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Application News

inspeXio™ SMX™-225CT FPD HR Plus Microfocus X-Ray CT System

Void Analysis and Shape Analysis of Automobile Inverter Components with X-Ray CT System

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User Benefits

- The size and distribution of voids, which can cause problems in inverter components, can be analyzed by non-destructive visualization of the internal structure.
- The shape of the components can be efficiently evaluated by analyzing the wall thickness over a large area at once.
- CT data can be converted into a mesh data format, which can be used for 3D printing.

■ Introduction

Inverters are an important component of electric vehicles, converting DC power from the battery into AC power to drive the motor. Optimizing the power control of the inverter improves the vehicle's dynamic performance and fuel efficiency, so it is important to develop products that can pass large currents with low losses to improve vehicle performance.

During inverter operation, a large current flows through the component parts, causing them to generate heat. For this reason, metal is used for inverter cases due to its good heat dissipation properties, perform quality control. and most of them are manufactured by the casting process, which has excellent productivity. However, the casting process has the disadvantage that voids tend to occur, which may cause strength loss and leakage. X-ray CT systems are used to visualize the presence and distribution of casting voids and to perform quality control.

This article presents an example of observation and analysis of inverter components*1, mainly the case, using the inspeXio SMX-225CT FPD HR Plus microfocus X-ray CT system (Fig. 1).

*1 Some components such as electronic circuit boards were removed and are not included in this example.

Fig. 1 inspeXio™ SMX™-225CT FPD HR Plus Microfocus X-Ray CT System

■ Fluoroscopic Image, Cross-Sectional Image

Fig. 2 shows a fluoroscopic image of the inverter component observed this time, showing the outer case and the inner electronic components such as capacitors and transistors. In fluoroscopic images, areas with lower densities and thicknesses are displayed brighter, while areas with higher densities and thicknesses are displayed darker. Although the fluoroscopic image is effective for a quick observation of the type and shape of the component parts, it is sometimes difficult to observe the details of an object with a complex structure because the parts overlap, as shown in the magnified image.

Fig. 3 and Fig. 4 show CT cross-sectional images of the same area as the image in Fig. 2, showing the transistor, cooling fins, and case. Unlike the fluoroscopic image, the CT image is darker in areas of lower density and brighter in areas of higher density. Compared with a fluoroscopic image, the parts are displayed individually and can be observed in detail. Also, voids in the case can be clearly visualized.

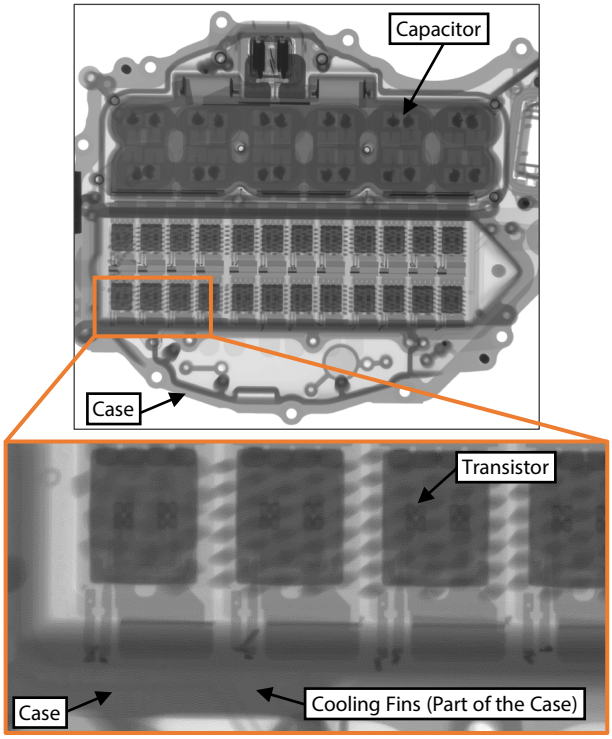

Fig. 2 Fluoroscopic Image of the Inverter Component

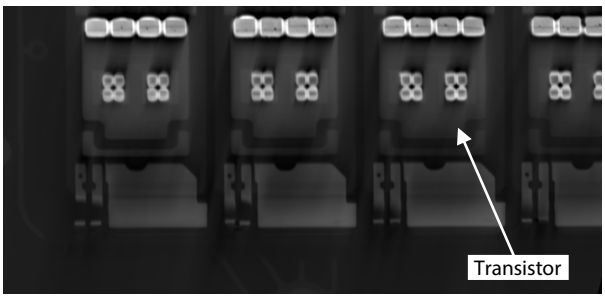

Fig. 3 Cross-Sectional Image of Transistor

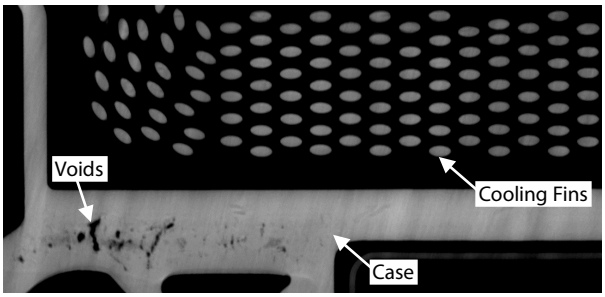

Fig. 4 Cross-Sectional Image of Cooling Fins and Case

■ Void Analysis, Wall Thickness Analysis, Mesh Data Conversion

Image analysis processing software can not only visualize voids, but also analyze their number and size. Fig. 5 shows a cross-sectional image of voids analyzed using the image analysis processing software VGSTUDIO MAX + Porosity / Inclusion Analysis Module. The voids are colored according to their volume, with colder colors indicating smaller volumes and warmer colors indicating larger volumes. The analysis results can also be shown in a 3D representation as shown in Fig. 6, making it easier to understand the 3D location, shape, and size of voids. Analysis results can also be displayed as a histogram as shown in Fig. 7. The horizontal axis in Fig. 7 shows the volume of voids and the vertical axis shows the number of voids, indicating how many and what size voids are included in the analysis range.

In addition to the observation and analysis of voids, the X-ray CT system can be used to check the shape of products. Fig. 8 is a color-coded image of the wall thickness of an inverter case analyzed with the VGSTUDIO MAX + Wall Thickness Analysis Module. Thin areas are indicated by cold colors and thick areas by warm colors. By this analysis, thickness can be checked over a large area at once. Fig. 9 is an image of the thickness of only the cooling fins analyzed in the same way. Since the coloring is applied to a narrower area, it is easier to capture minute differences in thickness.

Furthermore, by converting CT data with VGSTUDIO MAX, mesh data can be created as shown in Fig. 10. Mesh data, which consists of a collection of triangles or rectangles, is used for 3D printing and various analysis simulations.

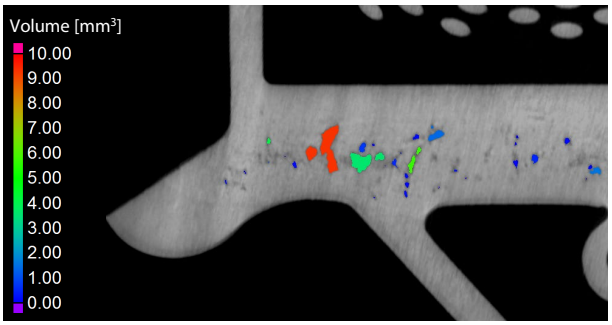

Fig. 5 Cross-Sectional Image of the Void Analysis of the Inverter Case

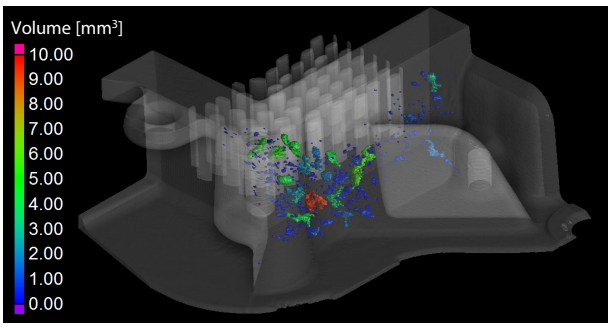

Fig. 6 3D Representation of the Void Analysis of the Inverter Case

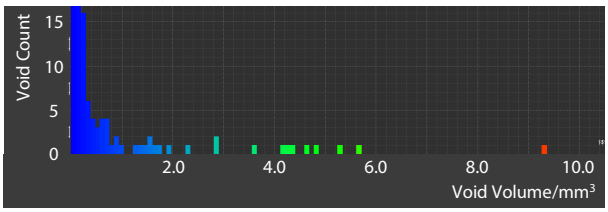

Fig. 7 Histogram of the Void Analysis of the Inverter Case

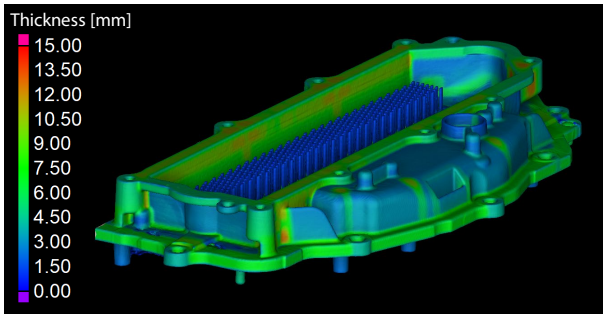

Fig. 8 Wall Thickness Analysis of the Inverter Case

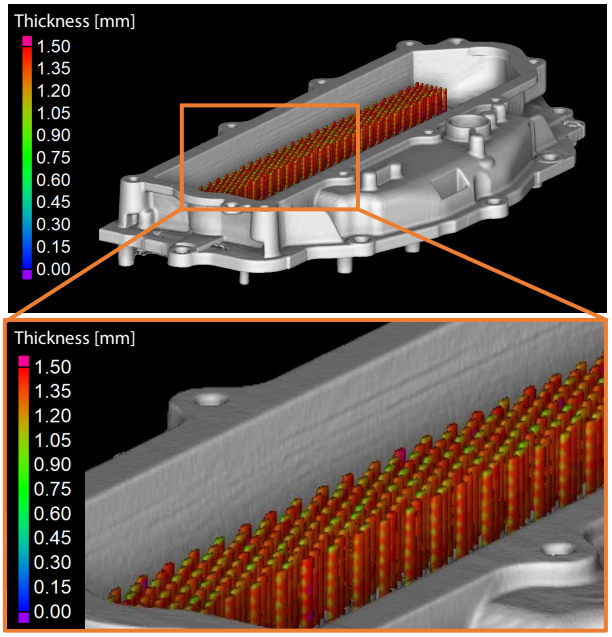

Fig. 9 Wall Thickness Analysis of the Cooling Fins

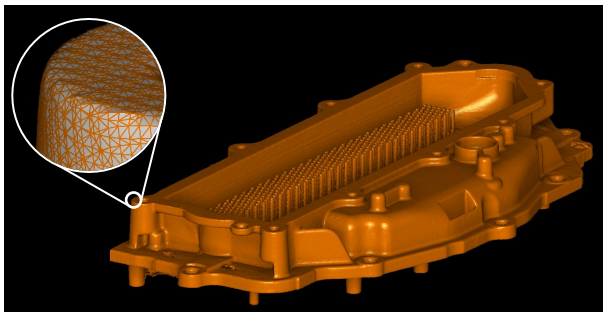

Fig. 10 Mesh Data for the Inverter Case

■ Conclusion

The microfocus X-ray CT system enables non-destructive visualization of the complex 3D structure of inverter parts, and observation and analysis of casting voids that cause strength loss and leakage. In addition, it is also possible to confirm that the product has been manufactured to the shape as designed, and to output mesh data that can be used for 3D printing and various analysis simulations. This is expected to be widely used in product quality control and research and development.

01-00609-EN First Edition: Sep. 2023

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