MLF Experimental Report	提出日 Date of Report 2013.5.21
課題番号 Project No. 2012B0003 実験課題名 Title of experiment Martensitic transformation and carbon partitioning 実験責任者名 Name of principal investigator Zengmin SHI 所属 Affiliation Huazhong University of Science and Technology	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 2013/02/18 ~ 2013/02/21

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.

Martensite steel C0.22Si0.87Mn1.6
Composition: Fe-0.22C-0.87Si-1.64Mn-0.024Ti -0.0015B-0.0025N (wt. %)
Physical form: Solid, rod specimens with a dimension of ϕ7×14 mm

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.

Experiment 1: High Temperature Deformation, Recovery and Recrystallization of Austenite.

Rod Specimens were heated up to austenitizing temperature 950 °C for 10min followed by gas cooling down to 850°C for being performed an isothermal process, and then cooling in gas atmosphere. During the isothermal process, specimens were applied compression or tension deformation, and then held for 90min to investigate the recovery and recrystallization behavior of the deformed austenite. The deformation amount was 15% for compression deformation and 25% for tension deformation, where the deformation rate was $0.001s^{-1}$. The whole experimental time for individual process is about 4 hours. One of the performed thermo-mechanical schedule is shown in Fig.1 (a).

Experiment 2: Continue Cooling with Compression Deformation.

Rod specimens were heated up to austenitizing temperature 950 °C for 10min followed by gas cooling above 850 °C, and then cooling in gas atmosphere from 850 °C. During cooling, the specimens were simultaneously compressed and the initial deformation temperature was 850 °C. The deformation amount was 0%, 10% and 30%, respectively, which implied that the specimen temperature was 850, 769 and 699 °C, respectively, at the end of deformation. The heating and cooling schedule under deformation amount of 30% is illustrated in Fig.1(b).

Experiment 3: Dynamic Ferrite Transformation

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

Rod specimens were heated up to austenitizing temperature 950 °C for 10min followed by gas cooling down to 690°C for 100min, and then cooling in gas atmosphere. During the isothermal process at 690°C, specimens were compressed by 0% or 40% at the deformation rate of 0.0015s^{-1}, or elongated by 20% followed by the compression deformation of 20% at the constant deformation rate of 0.0015s^{-1}. The performed thermo-mechanical schedule of the last deformation schedule is shown in Fig.1(c).

Experiment 4: Tempering Behavior of Martensite.

The experiment schedule is shown in Fig.1 (d). Specimens were heated up step by step to austenitizing temperature 950 °C and kept for 10min followed by gas cooling to room temperature. The step time was 10min and the heating speed was 5°C/s.

Experiment 5, Isothermal Transformation Behavior.

The thermo-mechanical schedule is shown in Fig.1 (e). Rod specimens were heated up to austenitizing temperature 950 °C for 10min followed by gas cooling down to 690°C, 550, 500°C for 60min, respectively, and then cooling in gas atmosphere to room temperature.

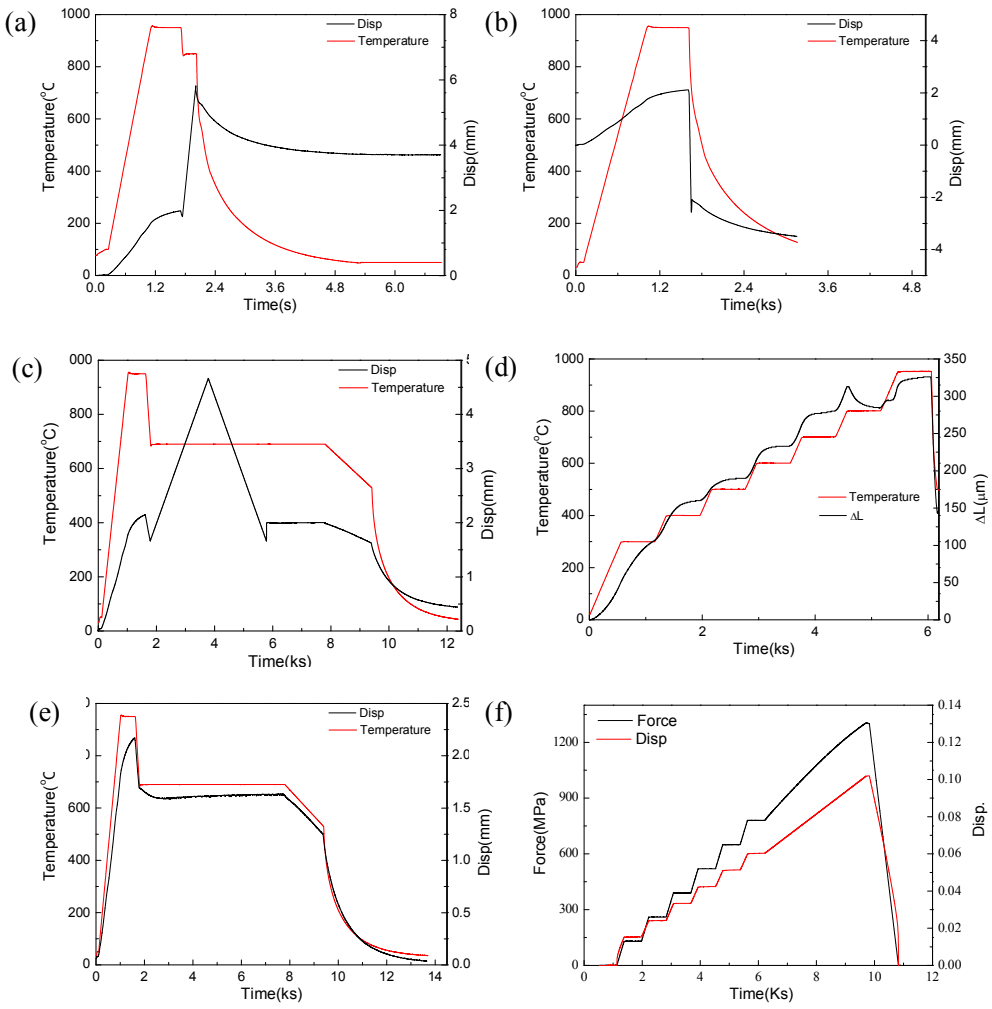

Fig.1 Thermal Schedule of the experiment (a) 1, (b) 2, (c) 3, (d) 4, (e) 5 and (f) 6.

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

Experiment 6: Tensile Behavior of Martensite at Room Temperature.

Rod specimens were tensile deformed at room temperature, and the applied force and displacement curve is shown in Fig.1 (f).

The diffraction data were analyzed by the Rietveld method. The diffraction profiles, diffraction intensity, the peak position and full width at a half maximum (FWHM) are used for studying the change of the phase volume fraction, lattice strain, lattice parameter and texture. From the analysis, some interesting conclusions can be drawn. For example, the conclusion of the experiment 2 are as follows:

The start ferrite transformation temperature detected from the neutron diffraction profile (Fig.2) increased from 686°C, 705°C to 716°C with the increase of austenite deformation amount from 0%, 10% to 30%, respectively. The deformation of austenite influenced the carbon partitioning during the transformation. The carbon content of retained austenite is decreased with the increase of the deformation amount, as shown in Fig.3. However, the quantity of carbon partitioning into the ferrite was not sufficient to make noticeable change of lattice parameter of ferrite. The deformation of austenite further intensified the {111} and {200} intensities in the transverse direction (RD) and gradually intensified the {220} intensity in the compression axial direction (ND) with increasing the deformation amount, as shown in Fig.4. While the {100} and {211} ferrite intensities in the ND were strengthened by deformation.

The others are being in analysis and omitted.

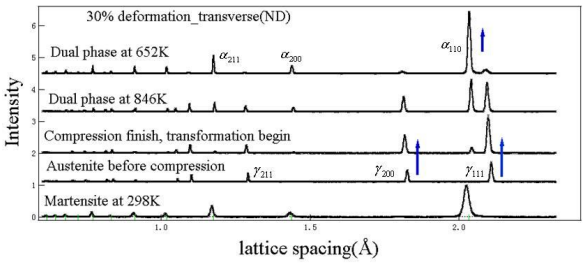

Fig.2 Neutron Diffraction profiles for the transverse direction (RD)

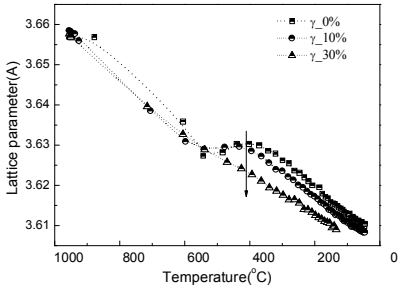

Fig.3 Change of the lattice parameter of austenite with temperature

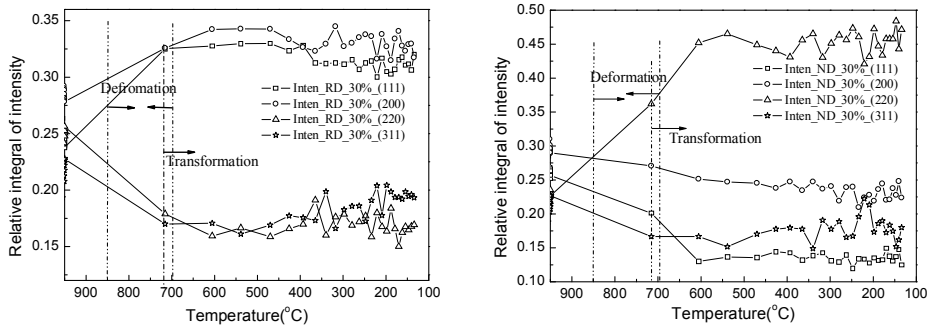

Fig.4 Relative integral intensities of austenite as a function of temperature with the deformation amount of 30% in the (a) RD and (b) ND.