Application News

Xslicer™ SMX™-6010 Microfocus X-Ray Inspection System

Inspection of Defects in an Automotive Inverter Component with X-Ray Inspection System

Tsuginosuke Hashimoto

User Benefits

- The internal structure of inverter components can be visualized and inspected in a short time without disassembly by fluoroscopic imaging.
- The overlapping structure of components can be visualized individually by CT imaging.
- It is useful for quality control and improvement of products by observing in detail the location and shape of internal defects.

■ Introduction

An inverter is an important component in an electric vehicle and is responsible for converting the DC power of the battery into AC power to drive the motor. By creating alternating current of any frequency, fine control of the motor output is possible, so the design and performance of the inverter will affect the electrical power consumption and power performance of the vehicle.

To improve electrical power consumption and power performance, inverters are required to be able to conduct large current with as little loss as possible, but the greater the current flowing through the electronic components in the inverter, the greater the risk of failure due to heat generation. Therefore, it is important to consider designs that reduce heat generation as well as to inspect components for defects that lead to heat generation.

In this paper, nondestructive observation of the inside of an inverter component (IGBT module) using the Xslicer SMX-6010 microfocus X-ray inspection system is introduced.

Fig. 1 Microfocus X-Ray Inspection System Xslicer^{TM} SMX^{TM}-6010

■ Observation of an Inverter Component

Fig. 2 shows a fluoroscopic image of the inside of an inverter component in a resin case using the panoramic imaging function. Panoramic imaging creates a single image by joining several fluoroscopic images, which is effective for observing the entire image at a glance. In fluoroscopic images, areas with smaller density and thickness appear brighter, while areas with larger density and thickness appear darker. Fig. 3 shows an image of the IC chip of the component observed at different magnifications, showing voids in the observed area. Since voids in solder joints and other components of electronic components can reduce thermal conductivity and joint strength, it is advisable to use components and joint methods with as few voids as possible. As shown in Fig. 4, it is also possible to observe the three-dimensional shape of components such as springs by changing the tilt and rotation angles of the detector. However, in fluoroscopic images, the multilayer structure at the observation point is projected onto a plane, so the structure may be difficult to understand.

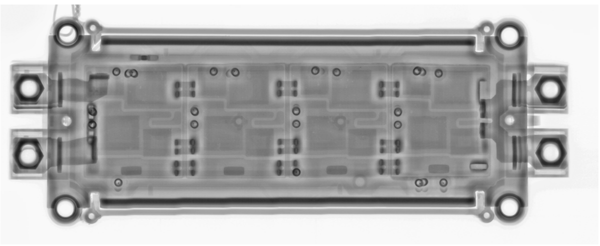


Fig. 2 Fluoroscopic Panoramic Image of the Entire Inverter Component

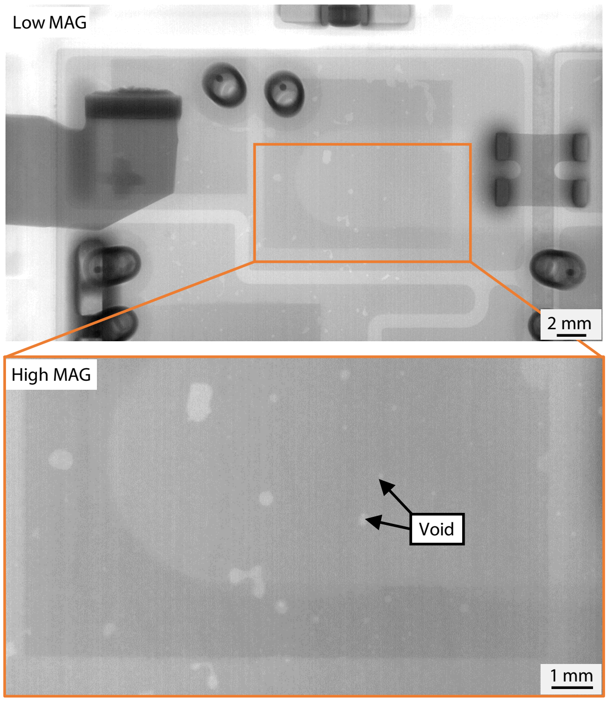


Fig. 3 Fluoroscopic Images of the Inverter Component

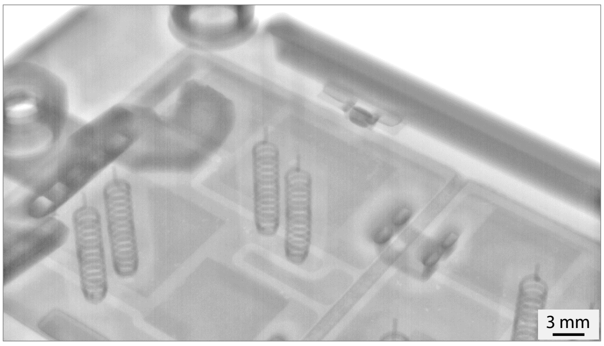


Fig. 4 Oblique Fluoroscopic Image of the Inverter Component

Fig. 5 shows cross-sectional images obtained by CT observation of the IC chip observed in Fig. 3. Unlike fluoroscopic images, low-density areas appear darker and high-density areas appear brighter. For the two cross-sectional images, the vertical and horizontal positions are the same, but the positions in the thickness direction are different. It is easy to understand the height information and shape of voids that are difficult to determine through fluoroscopy.

Fig. 6 shows an example of measuring the distance and angle of the component and voids from the cross-sectional image using measurement functions. Fig. 7 shows an example of using the area ratio measurement function to measure the area ratio and number of voids (shown by yellow lines) in the region of interest (shown by blue lines) set in the cross-sectional image. In this way, by using various measurement functions based on cross-sectional images, it is possible to quantitatively evaluate component shapes and defects, focusing only on the area of interest, and determine the quality of the internal structure.

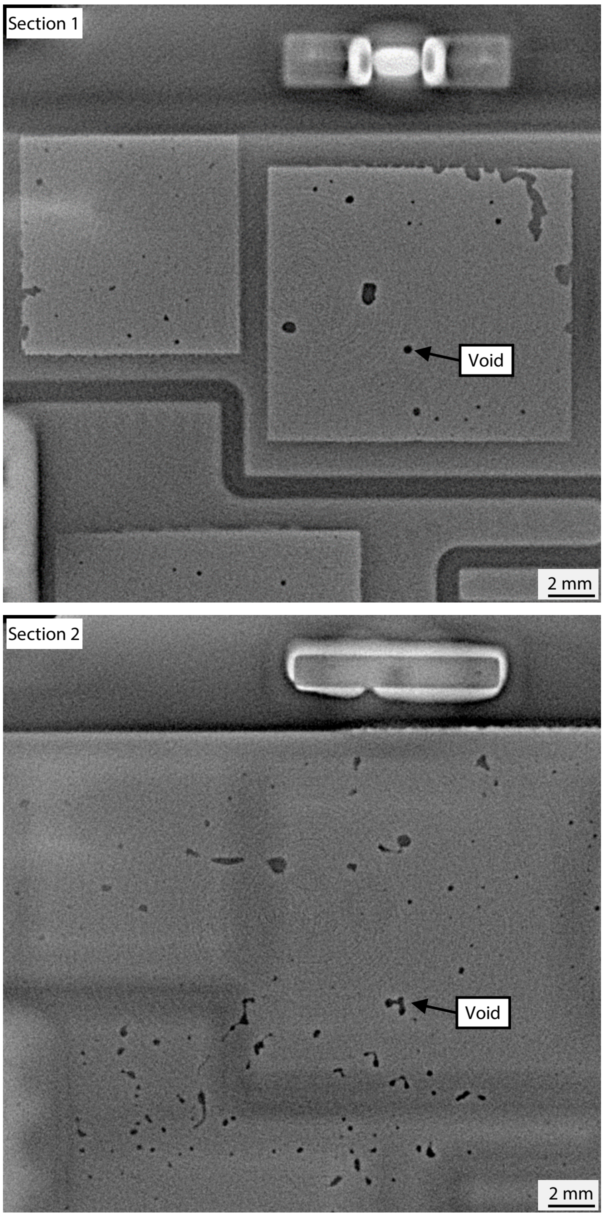


Fig. 5 Cross-sectional Images of the Inverter Component with Different Positions in the Thickness Direction

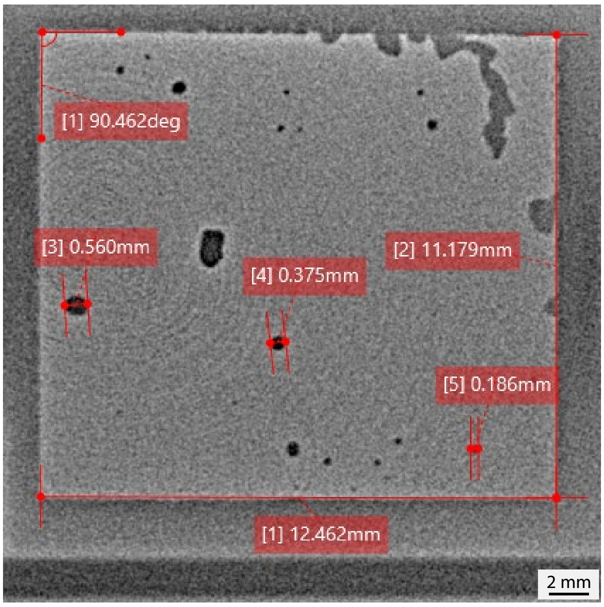
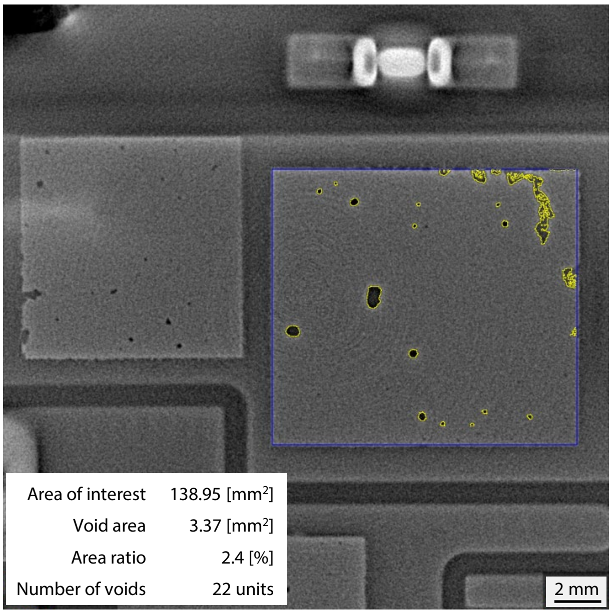


Fig. 6 Dimension Measurement inside the Inverter Component



Area of interest	138.95 [mm^2]
Void area	3.37 [mm^2]
Area ratio	2.4 [%]
Number of voids	22 units

Fig.7 Area Ratio Measurement of Voids in the Inverter Component

■ Conclusion

As described above, the micro-focus X-ray inspection system can visualize the internal structure of the inverter component nondestructively and easily. While observing the entire structure and defects in a short period of time with fluoroscopic images, if the product has a multilayer structure, the location and shape of the defects can be examined in detail by performing CT imaging. This is useful for quality control of products because it enables quick inspection while switching the observation method and function according to the object and purpose.

Xslicer and SMX are trademarks of Shimadzu Corporation or its affiliated companies in Japan and/or other countries.

SHIMADZU
Shimadzu Corporation
www.shimadzu.com/an/

01-00509-EN First Edition: Mar. 2023