MLF Experimental Report	提出日 Date of Report 2010 年　月　日
課題番号 Project No. 2009B0009 実験課題名 Title of experiment **SCC crack propagation characteristics from Inconel to low-alloyed steel** 実験責任者名 Name of principal investigator Yo Tomota 所属 Affiliation　Ibaraki University	装置責任者 Name of responsible person Kazuya Aizawa 装置名 Name of Instrument/（BL No.） Engineering materials diffractometer BL-19 実施日 Date of Experiment May 25–26, 28 (net 3 days)

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.

Low alloy steel: 0.20C-0.24Si-1.42Mn-0.01P-0.006S-0.11Cu-0.64Ni-0.12Cr-0.54Mo-0.003V-0.002Nb-0.001Ti (mass %) and Ni alloy: 68.90Ni-14.70Cr-7.23Fe-6.50Mn-1.55NbTa-1.50Nb-0.44Si-0.053C-0.004P-0.002S (mass%)

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.

To examine the SCC crack propagation from Ni alloy to low alloy steel, a welded component was prepared artificially. A compact tension specimen was made from this component and fatigue crack was introduced to reach near the weld interface. Trial was made to measure residual stress distribution near the weld interface and at the crack tip of fatigue crack. The gauge volume for strain measurement was adjusted using 2mm collimator in front of the detector and 2mm width slit for the incident beam. The measuring point was scanned as is illustrated in Fig. 1. Diffraction profiles were obtained from three orthogonal directions. The hkl lattice distance was determined by curve fitting using the Gaussian function. So called stress-free spacing was determined from coupons with 7x7x7mm for both Ni alloy and low alloy steel. The hkl lattice plane distance determined in each direction was converted to lattice constant (a) and the averaged a was calculated from available hkl plane distances obtained. Similarly, stress free value (a_0) was calculated for the data from the coupons. Then, elastic strains were computed by $(a - a_0)/a_0$. The stresses in three orthogonal directions were calculated from the general Hooke law, where Young modulus was taken as 214 GPa for the low alloy steel, 200 GPa for the Ni alloy and Poisson ratio was 0.30 for the both materials.

The stresses along line AB in Fig. 1 determined are plotted in Fig. 2. As seen, tensile residual stresses are found in the Ni alloy while compressive ones in the low alloy steel although some differences exist depending on the direction. This result for the low alloy steel region shows good agreements with those predicted from

2. 実験方法及び結果（つづき） Experimental method and results (continued)

the conventional X-ray method (on the surface) and determined by the angular dispersion neutron diffraction using RESA at JRR-3. In case of RESA, however, the stresses in the Ni alloy region could not be measured because of texture (and coarse grains). In this cases, the some hkl diffraction peaks were obtained from any direction even though the specimen is heavily textured. This is one of the merits to use the TOF method for stress evaluation. The data obtained along the line CD were similar to Fig. 2. Because the welded Ni alloy region shrinks during solidification, tensile stresses along the interface must remain while compressive stresses in the low alloy steel region. Although the welded specimen was subjected to stress-relief annealing, it was revealed not enough to reduce the residual stresses, which must affect the SCC crack growth behavior.

The ε_{xx} and ε_{zz} at point C in Fig. 1(b) can be evaluated because the edge effect did not appear. In this case, the upper half space of the gauge volume is occupied by Ni alloy, which does not bring any artificial peak shift. To obtain ε_{yy} at C, however, the sample has to be rotated by 180 degrees and the two diffraction profiles before and after rotation should be summed. Such a trial will be made in future.

The CT specimen was loaded in tension and strain measurement in front of crack tip was tried to measure. It is however the space resolution of 2x2x2 mm is not enough to evaluate the stress condition at the weld interface. Hence, other techniques like SEM/EBSD and synchrotron X-ray measurement are planned to be performed complementally.

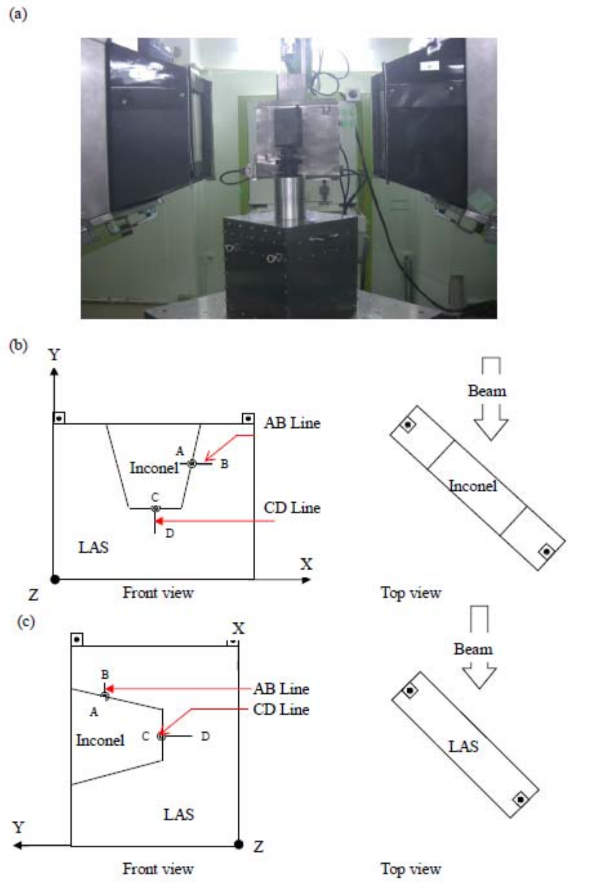

Fig. 1 Experimental conditions for residual stress measurement for a welded component

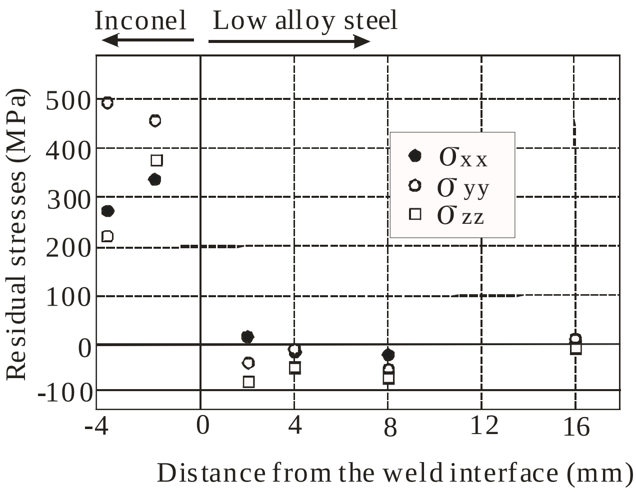

Fig. 2 Residual stress distribution along line AB near the weld interface