Excellence in Science

Application News

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

Example of Observing Dissimilar Metal Material Joint Using a Microfocus X-Ray CT System

Tsuginosuke Hashimoto

User Benefits

- X-ray CT imaging enables visualization of the internal structure of dissimilar metal material joint nondestructively.
- The quality of the joining material can be evaluated by observing and analyzing the dispersion of small metal pieces and voids in the metal that occur during the joining operation.

■ Introduction

In order to reduce CO_2 emissions and make efficient use of resources, weight reduction of automobiles and aircraft has become an important issue. Against this backdrop, the use of multi-materials to reduce body weight is being promoted by replacing high-strength but heavy component parts with moderately strong but light components where the impact is small. In order to promote the use of multi-materials, it is necessary to evaluate various joining materials and to consider better combinations of materials and joining methods.

X-ray CT observation is one of the techniques for evaluating joining materials. Using this technique, the three-dimensional internal structure of the object can be easily visualized nondestructively to observe internal defects in the joining material, and to observe and analyze the dispersion state of small metal particles generated during joining.

Here, an example of observing and analyzing joining materials of aluminum alloy and carbon steel using inspeXio SMX -225 CT FPD HR Plus, the micro-focus X-ray CT system (Fig. 1), is presented.

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

■ Observation of Dissimilar Metal Material Joints

Fig. 2 shows fluoroscopic images of materials in which the ends of carbon steel and aluminum alloy were joined by friction stir welding. Samples 1 and 2 were prepared under the same conditions. In fluoroscopic images, areas absorbing less X-rays due to lower density or thickness appear white, while areas absorbing more X-rays due to higher density or thickness appear black. In Fig. 2, parts of the aluminum alloy in samples 1 and 2 are observed to be darker than the surrounding areas, indicating that some of the carbon steel that became small pieces during joining has been dispersed in the aluminum alloy.

Fig. 3 shows cross-sectional images obtained by X-ray CT. In contrast to fluoroscopic images, areas that absorb less X-rays are black, and areas that absorb more X-rays are white. Comparing the cross-sectional images of the two samples, only sample 2 shows a void around the carbon steel piece. Although the samples were prepared under the same conditions, there was a difference in the presence or absence of voids in samples 1 and 2 in the areas observed this time. With dedicated image analysis processing software, it is also possible to create the three-dimensional representations shown in Fig. 4 from the cross-sectional images obtained by X-ray CT.

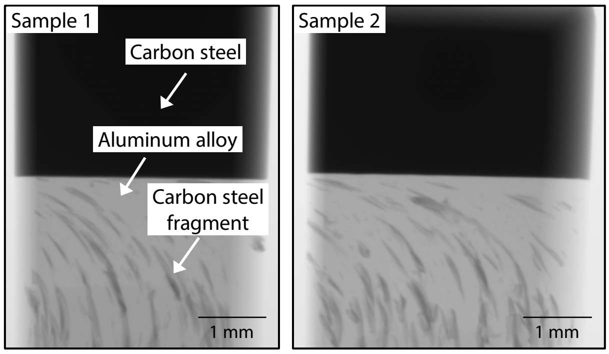

Fig. 2 Fluoroscopic Images of Joining Materials

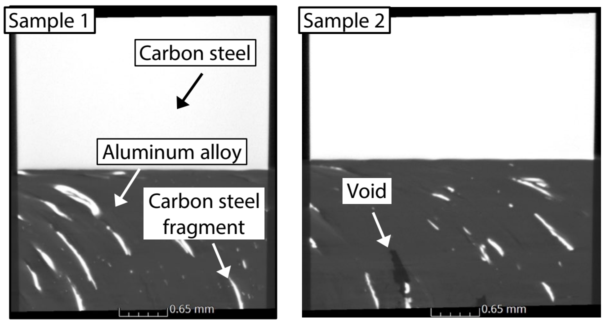

Fig. 3 Cross-Sectional Images of Joining Materials

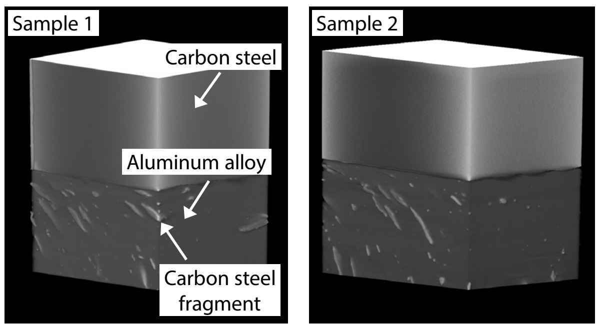

Fig. 4 Three-Dimensional Representations of Joining Materials

Fig. 5 shows three-dimensional representations obtained by volume analysis of the small pieces of carbon steel in the two samples. To make it easier to observe the position and size of the carbon steel pieces, the aluminum alloy is shown translucently, and the carbon steel pieces are colored according to their volume. Both samples show carbon steel pieces of varying size in the aluminum alloy.

In Fig. 6, the analysis results for the same small pieces of carbon steel are displayed in histograms. There was no significant difference in volume ratio or distribution of volume of carbon steel pieces to aluminum alloy between the two samples.

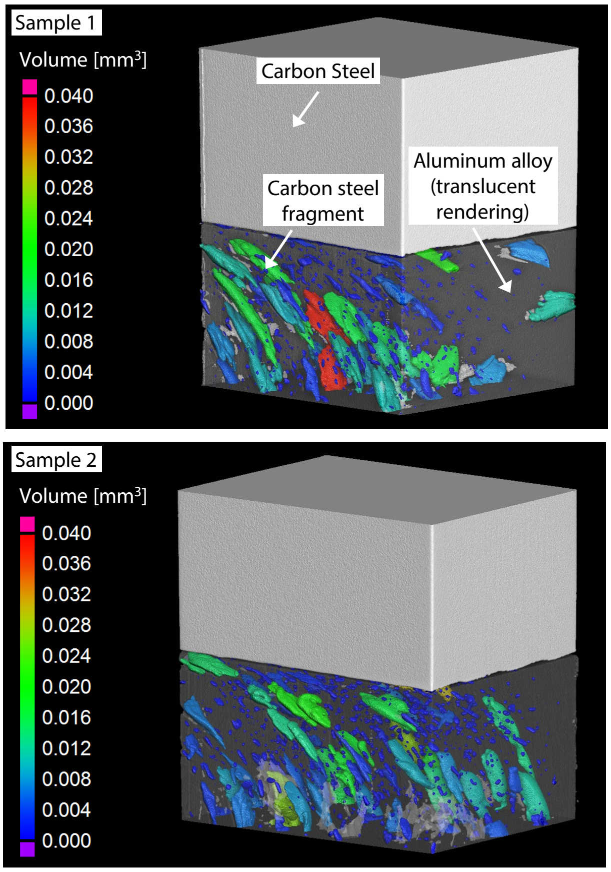

Fig. 5 Three-Dimensional Representations of Volume Analysis of Carbon Steel Pieces

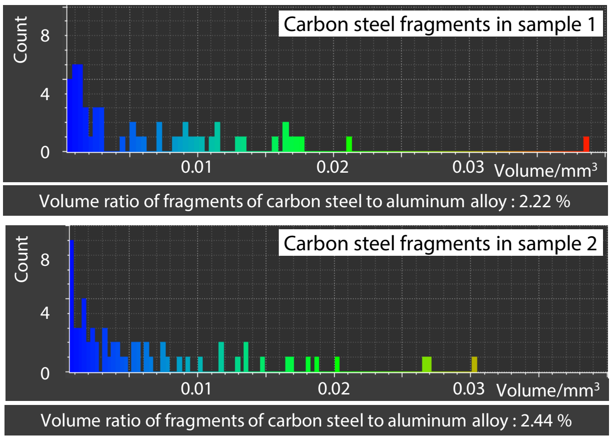

Fig. 6 Histogram of Volume Analysis of Carbon Steel Pieces

inspeXio and SMX are trademarks of Shimadzu Corporation in Japan and/or other countries.

Fig. 7 shows three-dimensional representations obtained by volume analysis of the voids in the two samples, and Fig. 8 shows histograms of the analysis results for the voids. Aluminum alloy is shown translucently, and voids are colored according to volume. The number and distribution of voids and the volume ratio to aluminum alloy were found to differ between the two samples, and the differences regarding the presence or absence of voids observed qualitatively in Fig. 3 are quantified.

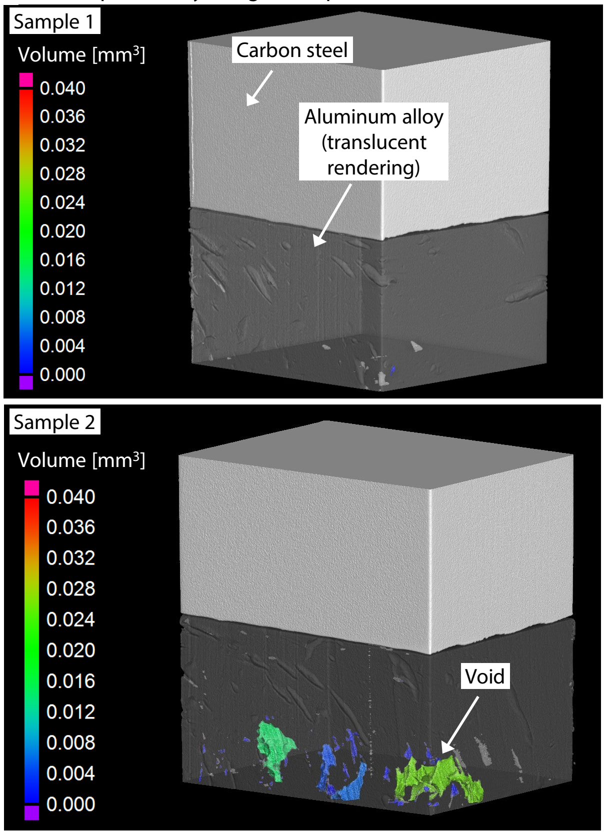

Fig. 7 Three-Dimensional Representations of Volume Analysis of Voids

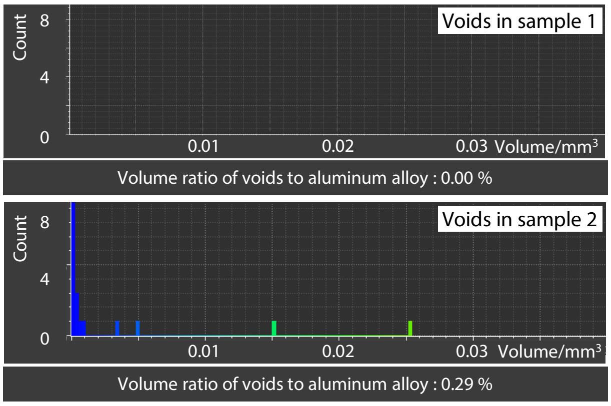

Fig. 8 Histogram of Volume Analysis of Voids

■ Conclusion

As demonstrated in this example, the microfocus X-ray CT system enables the visualization of small metal pieces and voids in dissimilar metal material joints and the calculation of their location and volume distribution, which can be used to improve joining conditions and to control the quality of joining samples.

Finally, the author expresses deep gratitude to Professor Masaki Okane of Toyama Technical College for providing the test pieces.

SHIMADZU

Shimadzu Corporation
www.shimadzu.com/an/

01-00383-EN First Edition: Dec. 2022

Related Products Some products may be updated to newer models.

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

Related Solutions

Engineering Materials

Observation

Price Inquiry

Product Inquiry

Technical Service / Support Inquiry

Other Inquiry