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Application News

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Microfocus X-Ray Inspection System

An Example Observation of a Large Mounted Circuit Board Using Xslicer SMX-6000

Introduction

Printed circuit boards are densely mounted with various electronic components, an integrated circuit, and metal wiring to enable electronic devices to function effectively. Over time, the density of the components mounted on circuit boards has become increasingly high and circuit boards have become increasingly compact.

For a circuit board to operate properly, its components must be defect-free and the components must be connected correctly. However, in reality the production of circuit boards involves a certain level of defects. Accordingly, there is a need for inspection methods that detect defective boards efficiently and identify the cause of the defects.

Fluoroscopic observation using X-rays is one of such inspection methods. X-ray fluoroscopic observation enables efficient inspections since the internal structure of samples can be checked quickly and non-destructively. Furthermore, when circuit boards are densely mounted with components in a complex manner and as such it is difficult to inspect and analyze them by fluoroscopic observation, the cause of defects can be identified by X-ray computed tomography (CT) observation.

This article introduces an example observation of a large circuit board using the Xslicer SMX-6000 microfocus X-ray inspection system (Fig. 1) that can be used for X-ray fluoroscopic observation and X-ray CT observation.

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Fig. 1 Xslicer SMX-6000 Microfocus X-Ray Inspection System

Observation of a Mounted Circuit Board

Using the Xslicer SMX-6000, we acquired multiple images of a circuit board. Fig. 2 shows an image of the exterior appearance of the circuit board and Figs. 3 and 4 show fluoroscopic images of the ball grid array (BGA, A in Fig. 2) and transistor (B in Fig. 2) respectively. A non-destructive inspection of internal structures can be performed by creating images based on the intensity of the X-rays. An object in a fluoroscopic image appears blacker the higher its density is and whiter the lower its density is. Since the stage of the Xslicer SMX-6000 is large, large circuit boards, such as the one shown in Fig. 2, can be accommodated so that each component can be observed without cutting the circuit board.

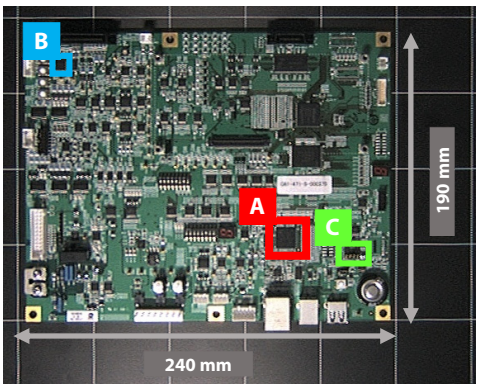

Fig. 2 Exterior Image of an Electronic Circuit Board

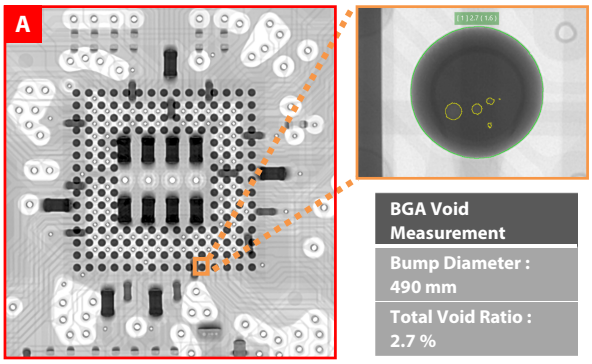

Fig. 3 Fluoroscopic Image of the BGA (A) and Void Ratio Measurement Results

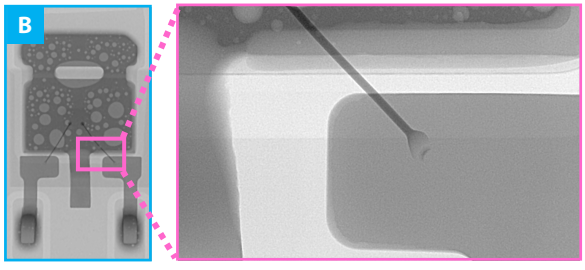

Fig. 4 Fluoroscopic Image of the Transistor (B)

By increasing the observation magnification, voids in the BGA (Fig. 3) and the state of wire bonding (Fig. 4) can be observed in detail. In addition, pass (OK)/fail (NG) evaluation can be performed for BGAs based on arbitrary thresholds by extracting the solder bump sections and the void sections and calculating the void ratio (the yellow sections in Fig. 3 are voids). These measurements can also be performed with the later described CT cross-sectional images.

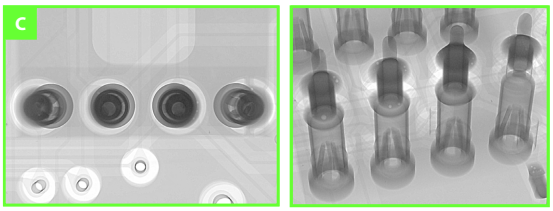

Fig. 5 Fluoroscopic Images of Pins (C)
(Left: No inclination, Right: Tilted at 45 degrees)

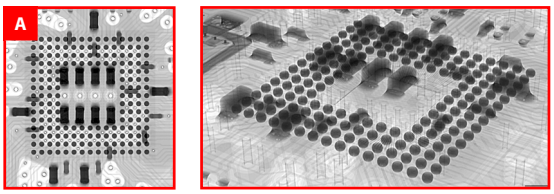

Fig. 6 Fluoroscopic Images of the BGA (A)
(Left: No inclination, Right: Tilted at 45 degrees)

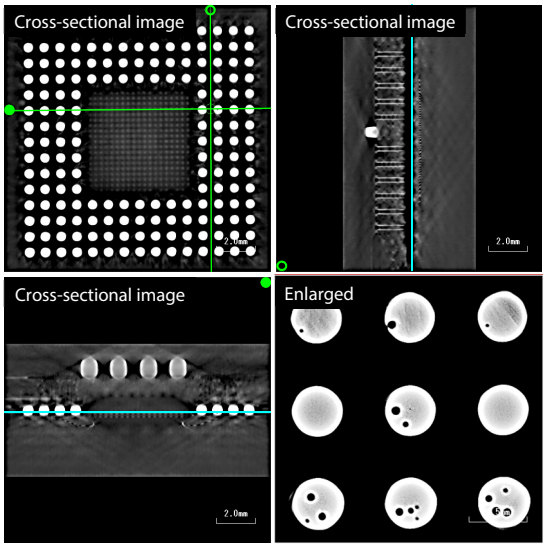

Fig. 7 MPR Images of the BGA

As shown in Figs. 5 and 6, components with structures that are difficult to observe from a position directly above can be effectively observed by tilting the detector. By observing components from various angles, the operator can intuitively grasp the structure and gain an understanding of the defective areas.

At the same time, it can be difficult to observe components even by tilting the detector when circuit boards have a multi-layer structure. In these cases, inspections can be performed by acquiring cross-sectional data using CT imaging.

Multi-planar reconstruction (MPR) images acquired by CT imaging are presented in Fig. 7. An MPR image is created by displaying an arbitrary cross-section from a data set acquired by CT imaging; transverse section images (above left) and orthogonal longitudinal section images (above right and bottom left) can be observed simultaneously. The bottom right image is a high magnification image that was acquired separately. Defects can be detected and analyzed easily as the operator can observe a single specific cross-section. SMX-6000 employs a CT imaging method called inclined CT. This method is particularly suitable for acquiring high magnification images of large circuit boards.

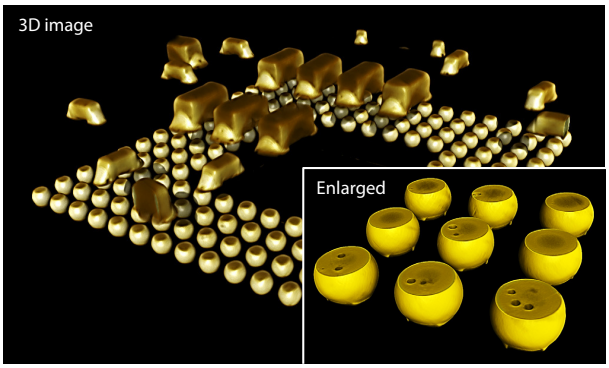

Fig. 8 3D Images of the BGA

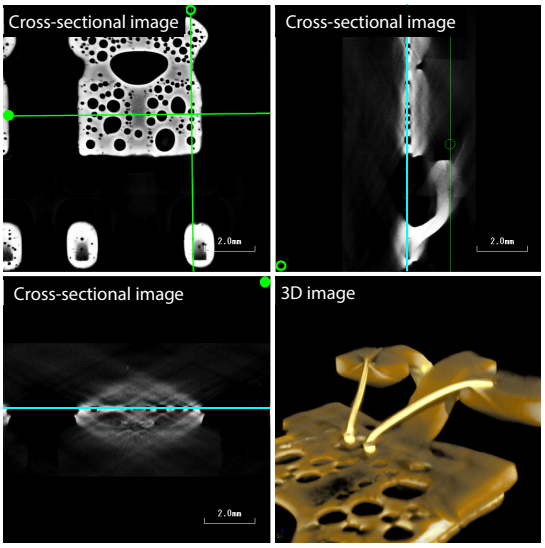

Fig. 9 MPR Images and a 3D image of the Transistor

The image shown in Fig. 8 is a 3D display of the same data shown in Fig. 7. As with Fig. 7, the bottom right image is a high magnification image that was acquired separately. The relative positions of components and the overall structure can be grasped even more easily in these images than in fluoroscopic and MPR images.

The images presented in Fig. 9 are of the transistor acquired at the same magnification as that used for Fig. 7. An inclined CT imaging system is advantageous because all components can be observed at high magnification regardless of their positions on the circuit board.

The above left cross-sectional image demonstrates that many voids are highly concentrated at a layer of a certain height. The void ratio measurement presented in Fig. 3 can be applied to this image as well. In addition, the three-dimensional form of a wire can be checked easily by observing it with a 3D image.

Conclusion

Inspection methods appropriate for the observation point and details can be selected when performing inspections with Xslicer SMX-6000. Any operator can perform inspections easily and efficiently with this system by acquiring data of the internal structures while switching between fluoroscopic observation and CT observation seamlessly.

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