# MLF Experimental Report	提出日 Date of Report August 19, 2010
課題番号 Project No. 2010A0047 実験課題名 In situ neutron diffraction during bainitic transformation from plastically deformed austenite 実験責任者名 Yo Tomota 所属 Ibaraki University	装置責任者 Name of responsible person Kazuya Aizawa 装置名 Name of Instrument/（BL No.） Engineering materials diffractometer BL-19 実施日 Date of Experiment June 22 – 26, 2010

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 in mass% of steels used in this investigation include,

Steel A: Fe-0.79C-1.51Si-1.98Mn-0.98Cr-0.24Mo-1.06Al-1,58Co, and

Steel B: Fe-0.19C-0.01Si-1.95Mn.

The bulk compression specimens were prepared: steel A was to study bainite transformation and steel B ferrite transformation.

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 specimen set up was extremely difficult because of very complicated compression apparatus. Different from the previous experiment done at ISIS, heating and high temperature deformation must be performed in vacuum, so that it took 1 to 2 hs for specimen setting every time. A cylindrical compression specimen was heated up to 1173K and cooled down to 573K and then held there for about 6 to 10 hs. It was expected that during the isothermal holding, bainitic transformation would progress. To realize such heat history, the specimen must be cooled rapidly. It is however too slow to hinder pearlite transformation, being different from the ISIS experiment. Hence, the result of this experiment was not satisfied but some information on diffusion controlled transformation during continuous cooling was obtained in a vacuum condition. Therefore, we have to introduce some gas cooling system to realize faster cooling rate enough to obtain a super-cooled austenite at a lower temperature for bainite transformation study.

Another aim of this proposed experiment is to make clear the effect of plastic deformation of austenite on the following ferrite transformation. We have already published a few papers on this issue using a reactor neutron source (NPI) and a spallation neutron source (ISIS). The motivation to make a similar experiment at J-PARC was to shorten a time interval in order to track transformation behavior more rigorously. In particular, the role of continuous plastic deformation during cooling, typically repeated compression deformation, was expected to examine at J-PARC.

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

As is presented in Fig. 1, steel B specimen became austenitic single phase at 1173K. Just after the compression deformation (CD) at 973K, ferrite peaks appeared suggesting the occurrence of deformation induced ferrite transformation. Then the specimen was cooled to 893K where the second compression was given. It is revealed that the acceleration of ferrite transformation really takes place as can be found in Fig. 1.

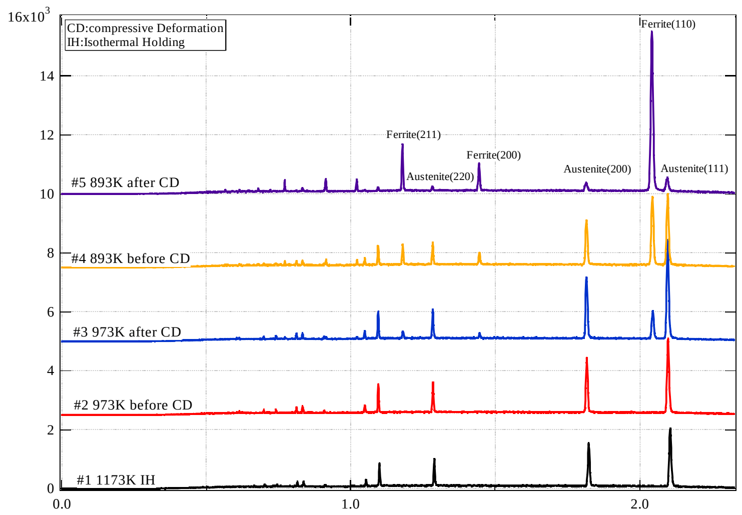

Fig. 1 Change in diffraction profile in the axial direction with heat program: heated up to 1173K, cooled down to 973K and compression (CD), followed by further cooling to RT.

Figure 2 shows the change in ferrite volume fraction which was estimated from ferrite major [hkl] peaks. More precise volume fraction would be obtained using the Z-Rietveld analysis in near future. Here, the case of a double compression hits are compared to those without compression. First, the ferrite transformation kinetics during cooling is confirmed nearly to be similar to the previous results. Then the double compression hits are found to accelerate the transformation apparently. In particular, the second hit at 893K is quite effective to accelerate the ferrite transformation. The detailed analyses including texture evolution, lattice parameter change associated with carbon partitioning, etc. are now under going. There is a skip in the data approximately from 930K to 900K. This is because neutron incident beam was accidentally stopped.

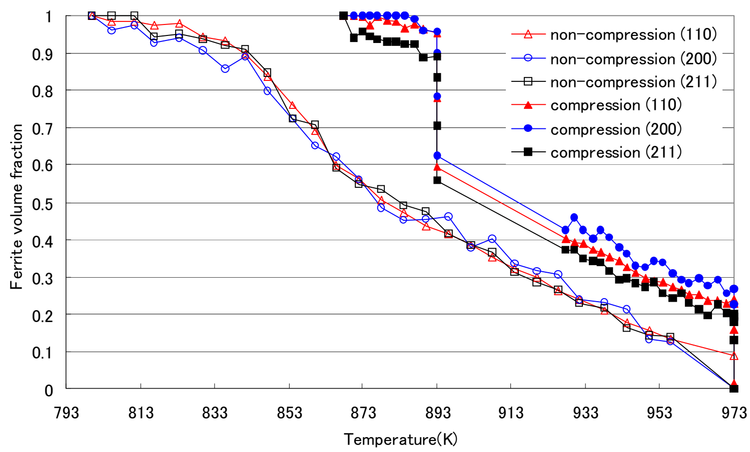

Fig. 2 Effect of double compression hits during cooling on the ferrite transformation estimated from *in situ* neutron diffraction data.

It is concluded now that the second compression at a lower temperature is very effective to accelerate the ferrite transformation which was not clear enough in the previous experiment at NPI. The problem here was that a specimen encountered buckling (or shear) easily at compression. The deformation machine must be modified to be more suitable for compression deformation. Although many improving issues have appeared during this beam time, very influential experimental evidence on advanced TMCP could be obtained soon.