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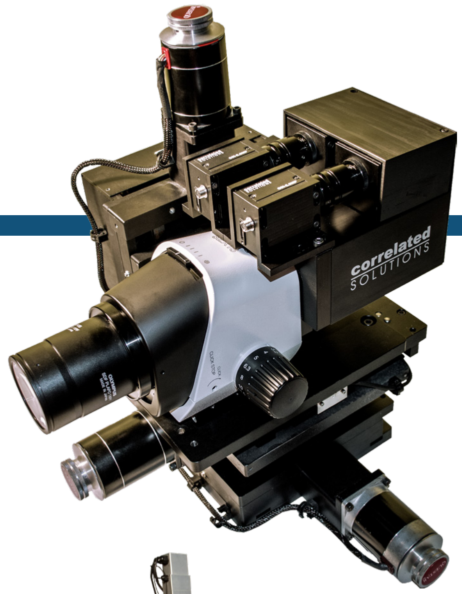
Measure with Confidence

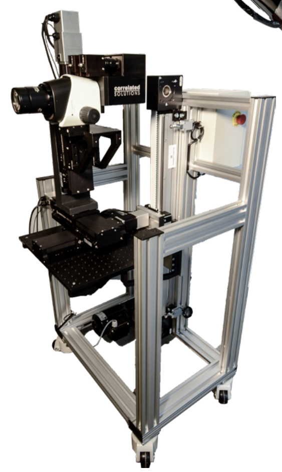
VIC-3D with *iris*
Stereo Microscope System

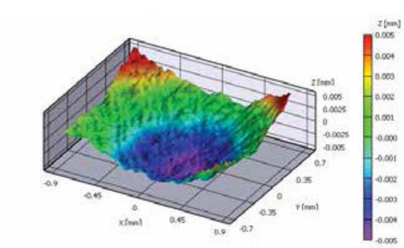


The VIC-3D Stereo Microscope system utilizes the powerful measurement technique known as digital image correlation (DIC) to measure three dimensional surface shape, displacements, and strains of microscopic specimens. This unique system utilizes a patented stereo-microscope distortion correction software module which removes complex optical distortions that can severely bias strain measurements. 3D DIC has been deployed for measurements that require high magnification, but due to the lack of suitable optics that provide sufficient depth-of-field, it has shown to be extremely difficult to achieve accurate data. Stereo microscopes appear ideally suited to provide these measurements, but present many challenges.

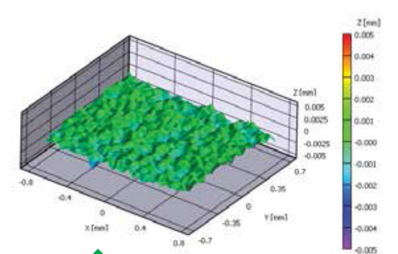
Challenge

The complex optical system of stereo microscopes prevents proper calibration of image distortions using traditional models such as Seidel lens distortions. Because of this, the data typically contains severely biased shape and strain measurements. In this case, it is common to observe bias levels of several thousand microstrain. An example of this bias is shown below (left).





Shape data of an optical flat without distortion correction



Shape data of an optical flat after distortion correction

	VIC-3D Microscope System
Field of View Range	0.8 mm - 8 mm *
In-plane Displacement Resolution	Down to ±10 nm
Out-of-Plane Displacement Resolution	±120 nm
Strain Resolution	±0.010%
Camera Resolution	Up to 5 MP *
Camera Frame Rate	Up to 2,000 fps *
Image Correlation Processing Speed	Up to 500,000 pts/s

** Depending on camera selection*

Solution

Correlated Solutions has developed a simple to use calibration method that does not suffer from the problems associated with the traditional parametric distortion models that are commonly used. The calibration method uses a planar object with a speckle pattern to compute the non-parametric distortion fields of the stereo microscope and has been shown to completely eliminate shape and strain bias from the measurements. This turnkey stereo microscope measurement system based on the VIC-3D platform can measure fields-of-view ranging from 10x - 1x (0.8 mm - 8 mm, which varies slightly with camera/sensor selection) with the comparable accuracy and ease-of-use as the popular low magnification stereo image correlation systems. Such a small field-of-view enables research to be performed on materials at a whole new level.

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CASE STUDY

Strain in Solder Loaded in Tension

The objective of this test was to determine the strain distribution within a solder line which is just 82 microns in thickness. The specimen was a copper dogbone soldered together in the middle region. The dogbone width was 3.0 mm, but the field of view was zoomed into a small 1.0 mm region on the edge so that strains within that very thin solder line could be investigated. This region is indicated in Figure 1.

The sample was loaded in tension until failure, and images were taken at every 2 lbs of applied load. The VIC-3D Stereo Microscope system tracked the sub-pixel movements of the speckle pattern to measure surface displacements and strain data on the specimen. The full-field analysis was able to show how the strain was distributed throughout the solder.

During the test, 23 image pairs were analyzed so that strain development could be observed and analyzed. Figures 1 and 2 explore the y-axis strain (strain in the tensile loading direction) at the last image taken before failure. The contour plots may be displayed in 2D and overlaid on the deformed image (as seen in Figure 1) or displayed on a 3D plot (as seen in Figure 2). Data extraction tools are also available in VIC-3D. This enables the user to investigate global or user-defined local areas. Any number of the variables may be extracted into plots and tabular data.

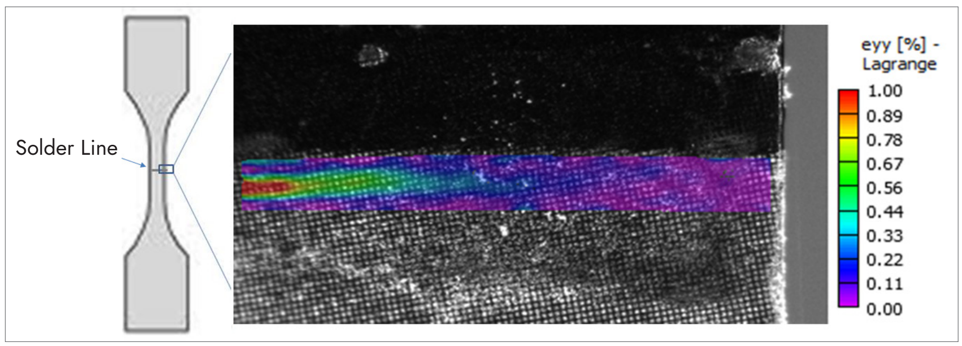

Figure 1

A 1 mm x 0.8 mm area of interest on the dogbone sample allows for Eyy strain to be obtained throughout the solder line (82 microns thick).

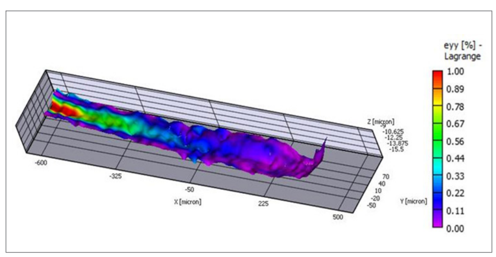

Figure 2

Y-axis strain, ε_{yy}, at maximum loading

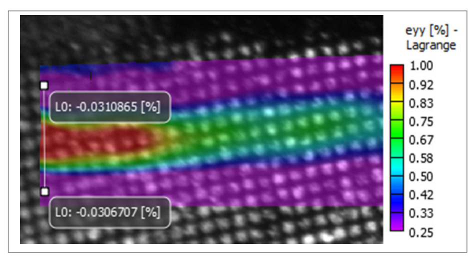

Figure 3

ε_{yy}, at maximum loading with user defined line

Figure 3 displays a user defined line within the solder region. Figure 4 shows the local strain along that user-defined line. The red line in Figure 4 reveals the strain along that user-defined line for the last image taken before failure, and the grey lines demonstrate how that strain is developed throughout the test. Loading data may be recorded through an analog signal and plotted against any of the available variables for global or user-defined local regions. Figure 5 shows the stress-strain graph for the average global strain.

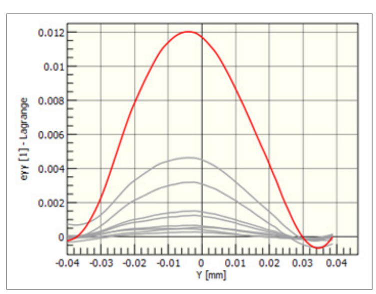

Figure 4

ε_{yy} development within user defined line

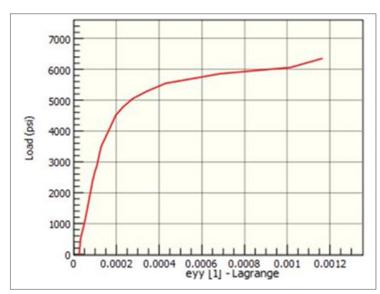

Figure 5

Load vs. Global ε_{yy}

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