MLF Experimental Report

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課題番号 Project No.
2013B0149

実験課題名 Title of experiment
Measurement and modeling of residual stress distribution in dissimilar invar joint by HIP

実験責任者名 Name of principal investigator
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装置名 Name of Instrument/（BL No.）
TAKUMI/ BL19

実施日 Date of Experiment
March 10th – March 12th, 2014

試料、実験方法、利用の結果得られた主なデータ、考察、結論等を、記述して下さい。（適宜、図表添付のこと）
Please report your samples, experimental method and results, discussion and conclusions. Please add figures and tables for better explanation.

1. 試料 Name of sample(s) and chemical formula, or compositions including physical form.

HIP invar-SS316L joint with a dimension of 20mm x 100mm x 200mm

- processing temperature : 1173 K
- Invar side: Fe-36Ni Invar alloy/ fcc
- SS316L side: SUS316L stainless steel/ fcc

2. 実験方法及び結果（実験がうまくいかなかった場合、その理由を記述してください。）
Experimental method and results. If you failed to conduct experiment as planned, please describe reasons.

The residual stress distribution of the Invar-SS316L HIP joint was measured using neutron diffraction with TAKUMI to verify the stress distribution numerically simulated by the Finite Element Method (FEM). High resolution mode (designed to be $\Delta d/d$~0.2) was utilized to reduce the data scattering associated with the large grain effect. The gauge volume was 2x2x20 mm^3 for all three directions, i.e. transverse, normal and longitudinal directions. The stress distributions were measured in the transverse path within ±50mm from the bonding interface at 2 mm and 10 mm depths. Diffraction patterns from the specimen over the range of *d*-spacing from 0.5 to 2.7 Å were measured in all three directions simultaneously using both detector banks installed at $\pm 90^{o}$. The average lattice constants were determined by multi-peak fitting procedure using Z-Rietveld code. The average lattice constant for all three directions at ±50mm were defined as the stress-free lattice constant.

Figure 1 shows the residual stress distributions of Invar-SS316L HIP joint measured by neutron diffraction. The results can be described as follows.

1. Residual stresses at 10 mm depth are larger than that at 2mm depth because of a strong restriction.
2. Residual stress in each direction seems to be balanced between SS316L and Invar sides.
3. Tensile and compressive residual stresses appear in longitudinal direction for SS316L and Invar sides, respectively, which can be explained by the difference in thermal expansion coefficient between these materials.
4. Transverse and normal stress distributions show different behavior at between 2 mm and 10 mm depth.

This is the first result to measure the residual stress distribution of the Invar-SS316L HIP joint using neutron diffraction. In the next step, we will verify this result by comparing it with FEM result.

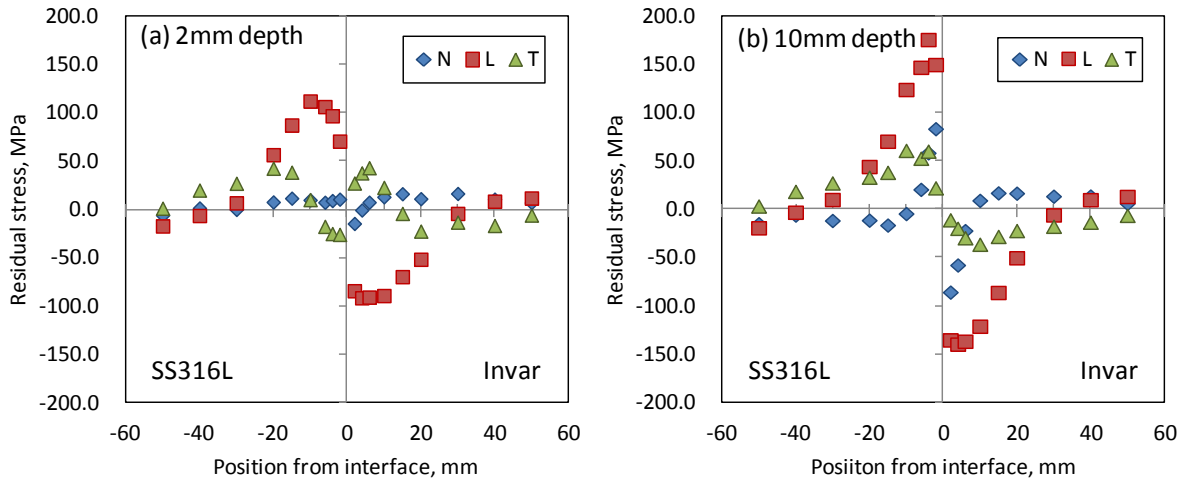

Fig. 1 Residual stress distributions of the Invar-SS316L HIP joint specimen measured using neutron diffraction at (a) 2 mm depth and (b) 10 mm depth.