MLF Experimental Report

提出日 Date of Report	
課題番号 Project No. 2015A0069	装置責任者 Name of responsible person Stefanus Harjo
実験課題名 Title of experiment Evaluation of Dislocation Densities in Dynamically Transformed Ferrite and Parent Austenite by in-situ Neutron Diffraction during High Temperature Deformation	装置名 Name of Instrument/(BL No.) BL19
実験責任者名 Name of principal investigator Akinobu Shibata	実施日 Date of Experiment 2015/11/17-11/19 2016/5/15-5/17
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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.

The chemical compositions of the used specimens are Fe-2Mn-0.1C (wt.%), Fe-2Mn-0.4C (wt. %), and Fe-10Ni-0.1C (wt. %).

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.

Changes in dislocation densities in dynamically transformed ferrite phase and parent austenite phase during deformation were evaluated by *in-situ* neutron diffraction experiments using a newly developed thermomechanical processing simulator at BL19 (TAKUMI). The appearance of the thermomechanical processing simulator installed at BL19 (TAKUMI) is shown in Figure 1.

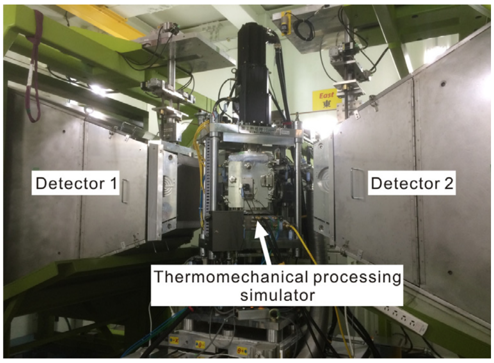

Figure 1. The newly developed thermomechanical processing simulator installed at BL19 (TAKUMI).

The specimen was austenitized at 1000 °C for 300 s, and cooled to deformation temperature ranging from 480 – 750 °C. Then, uniaxial compression deformation by at most 60 % was applied at the temperature. The strain rate in compression deformation was 1 × 10^{-3} s^{-1}. During the whole thermomechanical process, neutron diffraction was obtained.

One example of neutron diffraction profile is shown in Figure 2. The horizontal and vertical axes correspond to time-of-flight (TOF) and experimental time, respectively. The intensity of neutron diffraction is represented by change in color.

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

In the previous experiments, we used Si_3N_4 anvils for compression deformation, and the diffraction peaks originated from Si_3N_4 anvils were involved in the neutron diffraction profile. On the other hand, the anvils were replaced by cubic BN from the present experiment. As shown in Figure 2, we successfully removed the diffraction peaks of anvils, and the neutron diffraction profile consists of ferrite and austenite peaks.

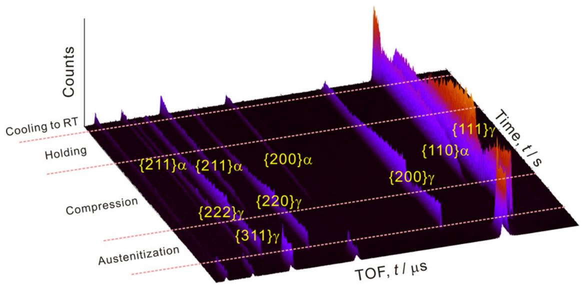

Figure 2. A bird view of neutron diffraction profile obtained during thermomechanical process (Fe−2Mn−0.1C, deformation temperature was 700 °C).

Change in volume fraction of dynamically transformed ferrite during deformation in Fe−10Ni−0.1C is shown in Figure 3. It is found that the volume fraction of ferrite increased with an increase in strain at the deformation temperatures of 480 °C and 520 °C. In contrast, ferrite did not form very much by the deformation at 560 °C.

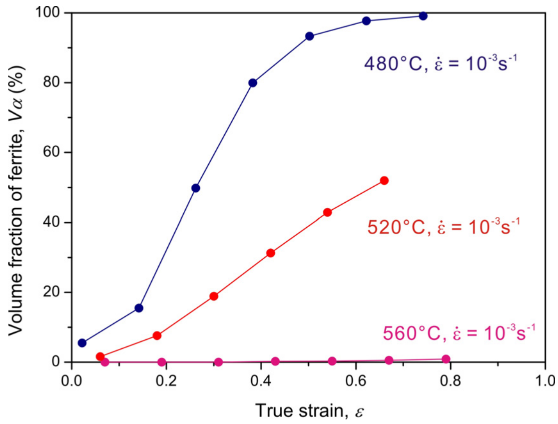

Figure 3. Volume fraction of ferrite plotted as a function of strain in Fe−10Ni−0.1C.

From the obtained neutron diffraction profiles, we estimated change in dislocation densities of dynamically transformed ferrite phase and parent austenite phase during compressive deformation by classical Williamson-Hall method. Figure 4 shows the change in dislocation densities of parent austenite phase in Fe−10Ni−0.1C. We can confirm that the dislocation density in austenite tended to increase during the deformation at 560 °C. On the other hand, the dislocation densities firstly increased and then kept constant during the deformation at 520 °C and 480 °C. In addition, the dislocation density at 480 °C was lower than those at 520 °C and 560 °C. In general, dislocation density increases with a decrease in deformation temperature. Accordingly, this results suggest that the deformation was accumulated on ferrite phase when dynamic ferrite transformation occurred. The same tendency has been confirmed in Fe−2Mn−0.1C and Fe−2Mn−0.4C.

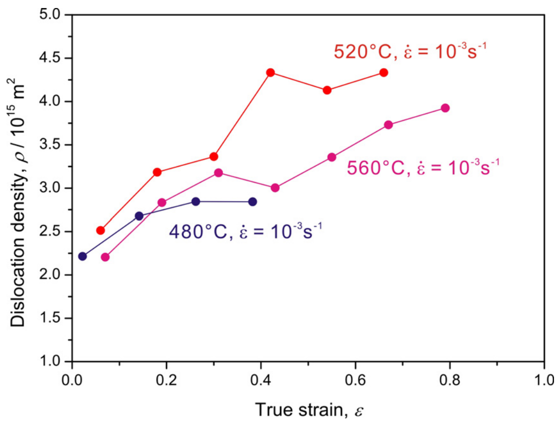

Figure 4. Change in dislocation densities of parent austenite phase plotted as a function of strain in Fe−10Ni−0.1C.

The accumulation of deformation in ferrite phase would enhance dynamic recrystallization of formed ferrite. As a result, we consider that the accumulation of deformation in ferrite phase is a key factor for the formation of ultrafine-grained ferrite structure with grain size less than 1 μm through thermomechanical process involving dynamic ferrite transformation.