（ ※本報告書は英語で記述してください。ただし、産業利用課題として採択されている方は日本語で記述していただいても結構です。）

MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2017A0129 実験課題名 Title of experiment Effect of strain rate on reverse austenite transformation behavior in medium Mn steel during thermomechanical processing 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 Kazuya Aizawa 装置名 Name of Instrument/（BL No.） BL19 実施日 Date of Experiment 6/22-25

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.

Fe-5Mn-2Si-0.1C (mass%) alloy

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.

Nowadays, new class of steels, medium Mn steels containing 3 – 7 mass % Mn, are classified as the 3rd generation advanced high strength steel (AHSS), and numerous research groups all over the world are focusing on the study about medium Mn steels. We utilized thermomechanical processing, i.e., precisely controlled heat treatment and deformation at elevated temperature, to control microstructures and mechanical properties in a medium Mn steel (Fe-5Mn-0.1C-2Si (mass %)). We found that thermomechanical processing in some specific conditions could obtain a certain amount of retained austenite at room temperature (RT). The medium Mn steels containing a certain amount of retained austenite showed mechanical properties with an excellent strength-ductility balance due to deformation-induced martensitic transformation of the retained austenite, i.e., transformation-induced plasticity (TRIP). We believe that elucidating the underlying mechanism for the formation of retained austenite in medium Mn steels not only advances phase transformation theory in metals and alloys, but also leads to an improvement of thermomechanical processing for achieving excellent mechanical properties based on theoretical aspects.

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

Recently, we have found through *in-situ* neutron diffraction analysis that the compressive deformation accelerated the austenite reverse transformation significantly. In order to understand austenite reverse transformation behavior during thermomechanical processing systematically, the present study investigated effect strain rate on austenite reverse transformation behavior during thermomechanical processing in medium Mn steel. In-situ neutron diffraction experiment was conducted using the thermomechanical processing simulator installed at BL19 Takumi. **Figure 1** shows the appearance and schematic illustration of the thermomechanical processing simulator.

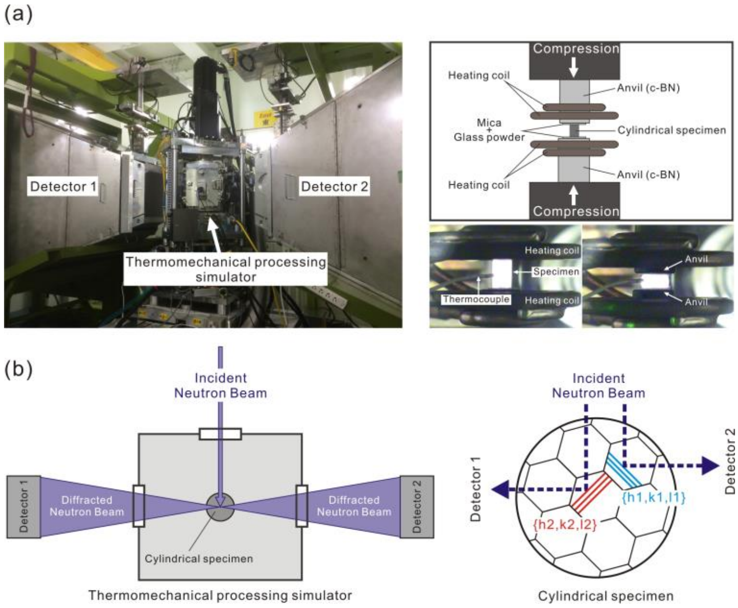

Figure 1 (a) The thermomechanical processing simulator installed at the BL 19 TAKUMI and schematic illustration of the testing part of the simulator (b) the geometry of the compression experiment with respect to the incident and diffracted neutron beams.

The cylindrical specimen 11 mm in height and 6.6 mm in diameter with fully martensitic structure was heated up to from 640 ˚C to 720 ˚C (ferrite + austenite two phase region). Then, the specimen was deformed in compression at a strain rate of 10^{-2} s^{-1} or 10^{-4} s^{-1} and kept at the same temperature for 10000 s after releasing the load. The experiment without deformation and with compressive deformation at a strain rate of 1 s^{-1} was conducted in our previous beamtime (proposal number: 2015E0001).

The volume fraction of reversely transformed austenite at 640 ˚C, 700 ˚C, and 740 ˚C evaluated from the neutron diffraction profiles are presented in **Figure 2** (black plots: without deformation, blue plots: with compressive deformation at a strain rate of 10^{-4} s^{-1}, green plots: with compressive deformation at a strain rate of 10^{-2} s^{-1}, red point: with compressive deformation at a strain rate of 1 s^{-1}). It should be noted that deformation period changes with strain rate, i.e., about 0.9 s for the strain rate of 1 s^{-1} and about 9000 s for the strain rate of 10^{-4} s^{-1}. The times for start of deformation and finish of deformation are also indicated in **Figure 2**. In the case of the deformation at strain rates of 1 s^{-1} and 10^{-2} s^{-1} (red plots and green plots), the volume fraction of reversely transformed austenite was much higher than that without deformation. This indicates that the compressive deformation with relatively fast strain rate accelerated austenite reverse transformation. On the other hand, we find the interesting tendency that volume fraction of reversely transformed austenite during compressive deformation at a strain rate of 10^{-4} s^{-1} (blue plots) was smaller than that without deformation.

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

Now we are evaluating changes in lattice constant (i.e., partitioning behavior of alloying elements) and dislocation density from the obtained neutron diffraction patterns and discussing the effect of strain rate on austenite reverse transformation behavior.

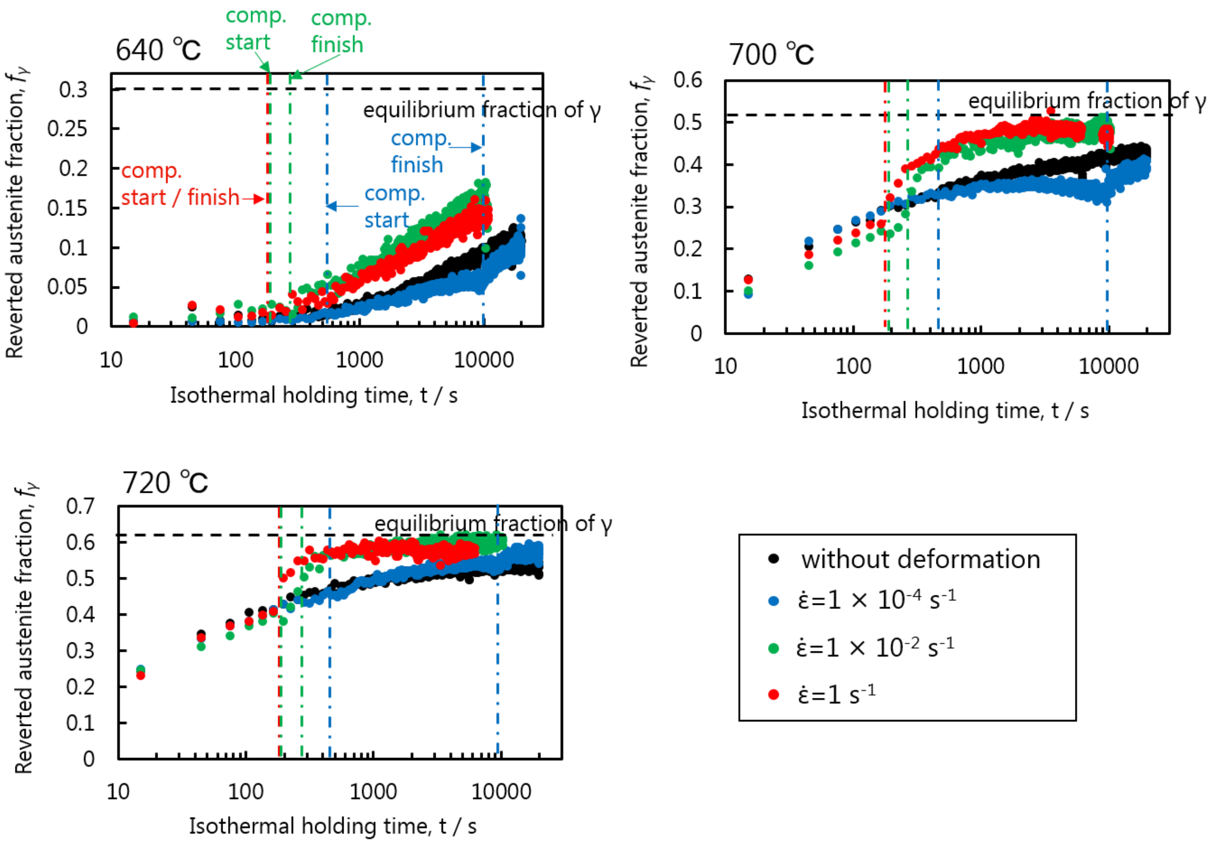

Figure 2 Volume fractions of reversely transformed austenite at 640 ˚C, 700 ˚C, and 740 ˚C ((black plots: without deformation, blue plots: with compressive deformation at a strain rate of $10^{-4}\ s^{-1}$, green plots: with compressive deformation at a strain rate of $10^{-2}\ s^{-1}$, red point: with compressive deformation at a strain rate of $1\ s^{-1}$).