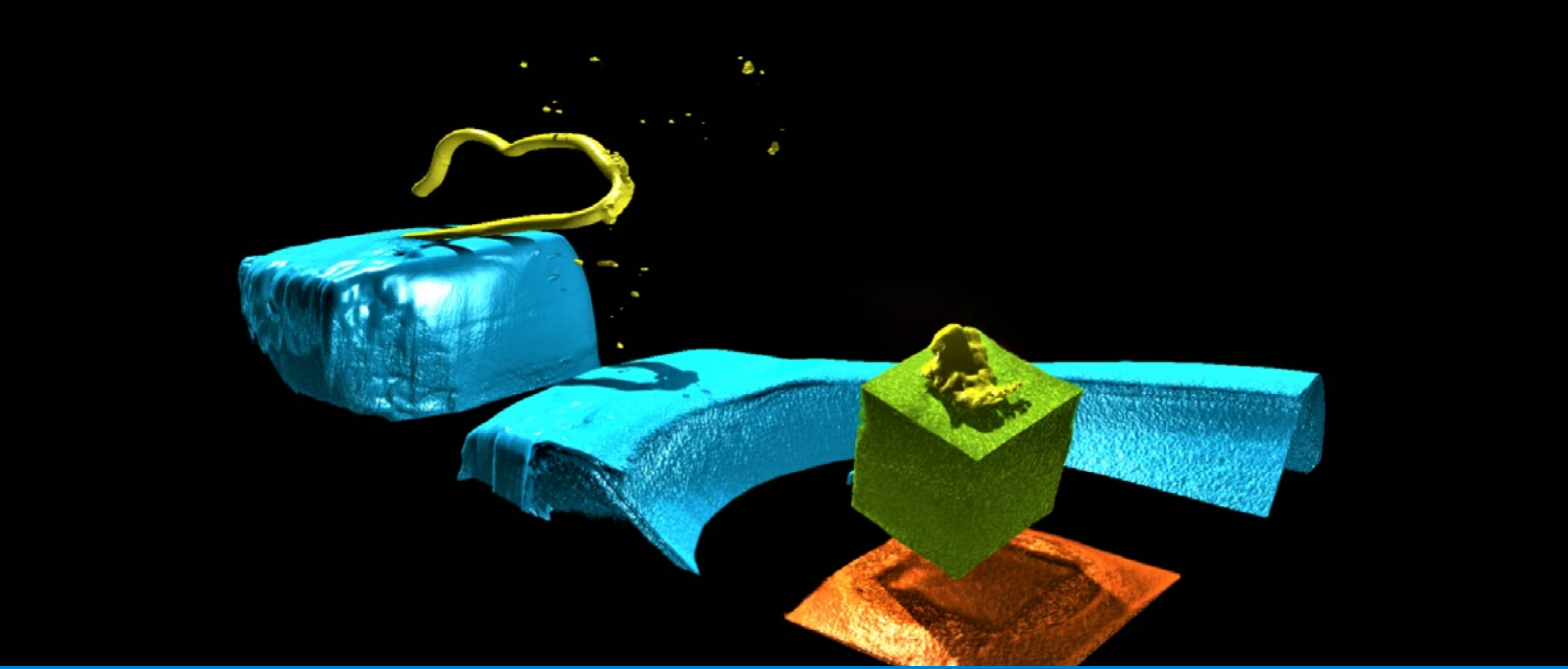

Get The Best From Your 3D Model

Application Note

Using the Volume Graphics software

There is a continuing trend for miniaturization in the electronics industry, causing packages to become more intricate through design. Ultimately, this has led to further demand for 3D non-destructive X-ray inspection. A challenge with 2D inspection is that you see all the layers to the device at the same time. 3D inspection offers the solution of layer separation for more accurate analysis.

Nordson X-ray Inspection tools use three main techniques for computed tomography (CT). **X-Plane** and **Planar CT** are ideal for quickly examining large samples while maintaining the highest magnification. **µCT** is perfect for obtaining the highest resolution results from smaller samples, typically up to 150 x 135mm.

The two CT techniques produce data that can be reconstructed into a virtual 3D model of your sample. The resolution of the model is dependent on several factors. These include the quality and quantity of 2D images captured from the X-ray system, sample set-up, magnification, and precision of reconstruction geometry.

In this note we demonstrate a selection of Volume Graphics 3D rendering algorithms available for analysis of CT data. There are several rendering algorithms available for manipulation of your 3D model such as Isosurface, Scatter HQ and Phong. These are demonstrated on the next pages with a focus on electronics applications.

Applications Requiring Measurements and Analysis

If your applications require volumetric measurements such as porosity, inclusion and wall thickness analysis then **Isosurface** rendering is ideal. This algorithm displays the surface of the selected object as defined by the surface determination line displayed on the greyscale histogram (see figure 3).

Figure 1 shows a Ball Grid Array (BGA) including porosity analysis. The measurement of voids is color coded making it easy to identify small (blue) and large (red) areas of voiding. The calculated values are displayed on a scale to the left of the image in mm^3.

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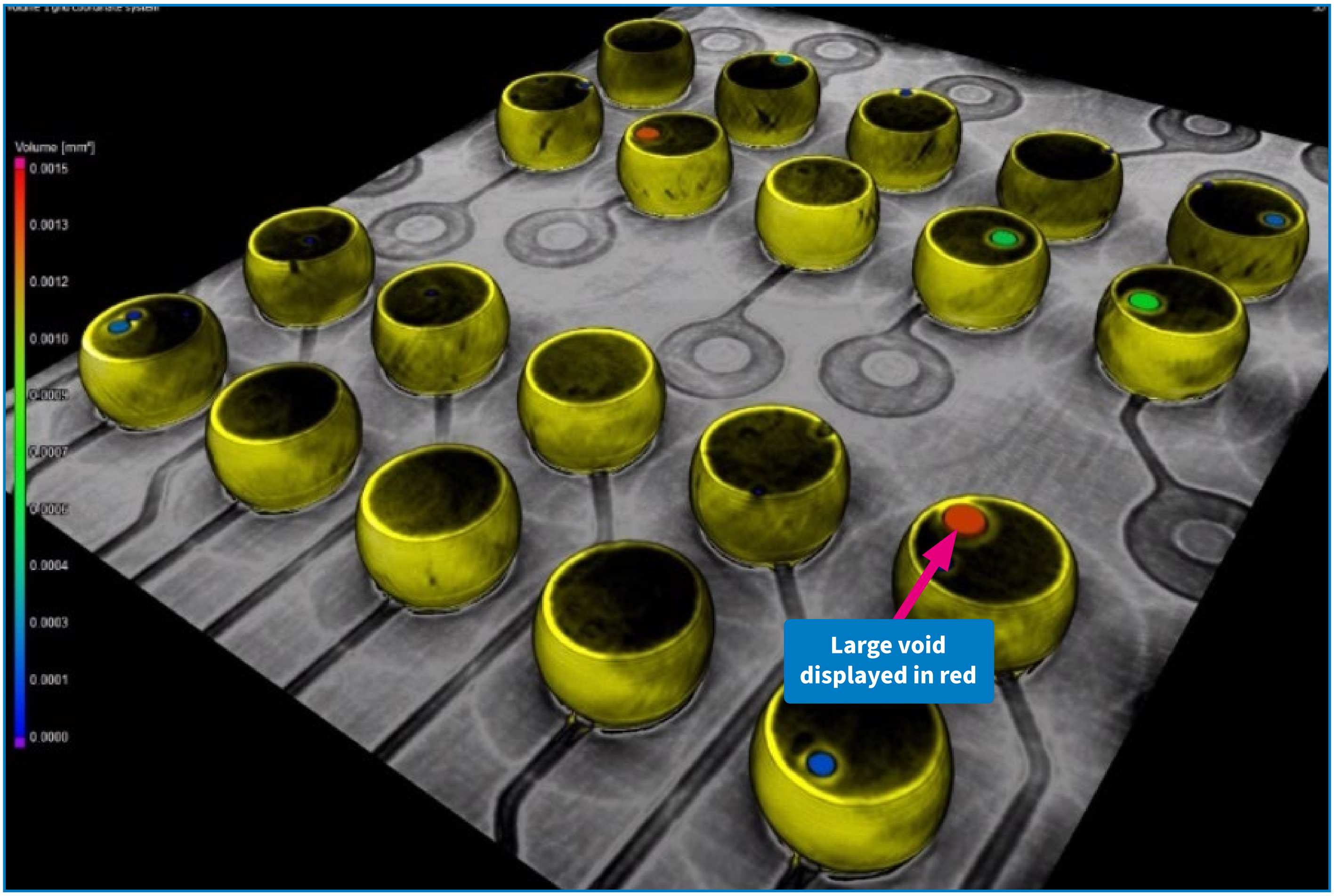

Figure 1. *Showcasing Isosurface rendering on a BGA displaying solder voiding and a crack. Data acquired using X-Plane CT.*

The 3D model can be visualized in several ways to interpret the analysis. Figure 1 shows the BGA as opaque, whereas figure 2 displays the BGA as transparent. The transparency effect is perfect for checking precise location of voiding.

Solder voiding is often caused because the device does not spend enough time above liquidus temperature during reflow, so the volatiles from the flux have insufficient time to escape the solder ball and become trapped when the solder cools.

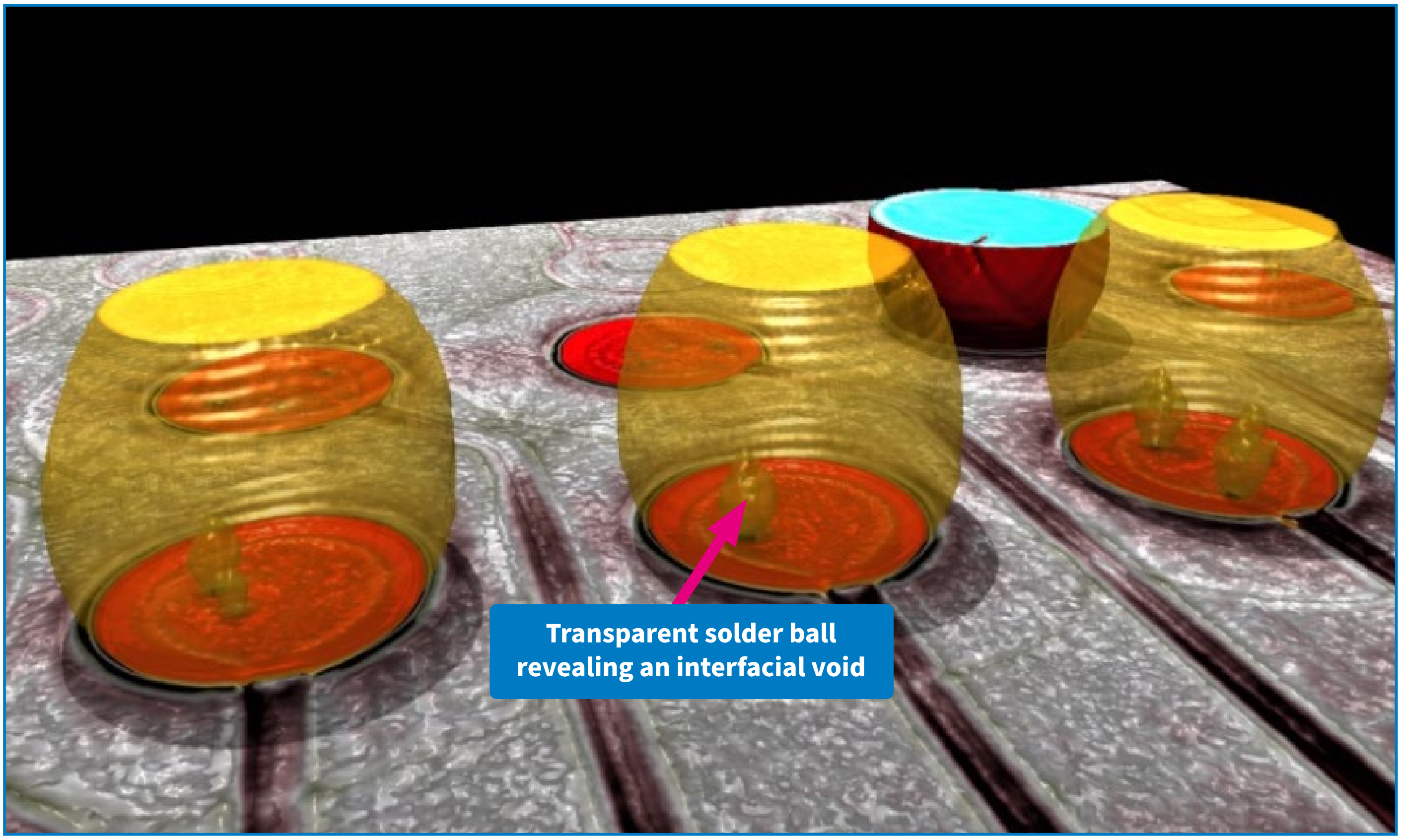

Figure 2. *Showcasing Isosurface rendering on a BGA displaying solder voiding and a crack. Data acquired using X-Plane CT.*

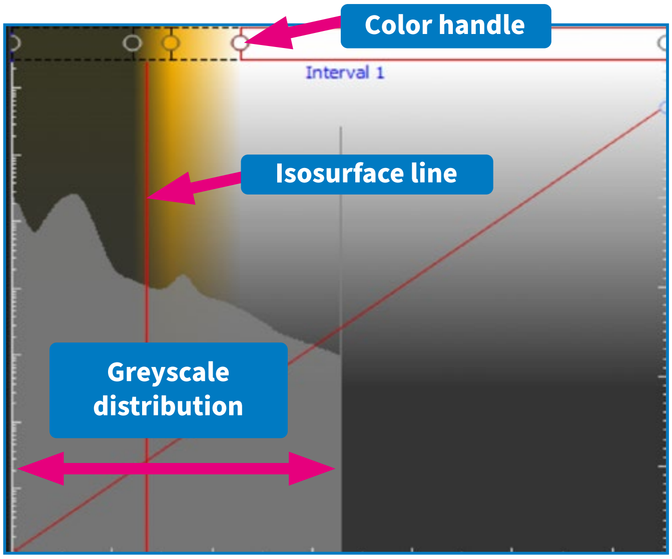

Figure 3. *Displaying the Isosurface greyscale histogram corresponding to the visualization shown in Figure 1.*

Figure 3 displays a greyscale histogram. This is used as a fine control for revealing different materials within the 3D model. Moving the Isosurface line left, and towards the peak of the greyscale will focus the 3D model on lower density materials, and moving the Isosurface line right, and away from the peak will focus the 3D model on higher density materials. In addition, several colors can be applied to distinguish the materials from each other for easier analysis.

Applications Requiring the Highest Quality 3D Models

Phong rendering emphasizes local gradients within the voxel data, and as a result this option displays the most detail compared to other algorithms. This is the ideal algorithm for visualizing low density materials, creating the highest quality 3D models, and is most suitable for animations. Below are example images demonstrating this.

Figure 4 displays a high quality 3D model revealing the build of an integrated circuit device. This 3D model acquired using Quadra's® µCT technique shows all the different materials that make up this device. There is a wide range of material density present here from silicon which has an atomic number of 14, to gold which has an atomic number of 79. Segmentation has been used to best represent each material correctly.

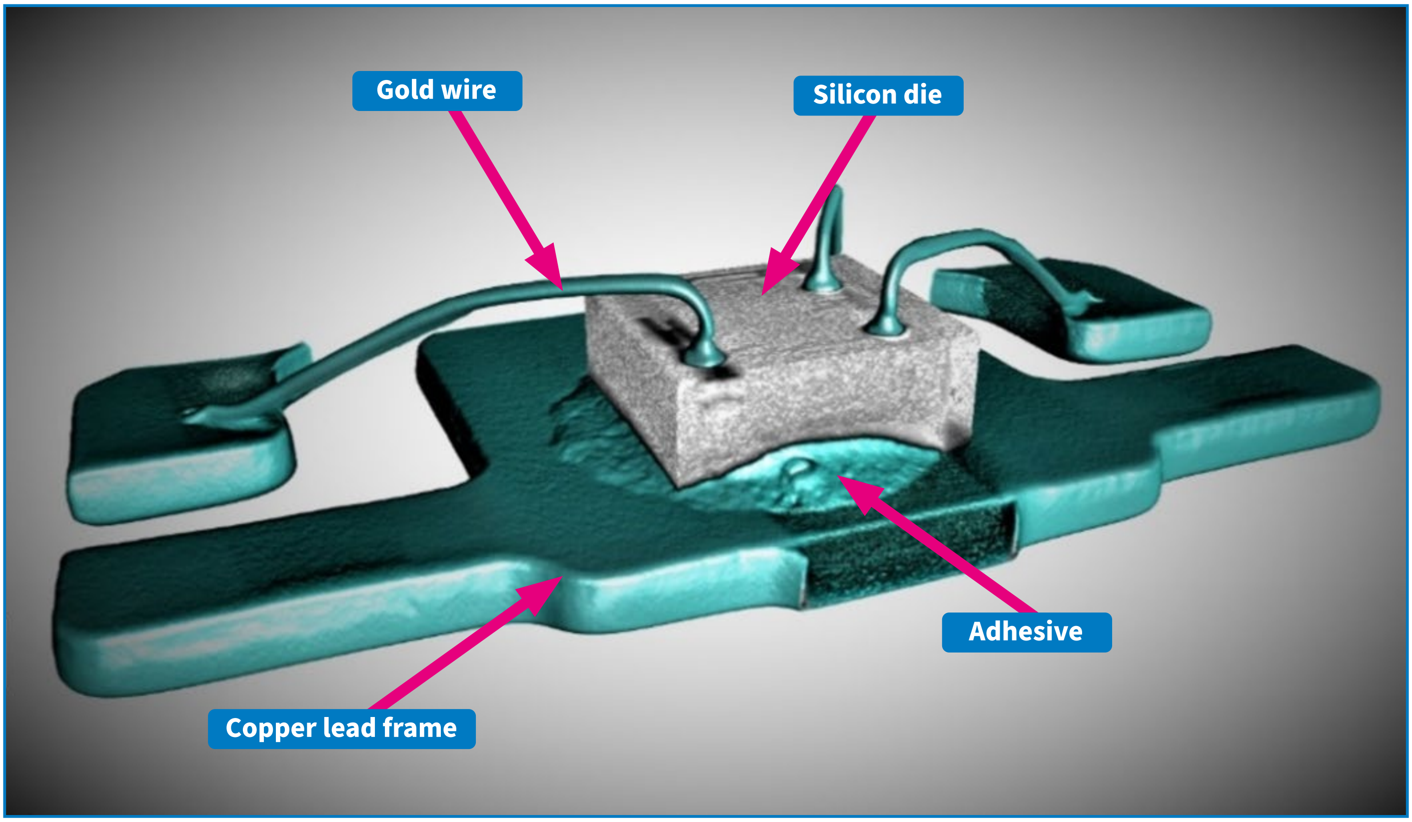

Figure 4. *Displaying an integrated circuit consisting of a variety of different materials. Data obtained using µCT.*

On this device an area typical for examination is the conductive adhesive beneath the die. Consequently, the silicon die has been removed so that the conductive adhesive can be easily inspected. A large void area is clearly seen, marked with a red box. This type of defect will weaken the connection between die and lead frame, and cause poor thermal conductance. Ultimately leading to a failure of this product.

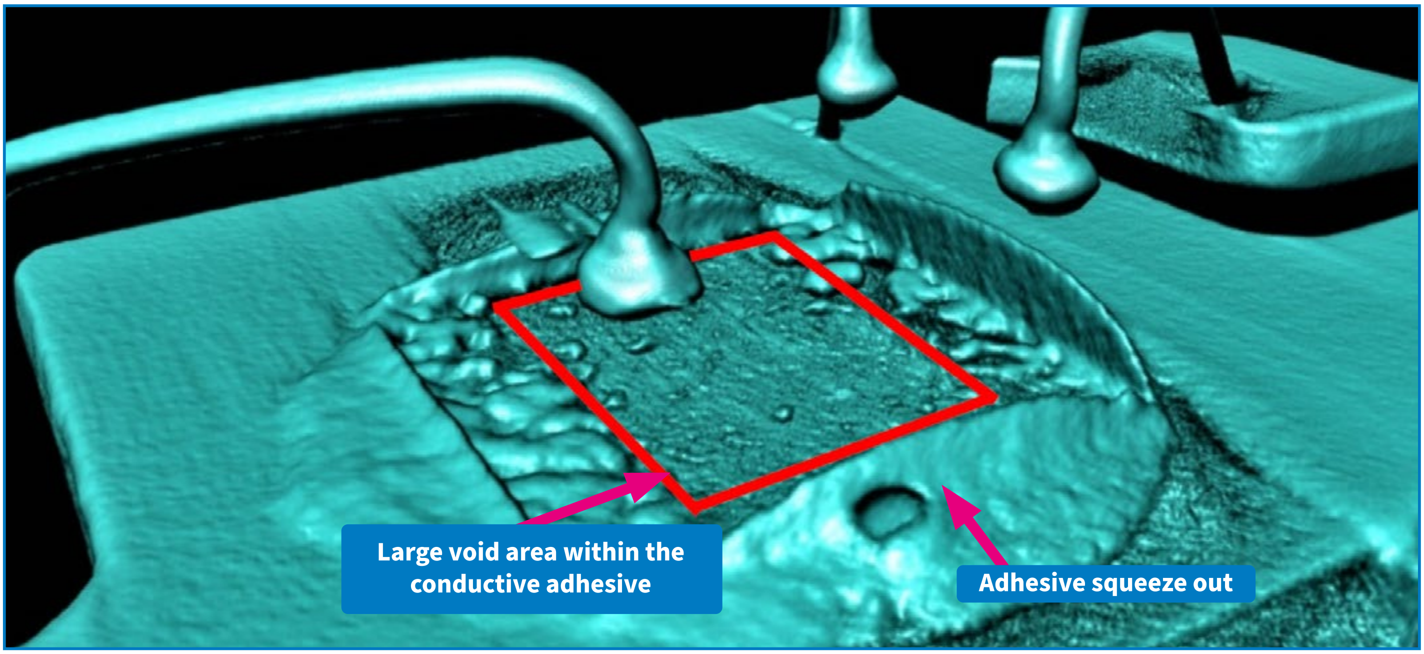

Figure 5. *Showing a large void within the conductive adhesive beneath the die. Data obtained using µCT.*

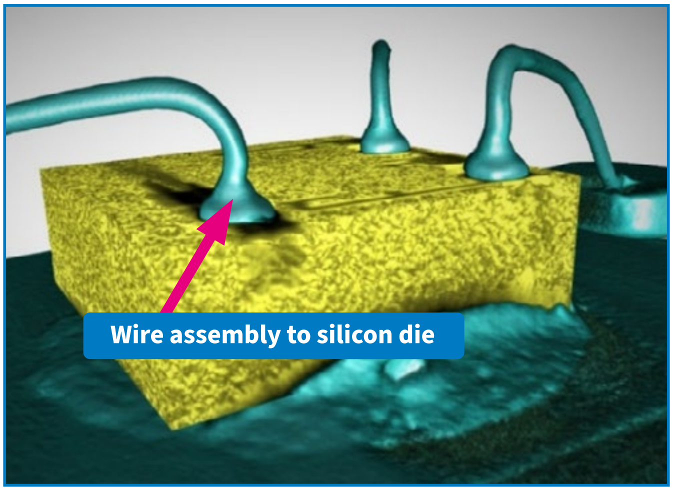

Figure 6. *Showing die placement above the adhesive and wire assembly to the die. Data obtained using µCT.*

Phong rendering is great for magnifying the model to have a closer look. The resolution is not compromised, as shown in figure 6. It is necessary to magnify the model when looking for tiny features or to see precise connections such as assembly of wires to the die, and the accuracy of die placement.

Applications Requiring Quick Processing

Scatter HQ is the all-rounder amongst the visualization algorithms and is well suited for the visualization of surface structure details, and the ideal rendering algorithm for applications requiring quick processing. Large CT models benefit from this option as the rendering speeds are fast while maintaining good resolution. This type of rendering provides a different representation of the 3D model, that in some cases works better than Phong rendering. Examples of this are shown in figure's 7 and 8.

There are several key components that make up this large 3D model including gold wire bonds, capacitors, PCB, BGA, micro-vias and adhesive. Figure 8 shows a magnified view of the BGA device, and it can clearly be seen there are several solder joints showing evidence of Head in Pillow (HiP). This defect can occur for several reasons such as insufficient reflow temperature, warping of the package and variables in the solder paste chemistry. The HiP solder joint can reveal enough of a connection to have electrical integrity but will be lacking adequate mechanical strength. Due to this, the component is likely to fail quickly once put through mechanical or thermal stress.

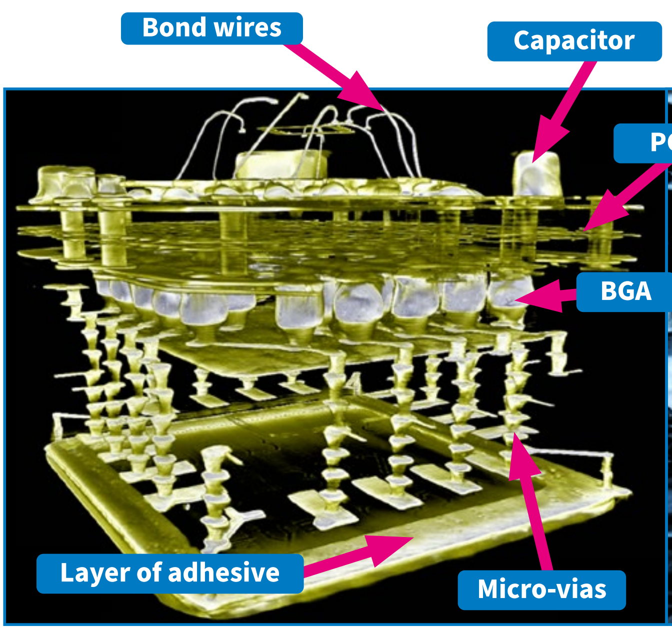

Figure 7. Showing a multi-layered integrated device. Data obtained using µCT.

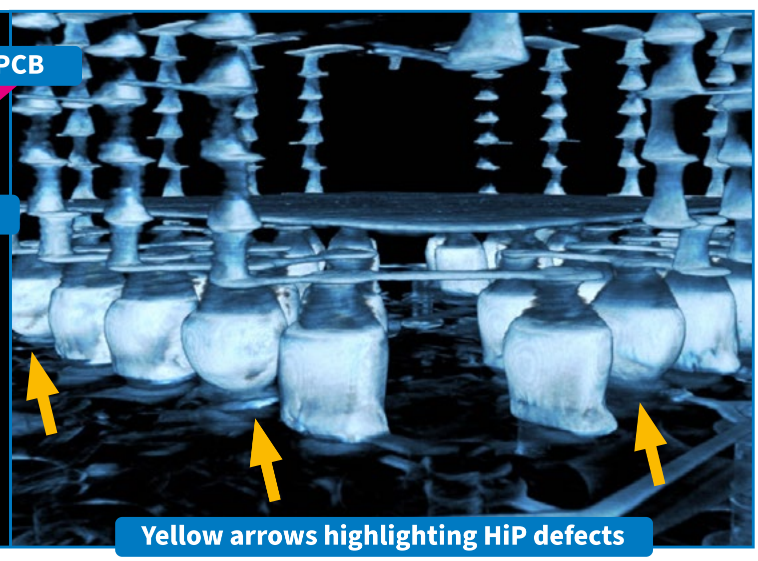

Figure 8. Showing a magnified view of the BGA where HiP defects are seen.

Get The Best From Your 3D Model **Application Note**

Summary

Using several electronics application examples, this note showcases the importance of using the correct 3D rendering algorithm for efficient analysis of CT data. The table below summarizes when best to use each rendering algorithm:

3D Rendering Algorithm	Applications requiring:
Isosurface	Measurements and analysis
Phong	Low density material inspection and the highest quality 3D model
Scatter HQ	Quick processing

For more information, speak with your Nordson representative or contact your Nordson regional office

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