MLF Experimental Report

実験課題番号 Project No. 2012P0602 実験課題名 Title of experiment 工学材料回折装置を利用した結晶組織構造情報可視化技術の高度化実 (Improvement of Crystalline Structural Information Imaging Techniques with Engineering Materials Diffractometer) 験責任者名 Name of principal investigator 鬼柳　善明 (Kiyanagi Yoshiaki) 所属 Affiliation 北海道大学 (Hokkaido University)	提出日 Date of report 2013/06/ 装置責任者 Name of responsible person 相澤　一也 (Aizawa Kazuya) 装置名 Name of Instrument/(BL No.) 工学材料回折装置 TAKUMI/(BL 19) 利用期間 Dates of experiments 2012/11/02/09:00 - 2012/11/05/09:00

1. 研究成果概要(試料の名称、組成、物理的・化学的性状を明記するとともに、実験方法、利用の結果得られた主なデータ、考察、結論、図表等を記述してください。

Outline of experimental results (experimental method and results should be reported including sample information such as composition, physical and/or chemical characteristics.

TRIP (Transformation induced plasticity)-aided multi-phase steel is one of important materials for automobile parts because of their mechanical properties of a good combination of strength, ductility and work-hardening response. In this steel, such mechanical property is due to the stress-induced martensitic transformation for the retained austenite phase during plastic deformation. Previous studies have been focused on the microstructural factor with uniform deformation. However, there are differences in mechanical performance depending on the position in industrial steel parts, as a result of non-uniform deformation on the manufacturing process. In this study, deformation distribution of TRIP steel during tensile non-uniform deformation was evaluated from analysis of Bragg's edge in neutron transmission spectrum.

[Sample information]

Name of sample: TRIP-aided multi-phase steel.

Compositions (mass%): Fe 97.0, C 0.20, Cr 0.02, Mn 1.67, Ni 0.07,Si 1.00, P 0.03, S 0.01.

Chemical formula: α(bcc-Fe) ferrite matrix, γ' (fcc-Fe) retained austenite phase and α' (bcc-Fe) martensite phase.

Physical from: Tensile plate with double notch.

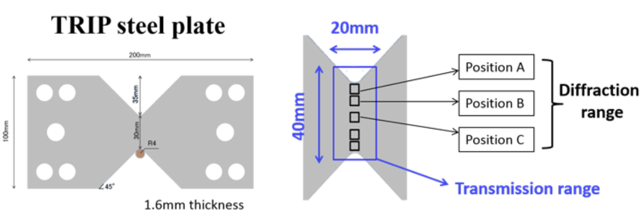

Fig. 1 schematic illustration of sample(left) and measuring range(right)

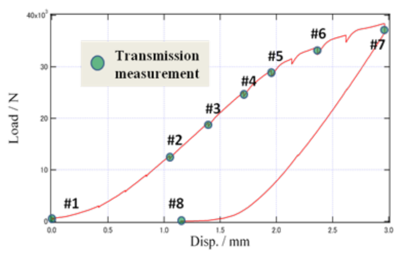

Fig. 2 Measurement point and the tensile load

1．研究成果概要（つづき） Outline of experimental results (continued).

[Experimental method]

Non-uniform deformation behavior measurements of TRIP steel were carried out by neutron transmission method and neutron diffraction method, while giving a tensile load step-by-step to the sample (Fig.1 and Fig. 2). The relative sample of TRIP steel was set up in tensile machine on the TAKUMI sample stage. The neutron transmission measurements were carried out as keep 90 degrees angle between the tensile stress direction and the incident neutron direction, by turning sample stage. In this measurement, the Li-glass 2D detector with 3x3mm spatial resolution was used. Therefore, transverse deformation behavior distribution to principal stress was measured. Analysis of the neutron transmission spectrum was done by the RITS code. In neutron diffraction measurement, the angle was kept at 45 degrees, and TAKUMI detector was used. That is, the deformation behavior of the two axial directions of the principal stress was observed.

[Results]

Distribution information was obtained in the transmission measurements. Then, point information of the two directions was obtained by diffraction measurements. Results of the two measurements were used as a complementary data or comparison. Microstructural factors distribution of TRIP steel during tensile non-uniform deformation was evaluated from analysis of Bragg-edge in neutron transmission spectrum. As a result of stress concentration, 2D strain distribution was observed by transmission Bragg-edge (Fig. 3). Strain obtained from Bragg edge was appropriate as compared with that obtained from diffraction. Martensitic transformation (i.e. the increase of martensite steel phase and the decrease of austenite steel phase) has been confirmed along with the strain increase, it was clearly at the notch position of the sample (Fig. 4). There was already strong texture before tensile deformation. After the elasto-plastic deformation due to tensile deformation, texture grew a little. It was not a large plastic deformation in this experiment, however, martensitic transformation was observed. By using the pulse neutron Bragg edge transmission, distribution measurement of martensitic transformation behavior in bulk steel is possible.

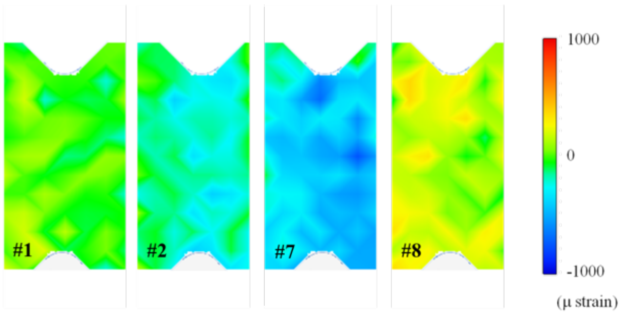

Fig. 3 bcc-Fe(211) strain mapping at transmission direction

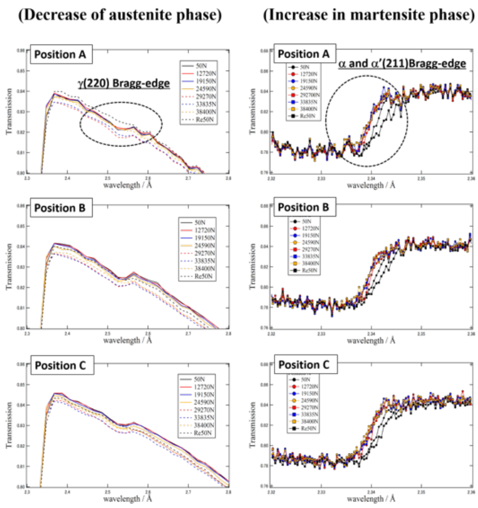

Fig. 4 Change in Bragg edges with martensitic transformation

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