MLF Experimental Report	提出日 Date of Report 2015/05/12
課題番号 Project No. 2014B0280 実験課題名 Title of experiment Direct Confirmation of Dynamic Ferrite Transformation above Equilibrium Transformation Temperature by in-situ Neutron Diffraction during High Temperature Deformation 実験責任者名 Name of principal investigator Akinobu Shibata 所属 Affiliation Kyoto University	装置責任者 Name of responsible person Stefanus Harjo 装置名 Name of Instrument/(BL No.) BL19 実施日 Date of Experiment 3/5 – 3/10

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. %) and Fe–6Ni–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.

The schematic illustration for the heat treatment and deformation procedures is shown in Fig.1. The specimen was austenitized at 850 °C for 300 s (Fe–2Mn–0.1C) or 800 °C for 180 s (Fe–6Ni–0.1C), and cooled to the deformation temperature ranging from 650 – 820 °C. Then, uniaxial compressive deformation by at most 60 % was applied at the temperature. The strain rate ($\dot{\varepsilon}$) was 1 × 10^{-2} s^{-1} or 5 × 10^{-2} s^{-1}. The above mentioned heat–treatment and deformation was conducted using the newly developed thermomechanical processing simulator which is applicable for BL 19 (TAKUMI). The appearance of the thermomechanical processing simulator installed at BL 19 (TAKUMI) is shown in Fig.2. The specimen was placed between two anvils (Si_3N_4) in the chamber, and heated by induction heating system. The chamber moves upward by the half of deformation amount so that neutron beam is always irradiated at the center of the specimen during compression experiment.

One example of neutron diffraction profile is shown in Fig.3. In addition to the ferrite and austenite peaks, we can observe the peaks originated from the anvils (Si_3N_4). This is probably because incident neutron beam was somewhat scattered at the incident beam window glass. We are planning to replace it by

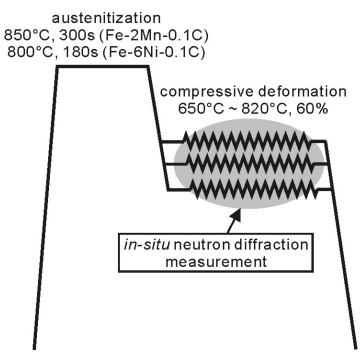

Figure 1. Schematic illustration for the heat treatment and deformation procedure.

aluminum plate. Because there are several ferrite and austenite peaks that can be clearly distinguished from those of anvils, we could analyze the dynamic ferrite transformation behavior from obtained neutron diffraction profiles. Fig.4 shows a neutron diffraction profile of the Fe–2Mn–0.1C during compression experiment at 700 °C ($\dot{\varepsilon}$ = 5.0 × 10^{-2} s^{-1}). The horizontal and vertical axes correspond to time–of–flight (TOF) and time after reaching the deformation temperature (700 °C), respectively. The intensity of neutron diffraction is represented by change in color. It is clear that ferrite peaks started to appear during compression. As a result, we demonstrated from Fig.4 that dynamic ferrite transformation surely occurred during deformation, not after deformation. Neutron diffraction profiles of the Fe–2Mn–0.1C during compression experiment at 820 °C ($\dot{\varepsilon}$ = 5.0 × 10^{-2} s^{-1}) are shown in Fig.5. Because the equilibrium temperature between ferrite and austenite (Ae_3 temperature) of the Fe–2Mn–0.1C is 802 °C, this deformation temperature was above Ae_3 temperature. The black and red profiles in Fig.5 were made from the obtained neutron diffractions integrated during compression (15 s) and integrated during compression (15 s) and subsequent holding for 185 s with loading, respectively. The ferrite peak can be observed, although the intensity of peak was very weak. This result suggested that the dynamic ferrite transformation could occur above Ae_3 temperature. However, further detailed study is necessary to demonstrate the occurrence of dynamic ferrite transformation above Ae_3 temperature. Although the data is not shown here, the Fe–6Ni–0.1C showed the same tendency of the Fe–2Mn–0.1C.

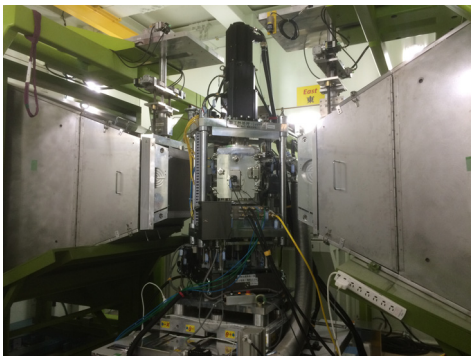

Figure 2. The newly developed thermomechanical processing simulator applicable for BL19 (TAKUMI).

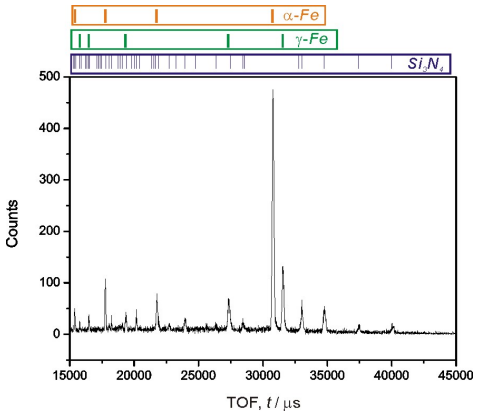

Figure 3. An example of neutron diffraction profile during compression experiment.

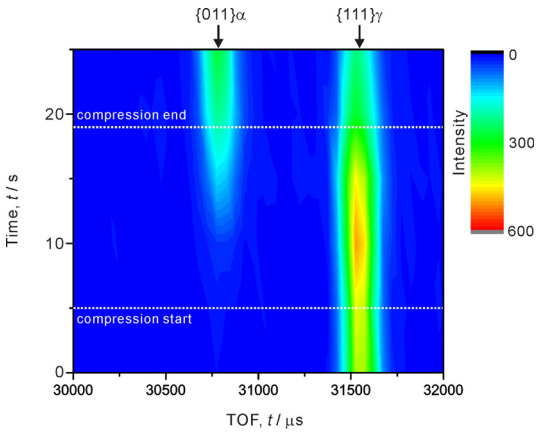

Figure 4. Color map showing the intensity of neutron diffraction peaks of the Fe–2Mn–0.1C during compression experiment at 700 °C.

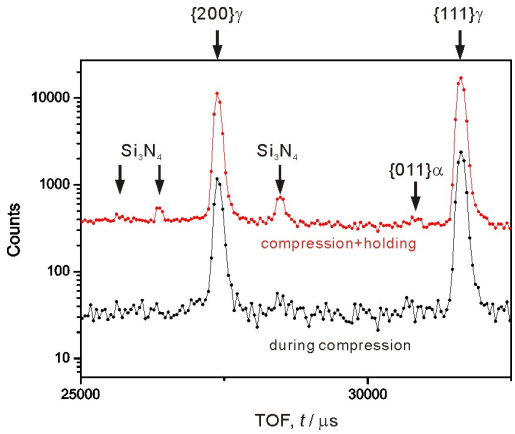

Figure 5. Neutron diffraction profiles of the Fe–2Mn–0.1C during compression experiment at 820 °C (above Ae_3 temperature).