MLF Experimental Report	提出日 Date of Report 22 June, 2015
課題番号 Project No. 2014B0098 実験課題名 Title of experiment Strain hardening mechanism relating to dislocation structures in duplex stainless steels 実験責任者名 Name of principal investigator Shigeo Sato 所属 Affiliation Ibaraki University	装置責任者 Name of responsible person Kazuya Aizawa 装置名 Name of Instrument/(BL No.) TAKUMI (BL19) 実施日 Date of Experiment From 24, Apr. 2015 to 27, Apr. 2015

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.

Stainless steel plates (ca. 2 mm in thickness) of SUS316L (austenite), SUS430 (ferrite), and SUS329J3L (austenite-ferrite duplex) were prepared for the neutron diffraction measurements. These steels were cut for the tensile loading with the gauge volume of 6 x 2 mm^2. The true-stress vs. true-strain curves of these steel specimens are shown in Fig. 1. In addition, the SUS329J3L specimen aged at 728 K for 20 h was also examined to investigate the effect of the spinodal decomposition in a ferritic phase on dislocation hardening.

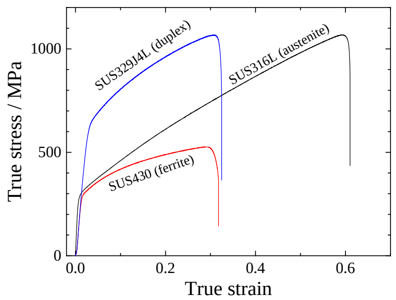

Fig. 1 True-stress vs. true strain curves of specimens.

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.

[Experimental method]

Neutron diffraction measurements were carried out at TAKUMI (BL19) beamline in J-PARC. The loading machine was mounted on the sample positioning table. The load axis is aligned horizontally at 45 degree to the incident bream, so that simultaneous measurement of lattice strains in directions both parallel and perpendicular to the applied load. Tensile loading was given at strain rates of 0.00002 s^{-1} for the SUS316L and the SUS430 specimens, and 0.00001 s^{-1} for the SUS329J3L specimens. The diffraction profiles were integrated for 500 s (SUS316L and SUS430) and 1000 s (SUS329J3L). Therefore, the diffraction profiles were taken at 0.01-strain interval. Since both the peak-tail shapes of diffraction profiles and the *k*-space (= 1/*d* space) resolution are important for the line-profile analysis, the medium -resolution setting with 5-mm radial collimator was employed for the neutron diffraction measurements. The instrumental profiles for the BCC and FCC steels were taken from the diffraction peaks of the annealed high-purity iron and the annealed SUS316L plates, respectively. The line-profile analysis was carried out by using the convolutional multiple whole profile (CMWP) program.

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

[Results]

Figure 2 shows an example of the diffraction profile of the SUS329J3L specimen, which was observed from the south bank (tensile direction) at the strain of 0.10. The area-weighted crystallite size (<*x*>$_{area}$), dislocation density (ρ), and the value of *M* for the ferritic and austenitic phases were estimated by fitting with the theoretical profile using the CMWP program. The value of *M* gives the strength of dipole character of dislocations: if *M* is small or large, the dipole character and the screening of the displacement field of dislocations are strong or weak, respectively.

Figure 3 shows the variation in the dislocation density of the ferritic and austenitic phases in the SUS329J3L specimen with the strain up to 0.11. It was revealed that the dislocation density and its variation against the strain of the ferritic phase were much smaller than those of the austenitic phase, suggesting that the austenitic phase primarily owed the strain hardening. It should be noted that the dislocation density for the tensile direction was about half of that of transverse direction in both of the ferritic and the austenitic phases. Moreover, the variation in the *M* value in Fig. 4 also exhibited rather distinct differences between the transverse and the tensile directions. While the *M* values for the transverse direction were rather small and increased slightly with the strain, the *M* values for the tensile direction were large and decreased with the strain, suggesting the dislocation arrangement differs depending on these directions. These anisotropic features relating to the dislocation characteristics are to be examined for discussing the effect of these dislocation parameters on the strain hardening.

We also examined the effect of the loading stress on the line-profile analysis. The tensile loading was released at every 0.05 strain, and the stress-free diffraction profiles were also measured. It was confirmed that the dislocation parameters estimated from the diffraction profiles under the stress-released states were comparable to those at the same strain level under the loading states.

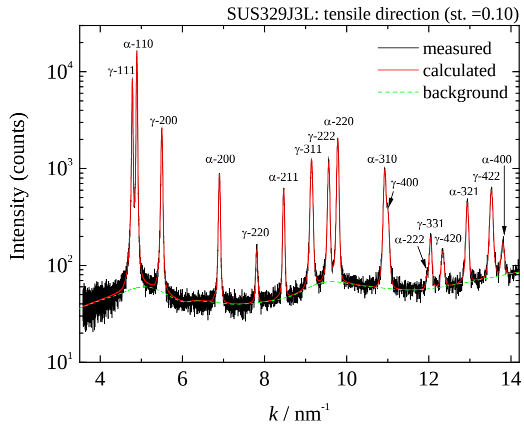

Fig. 2 Measured and calculated diffraction profiles of the SUS329J3L at the strain of 0.10.

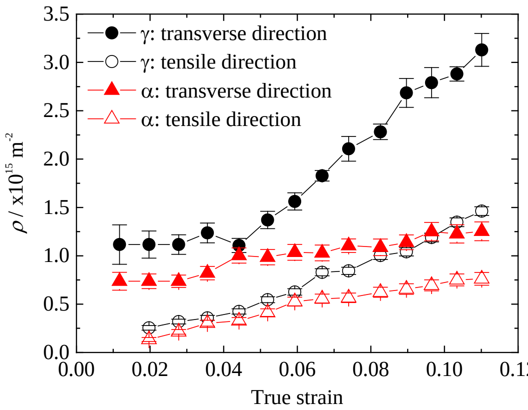

Fig. 3 Variation in the dislocation density of the ferritic (α) and austenitic (γ) phases of the SUS329J3L specimen with the true strain.

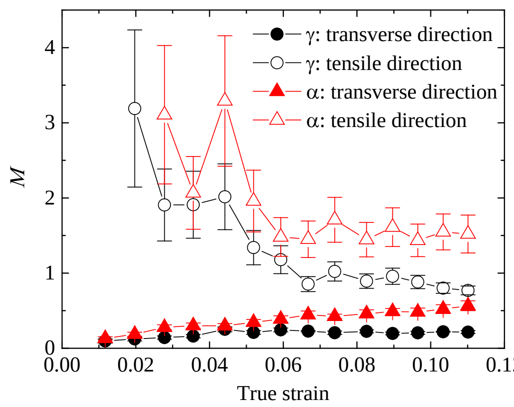

Fig. 4 Variation in the dislocation density of the ferritic (α) and austenitic (γ) phases of the SUS329J3L specimen with the true strain.