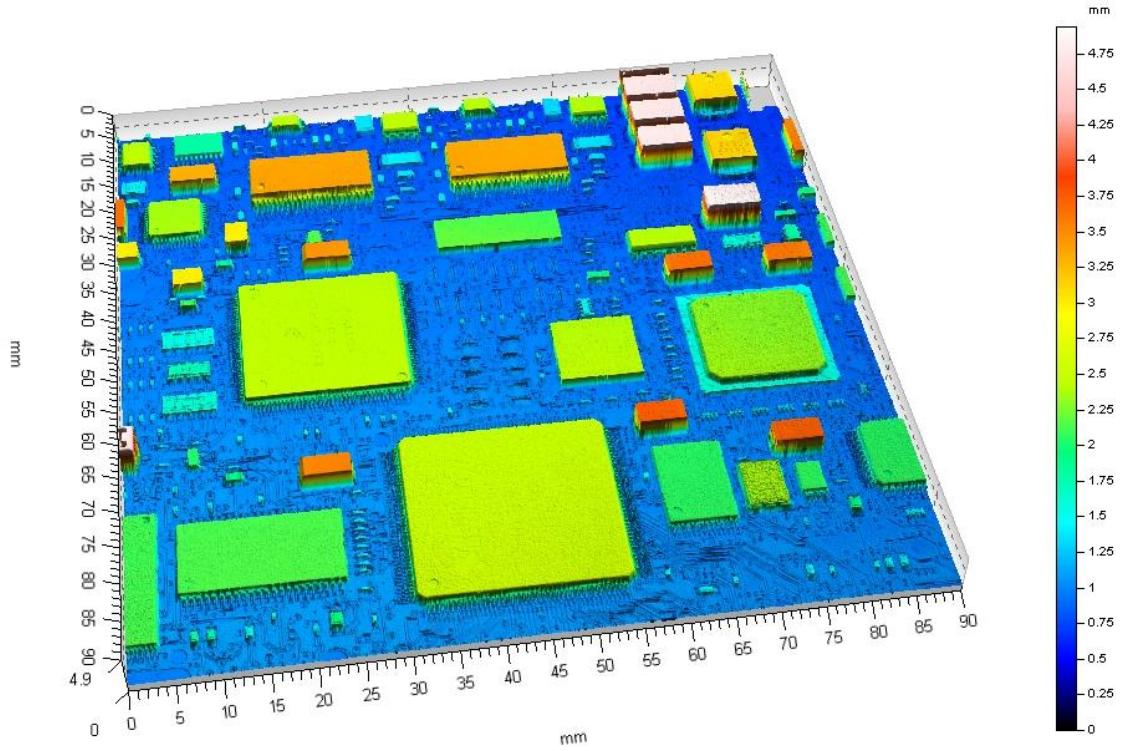
## MEASUREMENT PRINCIPLE:

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.



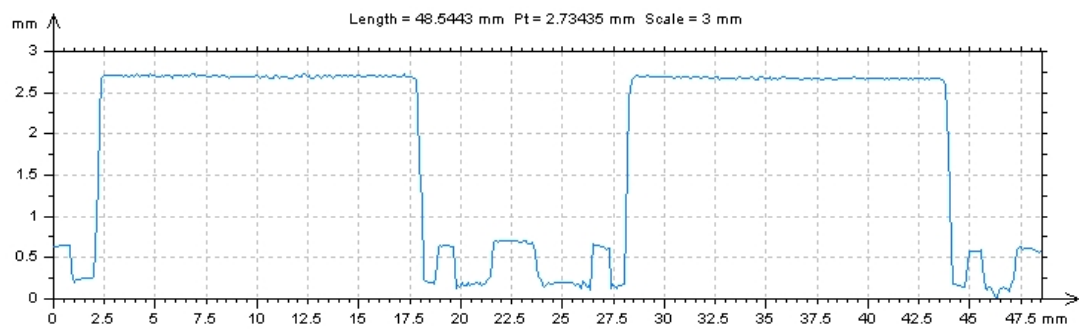
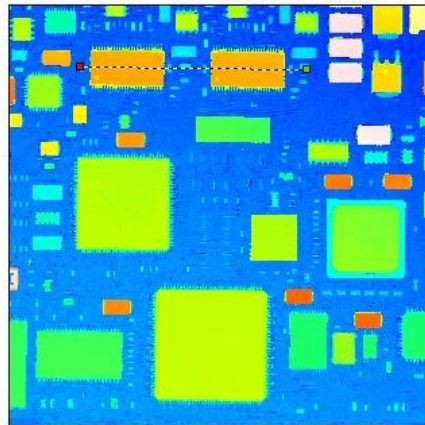
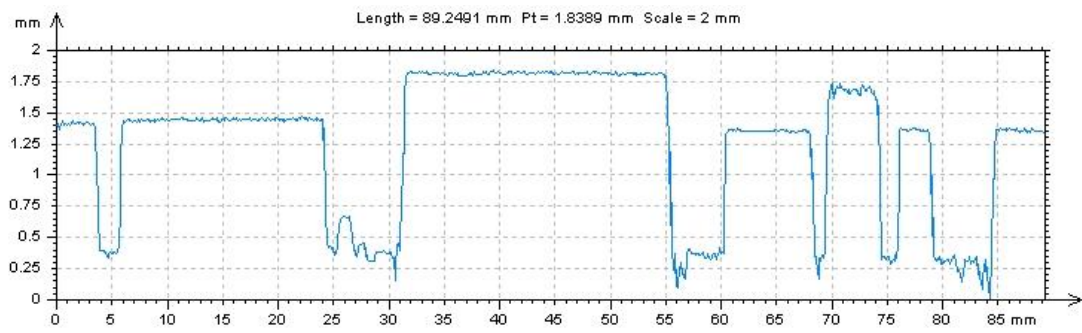
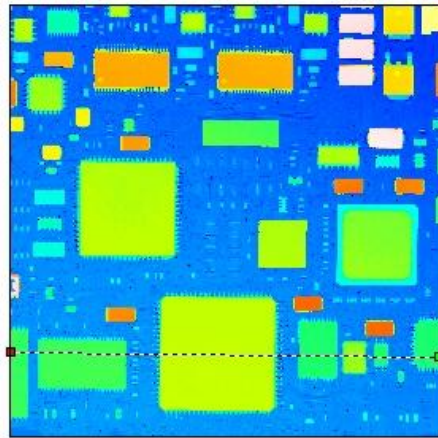
The spectral analysis is done using a diffraction grating. This technique deviates each wavelength at a different position, intercepting a line of CCD, which in turn indicates the position of the maximum intensity and allows direct correspondence to the Z height position.

# 3D Image of PCB





## 2D Cross Section



## CONCLUSION:

In this application, we have shown how the Nanovea ST400 3D Profilometer with a 12mm and 400 micron optical pen can precisely characterize both the macro surface/shape and the nanometer details of the board. From the 3D image it can be seen that the board is relatively flat, however there is a slight warpage noticeable in the color change from the bottom left to the top right of the 3D images. To further view in detail a 2D cross section can quickly be chosen to analyze, at nanometer range, step height and planarity among others. Nanovea 3D Profilometers speeds range from 20mm/s to 1m/s for laboratory or research to the needs of hi-speed inspection; can be built with custom size, speeds, scanning capabilities, Class 1 Clean Room compliance, with Indexing Conveyor and for Inline or online Integration