Why Upgrade to Akrometrix Studio?

April 12, 2011

To maximize a TherMoiré's capabilities and get the most value from the equipment investment, Akrometrix Studio must be installed on the machine.

Summaries of the major feature additions and enhancements available on TherMoiré PS200, PS400, and PS600 equipped with the Akrometrix Studio Software/Hardware Upgrade follow:

1 IMPROVED XY RESOLUTION

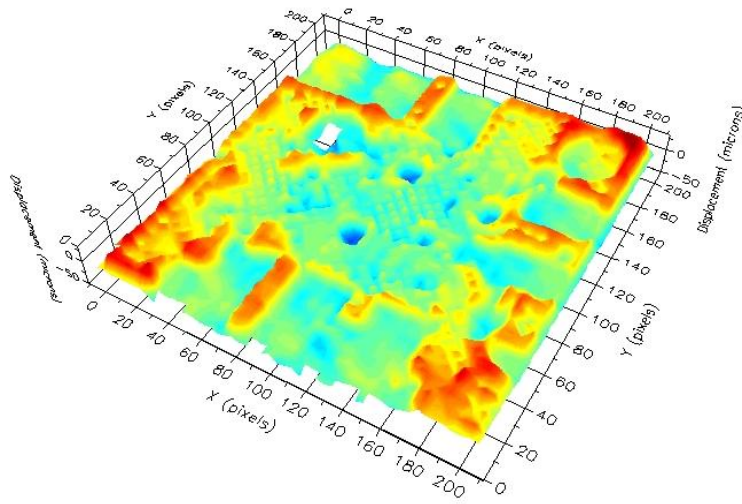**Benefit Summary: Small features that were blurred or missed are now sharp and visible when using Akrometrix Studio.**

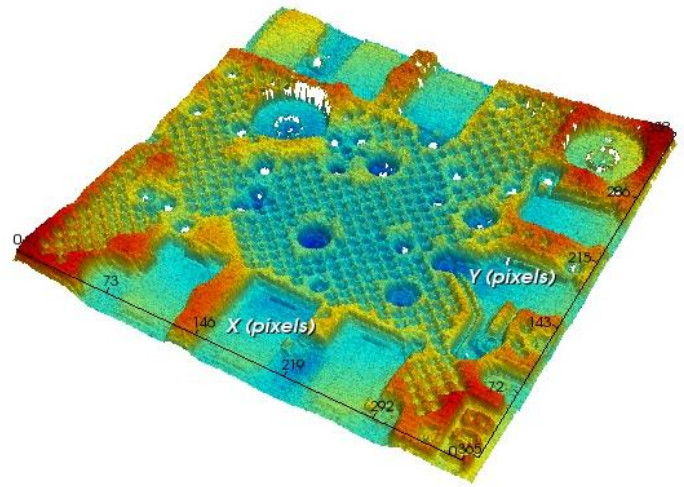**Figure 1. 22mm Bare PCB in legacy software w/ 300 LPI Grating**

Figure 2. 22mm Bare PCB in Studio software w/ 300 LPI Grating

1.1 Related Tools and Software Features

- 1.4 Megapixel Firewire Camera - Upgrade from 0.3 Megapixel frame-grabber controlled camera, provides more than 4.7x the number of pixels.

- Computer - Modern computer and GPU, camera image now all digital with Firewire controlled camera. Less noise and more detail compared to old analog frame-grabber driven camera.

- Studio: Surface Measurement and Surface Analysis - OpenGL rendered surfaces provide high quality surface graphics through texture mapping, lighting, and shadowing.

1.2 Benefit Details

More data points leads to more surface detail, which leads to more accurate warpage measurements. Closely examining Figure 1 and Figure 2 above may be the best way to highlight this Studio enhancement. In this test case both samples were tested with Akrometrix' highest resolution grating, the 300 line per inch (LPI); however, the image taken with the Studio software provides nearly 4x as many data points. With the addition of the 200 LPI grating as the standard grating in the PS200S and optional for the AXP and PS400 systems, the pixel count benefit is even more noticeable at the full field of view (FOV) of these systems where pixel count is easily greater than 4x more than pre-Studio systems over the same FOV.

Also, the ability to display those large data sets has also highly evolved due to Studio's rendering technology. Surface shapes and details are now rendered using modern a GPU with texture mapping, lighting, and shadowing. Feel free to zoom in more closely on Figure 1 and Figure 2 to compare the added level of detail seen on this single surface. Keep in mind that even greater detail can be seen when zooming in on such an image in the Surface Analysis software.

2   IMPROVED Z RESOLUTION

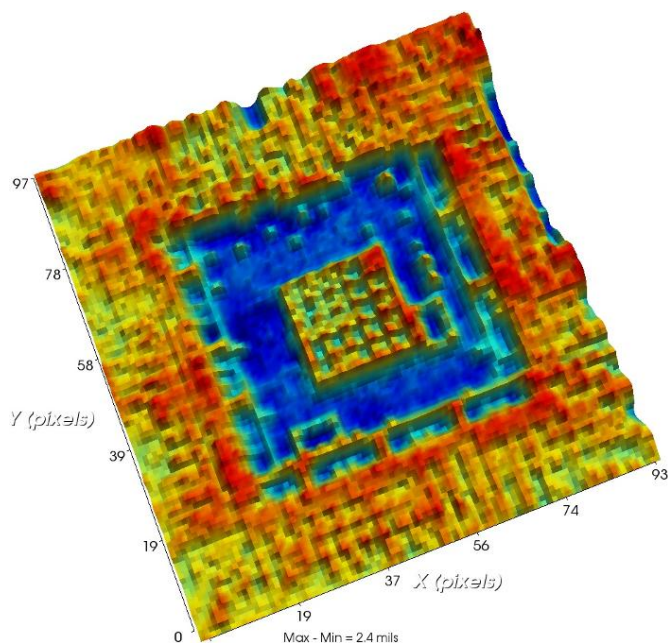**Benefit Summary: Smaller changes in height can now be detected and visualized on the sample surface.**

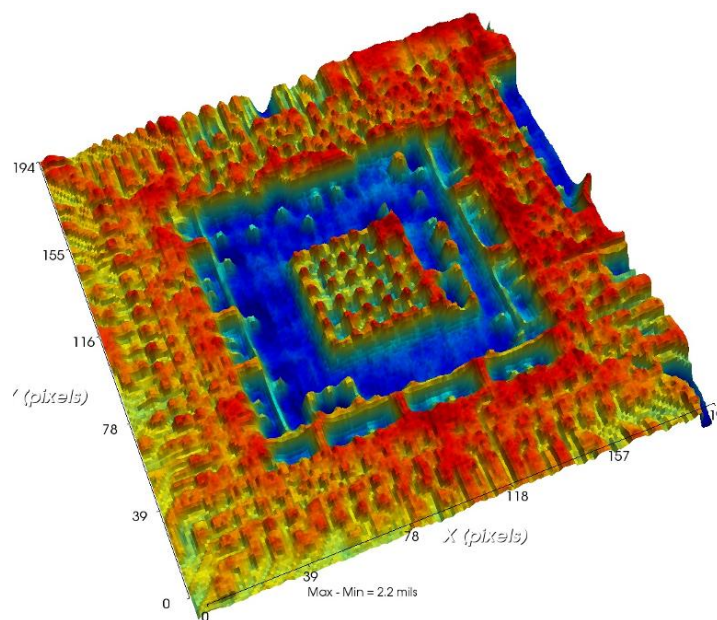Figure 3. PCB local area test with 100 LPI (Studio)

Figure 4. PCB local area tested with 200 LPI (Studio)

2.1   Related Tools and Software Features

- <u>200 LPI Grating</u> – By cutting grating pitch in half, transitioning from the 100 LPI to 200 LPI also cuts the Z-resolution in half (2.5 micron → 1.25 micron).

- <u>Computer</u> - Modern computer and GPU, camera image now all digital with Firewire controlled camera. Less noise and more detail compared to old analog frame-grabber driven camera.

- <u>Studio: Surface Measurement and Surface Analysis</u> - OpenGL rendered surfaces provide high quality surface graphics through texture mapping, lighting, and shadowing.

2.2   Benefit Details

For our purposes, resolution is defined as "the capability of making distinguishable the individual parts of an object." In an Akrometrix system, Z Resolution is mathematically defined as the system grating pitch divided by the light intensity range of the intensity images. When changing from the 100 LPI to 200 LPI, light intensity range should show only minor changes and can be considered constant. However, grating pitch changes from 254 microns to 127 microns between these two gratings. Mathematically, this represents cutting resolution in half (2.5 micron → 1.25 micron Z Resolution). Using either definition the benefit of improved Z resolution comes through in being able to see finer and more subtle changes in height on a sample surface.

Figure 3 and Figure 4 above show the same part measured with the Studio software in both cases. Here, only the grating was changed. In this case surface features are very subtle in some areas and are not as well defined with the 100 LPI grating. The added Z Resolution of the 200 LPI grating in the Studio software platform leads to a more accurate and defined surface topography measurement.

3 IMPROVED REPEATABILITY

Benefit Summary: Measurement to measurement surface data is more consistent through many analysis and acquisition features.
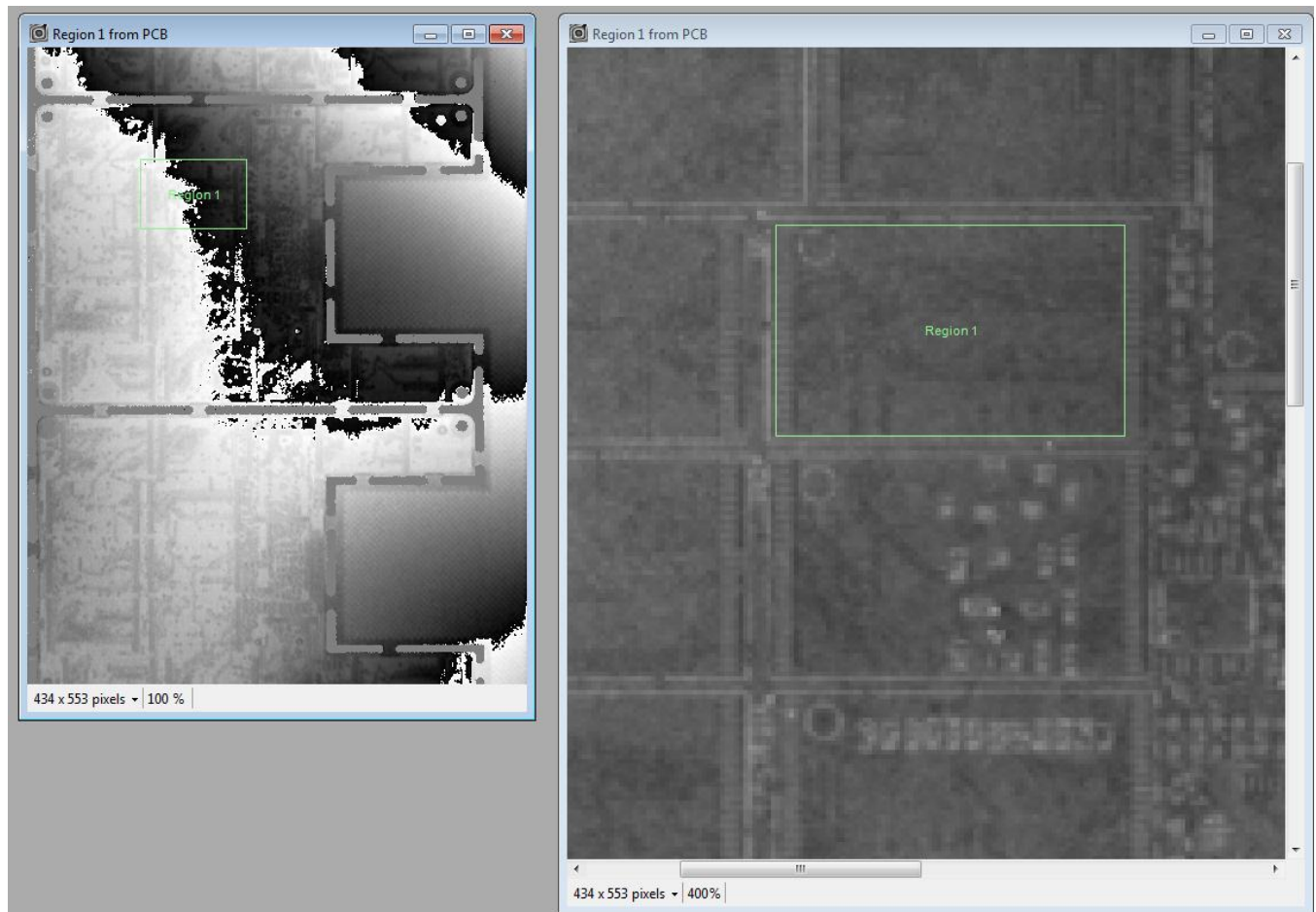

Figure 5. Zoom and Surface Image View Featured

3.1 Related Tools and Software Features

- <u>Studio: Surface Measurement and Surface Analysis</u> – A host of various features in both software applications lead to more repeatable data sets.

3.2 Benefit Details

Improved repeatability is the ability to limit variation in measurements taken by a single person on the same item and test conditions. Akrometrix phase stepping and shadow moiré analysis is fundamentally a highly repeatable process. The new Studio software implements numerous features to build upon and improve the repeatability of the TherMoiré measurement systems.

These improvements begin in Surface Measurement with the addition of the Fringe Height Calibration feature. This feature ensures consistent phase stepping through the system life, which is critical for repeatable measurements. The new Part Tracking feature can also lead to more repeatable data sets by providing a high level of accuracy in the chosen region(s) of interest.

Surface Analysis brings a range of new features to generate more repeatable data sets. In many of these features the critical point to a repeatable surface measurement is repeatable selection of the correct data set:

- Surface Image View: As shown on the right of Figure 5, this feature allows the user to perform data analysis (partitioning and masking) on a generated picture of the part instead of trying to interpret and process data on the phase image display (shown on the left of Figure 5). Accurately partitioning and masking the correct set of data is critical to repeatable and accurate results.

- Phase or Surface Image Zoom: The user can now zoom in up to 32X magnification on the phase or surface image to allow partitioning and masking of the data set down to the single pixel level.

- Phase Image Rotation: Phase images can now be rotated in space as much as needed, most typically to allow the user to consistently define a rectangle shape on a part not perfectly aligned.

- Chord Plot Interface: Generating chord plots in legacy Akrometrix software was never a repeatable process, as only single plots could be generated and the exact beginning and end were not clear. Chord plots can now be drawn using the above features, like Surface Image view and zoom, to the user's advantage and can be saved and loaded for repeatable coordinate plotting on multiple measurements.

- Partitioning: The key to generating repeatable surface data often comes down to the ability to partition captured data accurately. Using the above features to the user's advantage, partitioning a part or local area is a much more repeatable process. Figure 5 is a strong example. On the left side of Figure 5 pulling out any local areas accurately would not be reasonable, but looking at a zoomed view of the Surface image on the right side of Figure 5 allows the user to select a desired local area down to the pixel. This partition can of course be saved for reuse, as well as copied and pasted to capture multiple parts or local areas of the same size.

4 IMPROVED REPRODUCIBILITY

Benefit Summary: Consistency in measurement results is improved across different users, different test runs, and even different Akrometrix equipment.

Figure 6. Metadata accessed in Surface Analysis

Figure 7. Found and partitioned parts using Part Tracking

4.1   Related Tools and Software Features

- <u>Studio: Surface Measurement and Part Tracking</u> – Many software enhancements allow test setup and ROI selection to be much more consistent, even with different Studio equipment.

4.2   Benefit Details

Improved reproducibility could be the most important improvement made in upgrading to the Studio software platform. Accuracy, resolution, and repeatability improvements are all undervalued if two different users/systems cannot generate the same test results. Reproducibility issues with Akrometrix equipment have historically come down to consistency in either test setup or data analysis choices.

Metadata is information stored within a phase image file that is automatically generated with a measurement acquisition. Figure 6 shows one tab of all the numerous information that is stored within all phase images; here, it is worth reading through the fields listed in this image. This includes all software tracked test setup details and image details. This information allows the user to communicate and confirm test parameters across different tests, equipment, and even companies.

The Part Tracking feature goes a step further and does much of the test setup and analysis work automatically, which can be easily reproduced. In this case the chosen Part Tracking configuration, which includes region(s) of interest size, can be saved and used among different users. Part Tracking is discussed in more detail in other available Akrometrix documents. Also, an example of parts found in the camera view using the Part Tracking functionality is shown in Figure 7.

5 IMPROVED ACCURACY

Benefit Summary: Through higher data density, higher grating pitch, less pixel averaging, and better edge definition surface results have improved accuracy.
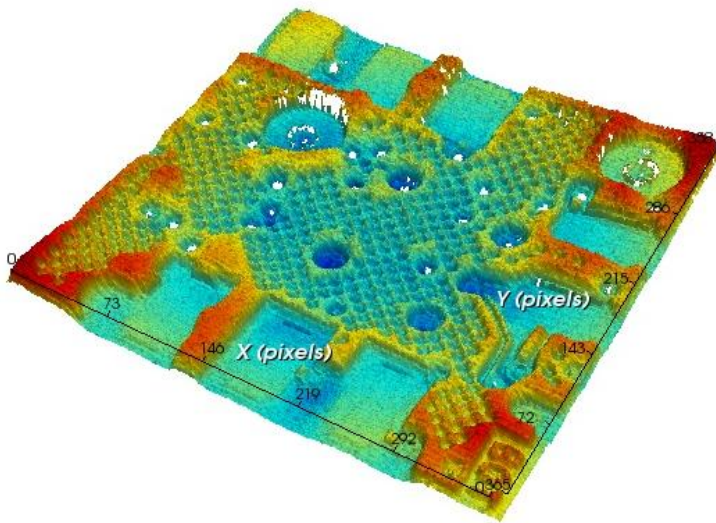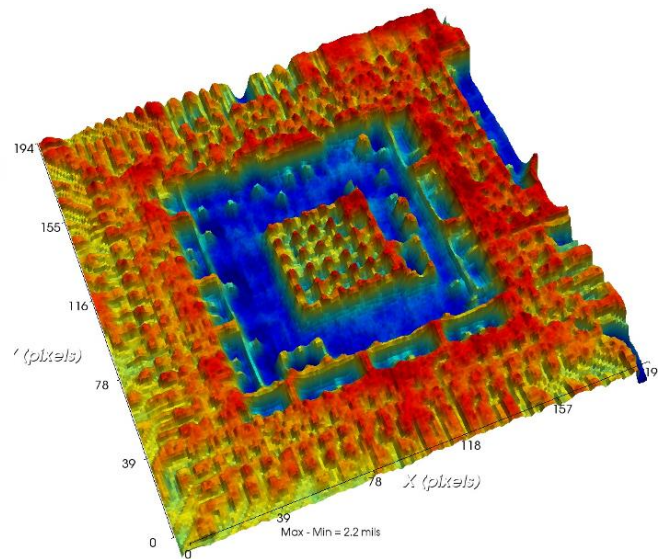

Figure 8

Figure 9

5.1 Related Tools and Software Features

- <u>1.4 Megapixel Firewire Camera</u> - Upgrade from 0.3 Megapixel frame-grabber controlled camera, provides more than 4.7x the number of pixels.

- <u>Computer</u> - Modern computer and GPU, camera image now all digital with Firewire controlled camera. Less noise and more detail compared to old analog frame-grabber driven camera.

- <u>200 LPI Grating</u> – By cutting grating pitch in half, transitioning from the 100 LPI to 200 LPI also cuts the Z-resolution in half (2.5 micron → 1.25 micron).

- <u>Studio: Surface Measurement and Surface Analysis</u> – Enhanced surface rendering, Part Tracking, and analysis capabilities lead to more accurate surface renderings.

5.2 Benefit Details

Accuracy, also defined as a degree of conformity to a true value, can be difficult to quantify when considering how resolution, repeatability, and reproducibility all play in to the above definition of accuracy. However, it is clear that the previously expressed improvements related to resolution, repeatability, and reproducibility ultimately lead to a higher degree of conformity to a true value.

Other points worth highlighting for improved accuracy include: less pixel averaging and better edge definition. Akrometrix legacy hardware and software not only had worse data density, but also included more pixel averaging between the camera and final display. As finer surface image features become more critical the pixel density and clarity of the Studio software becomes even more essential for the most accurate results. Additionally, when absolute high and low points are so often on the very edge of the part in question, a very small difference in region of interest can make a noticeable difference in gauge results. Part Tracking, among others features in Surface Analysis, ensures the correct region of interest is selected.

6 IMPROVED SETUP TIME

Benefit Summary: Time taken between test conception and starting a thermal profile run is noticeably reduced and easier to setup.
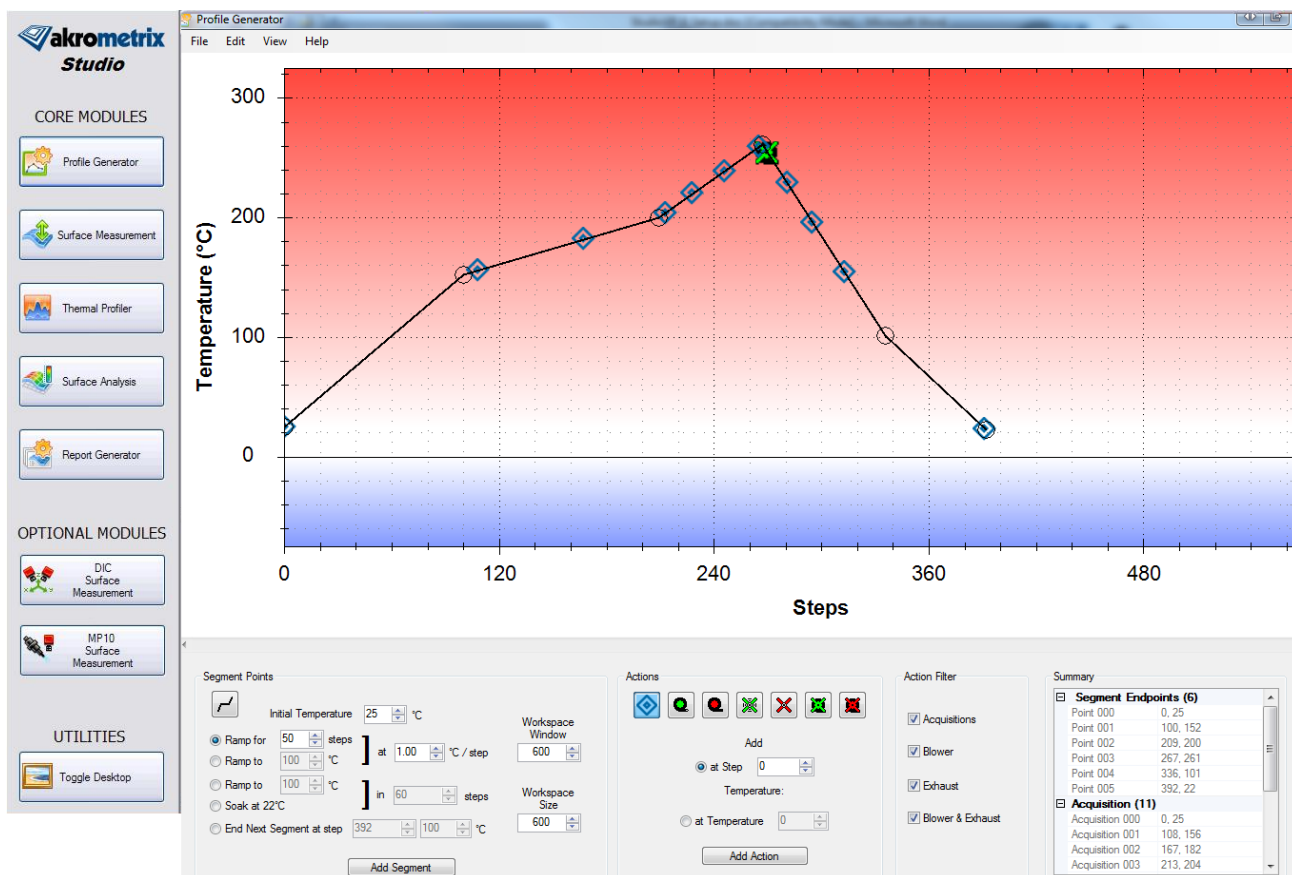

Figure 10. Studio Manager and Profile Generator with Programmed Reflow Profile

6.1 Related Tools and Software Features

- <u>Studio: Profile Generator</u> – User friendly application to create input thermal profiles.
- <u>Studio: Part Tracking and Surface Analysis</u> – Using either Part Tracking or the phase image rotation capability in Surface Analysis, sample angle no longer needs to be lined up carefully.
- <u>Studio Manager:</u> - Allows the user to quickly switch between Studio applications.

6.2 Benefit Details

The Studio software makes the most efficient use of equipment user time. The Studio Manager application supports the multi-windowed and multi tasking feel of Studio. While the Profile Generator application allows fast and accurate creation of input temperature profiles. Profile Generator can be used to create a very fast drawn profile with mouse clicks, or numerically accurate profile timing using segment, ramp, and soak commands. Data acquisitions and cooling commands can also be added.

Utilizing phase image rotation, or even better, by utilizing the Part Tracking functionality sample setup time is greatly minimized. The user no longer needs to line up numbers of small samples in parallel; instead all parts at mismatched angles are found and "squared up" by the Part Tracking software.

7 IMPROVED THROUGHPUT AND PRODUCTIVITY

Benefit Summary: The Studio software greatly reduces the time spent in processing and analysis of measurement data.
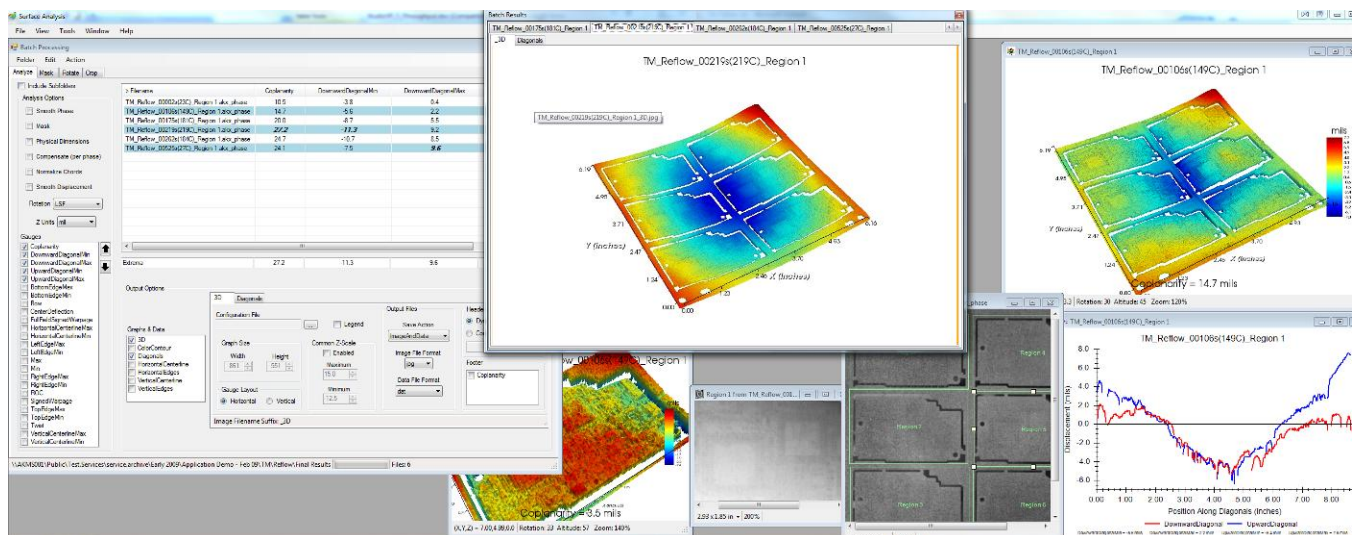

Figure 11. Surface Analysis Multiple Windows and Batch Processing

7.1   Related Tools and Software Features

- <u>Studio: Part Tracking</u> – Part Tracking has the capability to make data processing either very simple or not needed at all.

- <u>Studio: Surface Analysis</u> – A long list of Surface Analysis improvements aid processing throughput.

7.2   Benefit Details

Carefully positioning and aligning the samples in the region of interest, partitioning all desired regions of interest, and analyzing the partitioned data set can represent a substantial amount of total testing time. The Part Tracking feature is capable of performing all these steps automatically for the user instantly. Part Tracking is further explained and highlighted in other available Akrometrix documents.

In case there is still analysis work to be done the Surface Analysis software has a number of improved and new features to make analysis faster and easier. As a compliment to these features the Surface Analysis software continues with the Windows feel of the Studio package as seen in Figure 11. Quick processing and multiple high detail windows are all made possible by a modern computer and are easier to see with the larger computer monitor sold with the Studio upgrade and systems. Some of the highlighted features for improved throughput in Surface Analysis include:

- A new batch processing interface incorporates masking, partitioning, rotating, and analysis all within a similar interface. The user can quickly move among the different processing functions.

- The user can save, copy, and paste masks, partitions, and chords for quick processing of complex shapes or high quantities of features. Additionally, pre-defined chords of all edges and centerlines are only a keyboard shortcut away for the user.

- Image rotation allows for less careful sample alignment during setup, and the image shift function can make quick adjustment of partitioned areas that may have moved during heating.

8 IMPROVED ANALYSIS CAPABILITIES

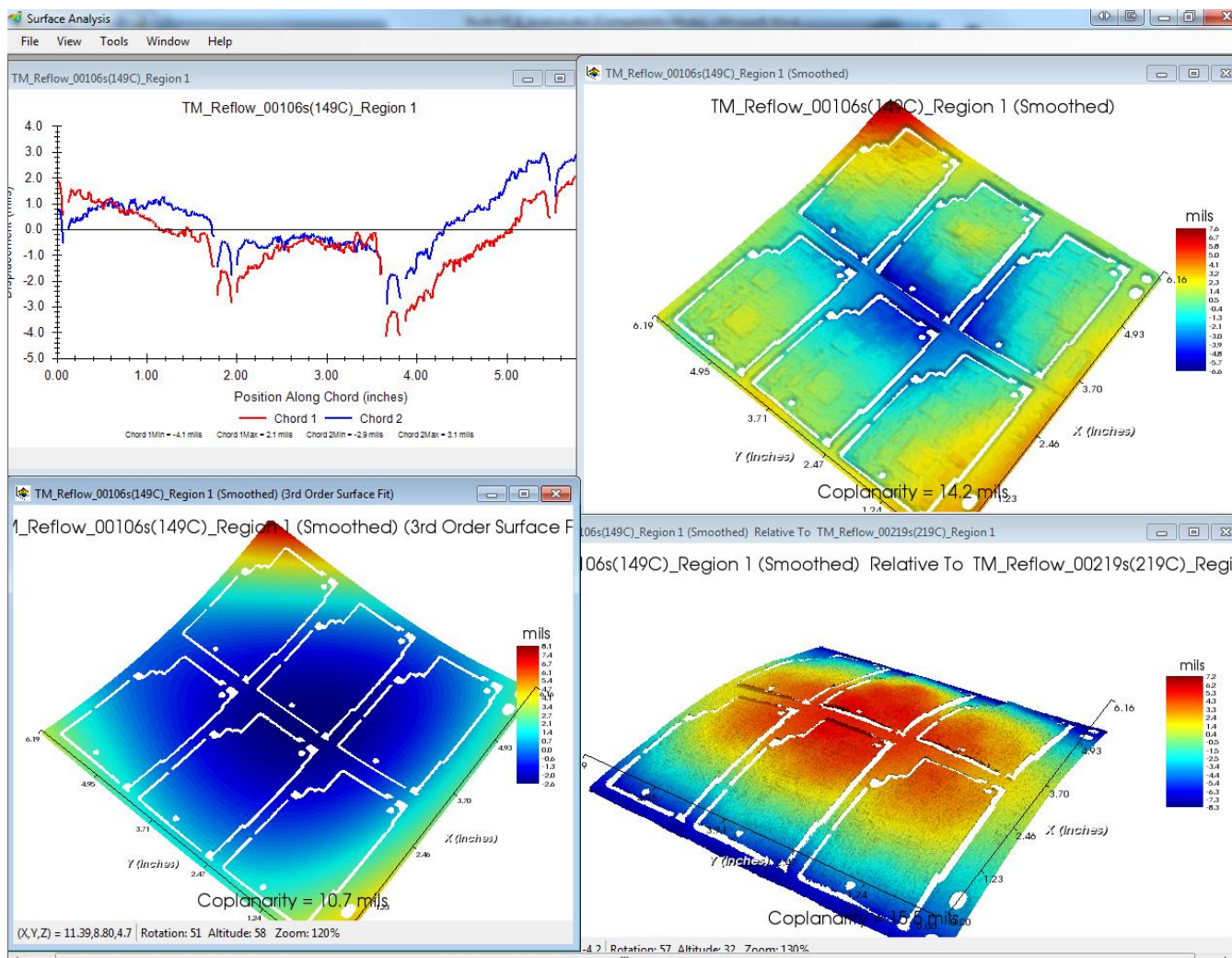**Benefit Summary: Studio's analysis software comes with a range of new and powerful features.**

Figure 12. Surface Analysis showing Displacement Smooth, Relative Plots, Chord Plots, and Polynomial Surface Fits

8.1   Related Tools and Software Features

- <u>Studio: Surface Analysis</u> – Features highlighted below.

8.2   Benefit Details

- Multi-window display allows side-to-side comparison of graphs and surface plots.

- Custom and pre-programmed chord plots allow multiple point-to-point line graphs to be drawn anywhere on the sample surface and plotted together or separately.

- Any data set can be fit to a 1st, 2nd, or 3rd order polynomial to turn a complex shape into a simplified surface. Additionally, a new surface spherical fit is also available.

- Changes between surfaces in any combination can easily be visualized using Relative Plots, which subtracts one data set from another and plots the difference between the two surfaces.

- Partitioning and Masking shapes are no longer limited to rectangles. Now a range of shapes are available for partitioning and masking complex shaped samples.

- New smoothing features are available in the software, now with the ability to smooth at the displacement data level.

- All sample visuals, like surface, intensity, or phase images, seen in Surface Analysis can be saved as an image. Saving a surface image is basically saving a picture of the part as seen from the system camera, which can be useful for reporting purposes.

- Views of 3D surface plots can be copied from one image to the next. Also, the mouse wheel can be used to zoom in on surface plots to see every detail that the Studio software generates.

9 IMPROVED GAUGES

Benefit Summary: Studio adds new useful gauges that allow the users to make more informed decisions on the found surface shape.
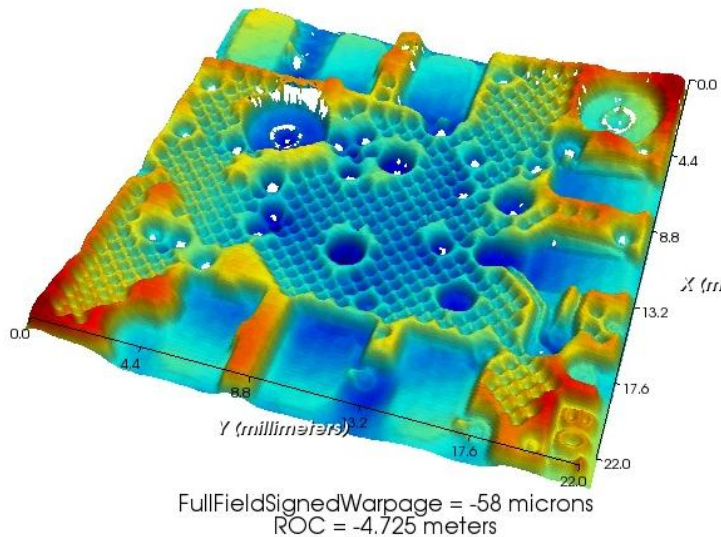

FullFieldSignedWarpage = -58 microns
ROC = -4.725 meters

Figure 13. 3D plot with FF Signed Warpage and ROC

HorizontalCenterlineMin = -24 microns   HorizontalCenterlineMax = 2 microns
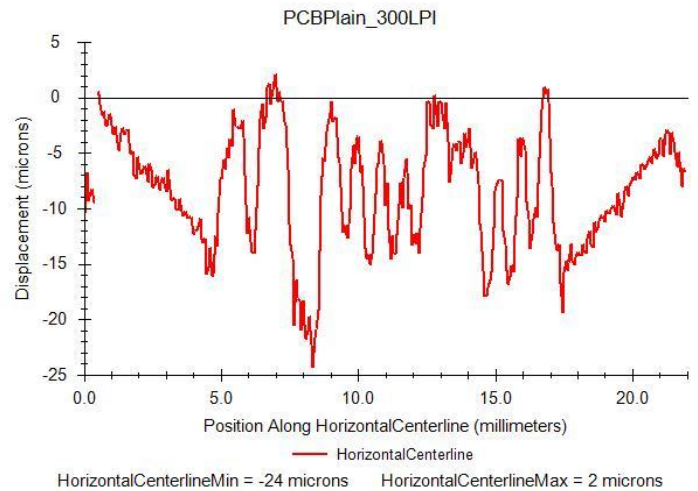
Figure 14. Horizontal Centerline with Max/Min

9.1 Related Tools and Software Features

- <u>Studio: Surface Analysis</u> – Adds new gauges listed below, in addition to all of the gauges in the legacy software.

9.2 Benefit Details

- Signed Warpage – This gauge adds a positive or negative sign to found coplanarity based on industry standards (JEDEC and JEITA). This gives the user more information about the part shape based off this found value.

- Full Field Signed Warpage – This Akrometrix specific gauge behaves similar to Signed Warpage, but Full Field Signed Warpage takes the entire data set into account and is also less sensitive to noise. Akrometrix recommends this gauge for assigning a sign to a found data set. Using either signed gauge, plotting signed warpage over temperature is a popular and effective method for quantitative communication of surface warpage.

- Radius of Curvature (ROC) – This gauge comes from the spherical fit capability in Surface Analysis and requires the input of X and Y dimensions. This gauge is effective in quantifying warpage versus physical part size.

- Chord Max/Min – All Chord plots can have maximum and minimum values calculated for either preprogrammed chords or custom chords. While diagonal plots have always been the most popular chord plot, users may want to make decisions based on centerline max/min values, or other chords in some cases.

10 IMPROVED BATCH PROCESSING

Benefit Summary: An expansive list of savable options is available for batch processing data analysis, as well as batch masking, rotating, and cropping (partitioning) images.
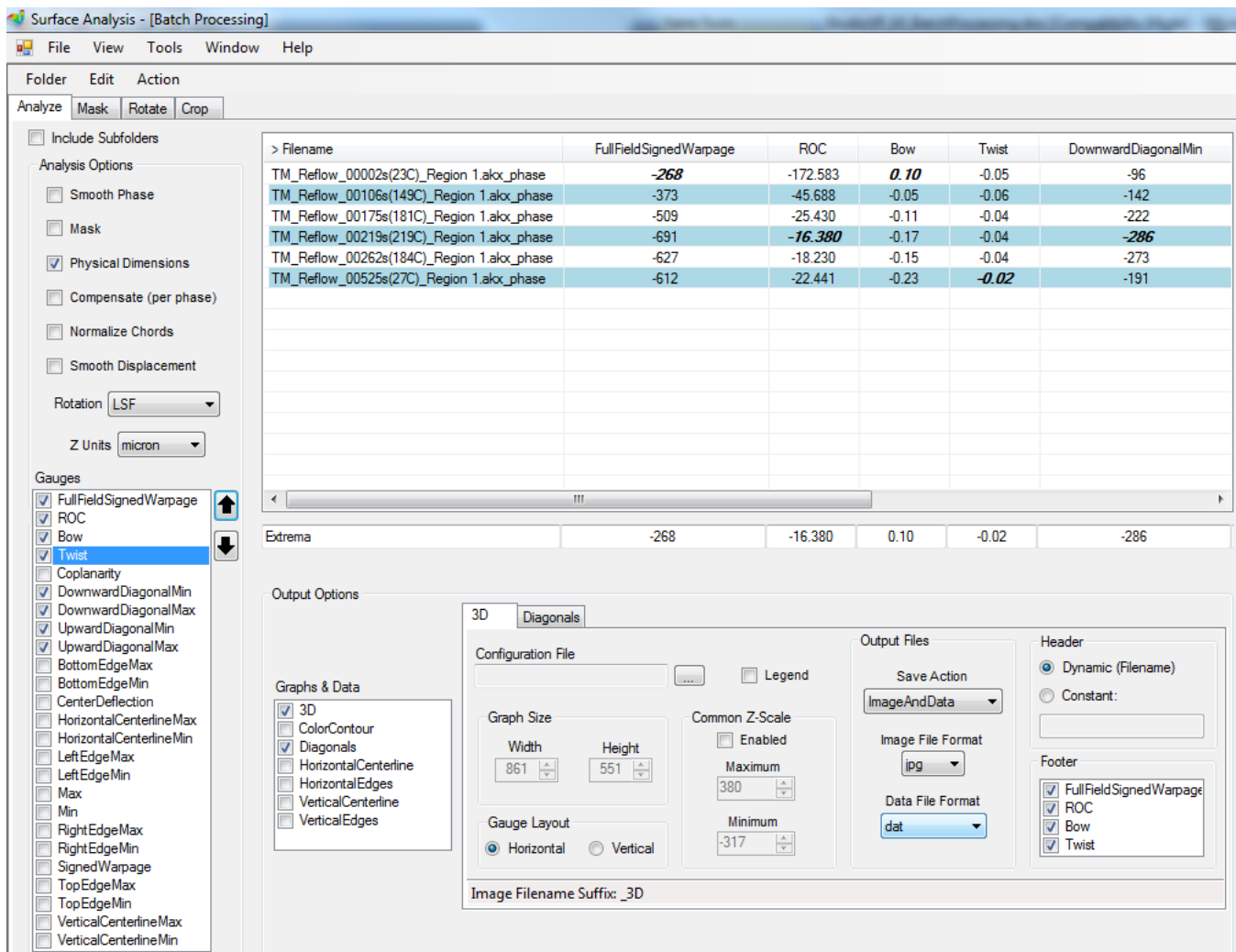

Figure 15. Batch Processing interface

10.1   Related Tools and Software Features

- <u>Studio: Surface Analysis</u> – Batch processing interface is shown in Figure 15.

10.2   Benefit Details

Along with all new gauges and preprogrammed chord plots, the new batch processing interface allows quick processing of folders worth of data with many analysis and display options available to the user. Unlike the legacy software, all batch processing functions are now centrally located. Taking a close look at Figure 15 above is the best way to understand all of the available options.

At the top of Figure 15 notice the tabs for Mask, Rotate, and Crop (often referred to as Partition). Each tab has a similar interface for consistency and ease of use. In all cases settings can be saved for use at a later date. Batch cropping and masking, in particular, each utilize files which are created when working with a single image. These files can be reused and shared among users.

11 IMPROVED APPLICATION OPTIONS

Benefit Summary: With the improvements of the Studio upgrade, the Akrometrix equipment has the capability to handle many new testing applications.
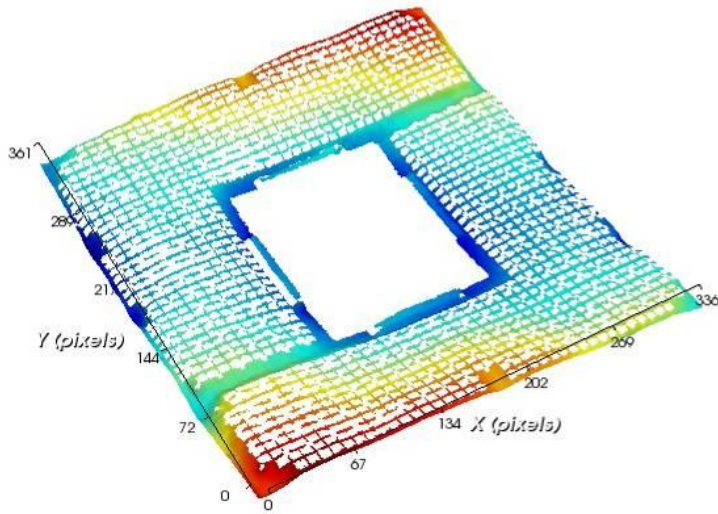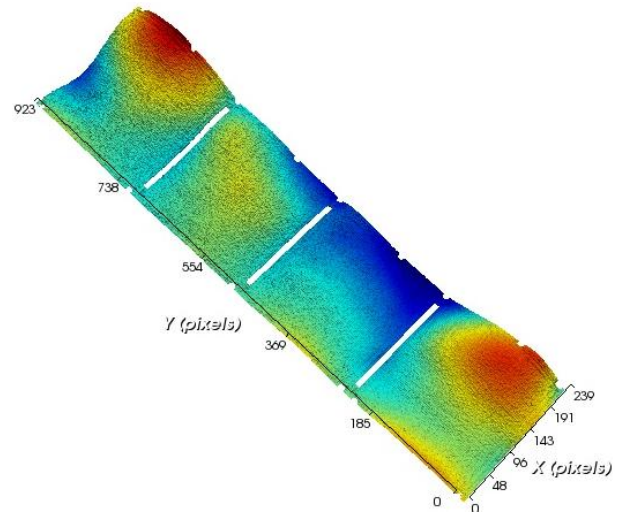
Figure 16. Socket Warpage

Figure 17. Strip Warpage

11.1   Related Tools and Software Features

- <u>1.4 Megapixel Camera</u> - Upgrade from 0.3 Megapixel frame-grabber controlled camera, provides more than 4.7x the number of pixels.

- <u>200 LPI Grating</u> – By cutting grating pitch in half, transitioning from the 100 LPI to 200 LPI also cuts the Z-resolution in half (2.5 micron → 1.25 micron).

- <u>Studio:</u> – Studio has made possible some previous applications that were not feasible with the shadow moiré technique, and turned them into strong testing applications.

11.2   Benefit Details

Testing sockets with shadow moiré has been both a challenge and a desired application for TherMoiré tools. Previous socket measurement techniques involved defocusing the camera image and gave an approximation of the shape but not a truly accurate surface. With the many benefits presented in the Studio upgrade, including a new camera and grating, a new technique for highly accurate socket testing has been developed. Acquiring the data in Figure 16 is only possible with a Studio system. Details on socket testing can be found in Akrometrix' Socket Testing Protocol.

With more resolution in all dimensions and the ability to further partition data into many segments, many application possibilities are presented. Testing strips before singulation has always been reasonable with shadow moiré. However, with Studio improvements, analyzing each individual cutout out of an entire strip of dies or packages is now quite feasible.

The list of new applications continues to increase as Studio is developed. For example, the increase in XY resolution has also increased the shadow moiré technique's tolerance to sudden height changes. Studio can handle over twice as much height change for samples that exhibit extreme warpage in an area, like many flex circuits, for instance.

12 IMPROVED EXPANSION OPTIONS

Benefit Summary: The DIC add-on module provides in-plane strain maps, CTE calculation, and out-of-plane displacement on discontinuous surfaces.
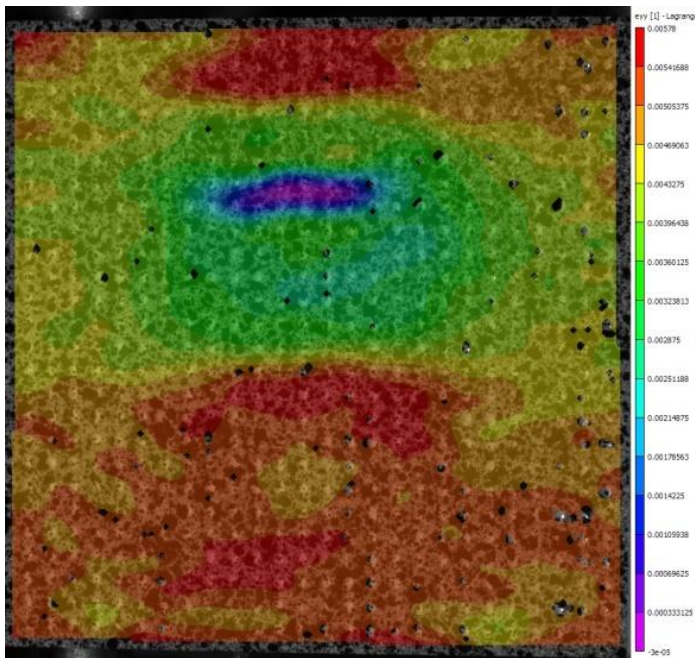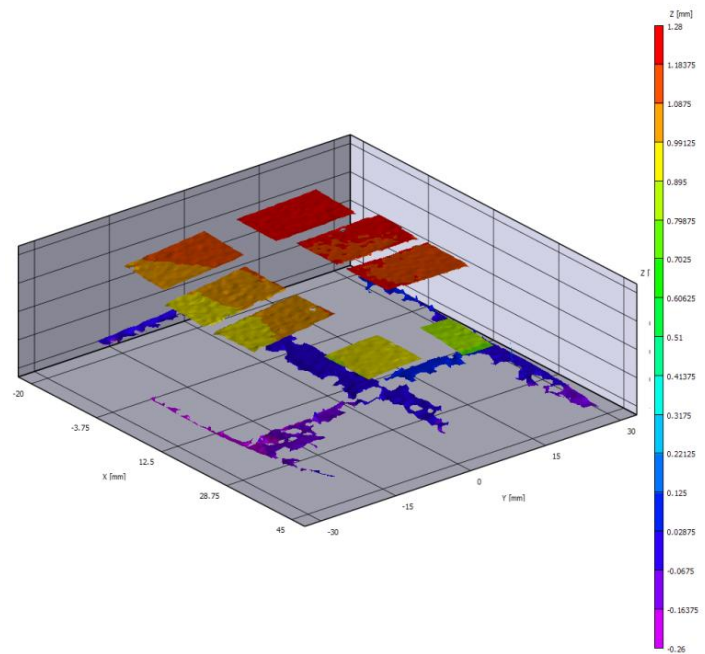
Figure 18. Y Strain map on a component surface

Figure 19. Z displacement surface plot with discontinuous surfaces

12.1   Related Tools and Software Features

- <u>DIC Hardware</u> – The hardware for the DIC Module includes two 1.4 Megapixel cameras with lenses, a movable calibration target, and necessary brackets/fixtures/cables.

- <u>Studio: DIC Surface Measurement</u> – With a very similar interface as standard Surface Measurement, this application performs data acquisition and uses the same Thermal Profiler.

- <u>Vic-3D</u> – The analysis software package for DIC.

12.2   Benefit Details

The optional DIC (Digital Image Correlation) tool is the first add-on optical measurement technique to TherMoiré systems, and it is only usable with Studio software. This optical measurement technique serves as a compliment to the base shadow moiré measurement, by providing both in-plane and out-of-plane displacements, as well as exhibiting a very high tolerance to step heights where shadow moiré has limitations. Figure 18 shows a strain map in the Y direction on a sample surface. The in-plane displacement data can be used to calculate both strain maps and CTE. Figure 19 shows a 3D surface plot of a sample with discontinuous surfaces that could not be connected using the shadow moiré technique.

The primary use for the DIC module has been its in-plane measurement capabilities and, often, specifically, CTE calculation. It is also worth noting that DIC takes measurements in less than a second for thermal testing purposes. Also, the maximum field of view for this technique is currently 88x66 mm.

13 IMPROVED SUPPORT & DEVELOPMENT

Benefit Summary: The Studio software package comes complete with renewable customer support and continued software development.

13.1 Support

Studio customers have the best access to Akrometrix experienced application engineers and corresponding representatives. Additionally, all Akrometrix PS200, PS400, and PS600 models can now be upgraded to the single, highly supportable, Studio software platform.

13.2 Development

Upgrading to the Studio software platform entitles the customer to stay at the forefront of Akrometrix software development with continuing Studio software releases. The Studio software is designed to be an expanding platform. Similar to the Part Tracking development, Akrometrix will continue to add powerful features to the Studio software package.

By upgrading to a Studio machine, customers also have the chance to contribute to the direction of Akrometrix software development. Akrometrix software development takes in software feature requests from all Studio customers and enters them into a tracking system. With this information, Akrometrix makes informed decisions in continuing to develop the Studio platform to most benefit the Akrometrix customer base.

Integration with the Windows 7 operating system is now among the many features currently in the Studio development plan.

STUDIO UPGRADE BENEFIT SUMMARY

The Studio software features detailed in this document were selected to help customers currently utilizing the TherMoiré software to better understand the value and benefits associated with upgrading their legacy TherMoiré systems to the Studio software platform.

The initial version of the Akrometrix Studio software platform was released in November of 2008. Since that time Akrometrix has continually enhanced Studio software by releasing at least one major update per year. Studio software customers are required to stay current with their annual software maintenance fees in order to continue to receive software enhancement updates. Paying the annual software maintenance fees ensures accurate correlation and compatibility with all other Studio installations worldwide.

For more information about upgrading to the Studio software platform, please contact your local Akrometrix representative.