MLF Experimental Report	提出日 Date of Report August 19, 2010
課題番号 Project No. 2010A0048 実験課題名 *In situ* neutron diffraction during tension-compression cyclic deformation in advanced steels and cast irons 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 15 – 17, 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.

Tension-compression specimens made of the following austenitic steels and cast irons were used. The main chemical compositions in mass % of these bulky materials were also listed below.

(1) High nitrogen bearing steel: 0.019C-0.14Si-23.0Cr-4.16Ni-2.03Mo-1.0N
(2) Low nitrogen bearing steel: 0.048C-0.80Si-0.80Mn-25.1Cr-19.80Ni-0.023N
(3) Fine graphite cast iron: 3.66C-2.55Si-0.28Mn-0.004S-0.17Cu-0.045Cr-0.030Mg
(4) Coarse graphite iron: 3.72C-2.02Si-0.24Mn-0.006S-0.30Cu-0.046Mg

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.

Tension-compression deformation was applied to a specimen with a load control manner at RT under *in situ* neutron diffraction. The maximum load was set at 2% flow stress in tension and the identical absolute stress was set as the minimum load in compression. Tension-compression continuous deformation was repeated three times for each specimen. The diffraction profiles for the axial direction and for the transverse one were simultaneously collected with an event mode. After the measurement, appropriate time slicing was examined taking the statistic reliability and deformation stress/strain interval into consideration. As long as we know, this is the first *in situ* neutron diffraction study for low cycle fatigue test. To improve the quality of data, we should use a suitable extensometer to monitor exact displacement of a tension-compression specimen and higher neutron beam with non-stop supply during the experiment. We sometimes missed important data because of neutron beam stop. In this experiment we employed the constant maximum and minimum load controlled cyclic deformation, but a strain control cycling would give us more comprehensive information on low cycle fatigue properties of various materials. In future, it is expected to change test temperature and strain rate. Anyway we have a bunch of diffraction data now and need more time and man power to find the optimum analyzing procedure, which is under going.

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

Figure 1 shows (111) and (200) lattice strain changes as a function of the applied stress for the two stainless steels. First, the hysteresis loops for (111) and (200) were found quite different from each other. It is well known the [200] oriented family grains are elastically softer but plastically harder than the other [hkl] oriented grains. As seen in Fig. 1, the internal stress in [200] grains is larger and hence the lattice strain deviates to upper side from the elastic straight line in the first tension. Then the tensile strain remains apparently after unloading. With the following compression, the [200] lattice strain deviates again from the linear line toward lower side indicating to share higher compressive stress and then compressive residual strain remains after the first compression. Contrary to this [200] behavior, the lattice strain in [111] grains show little deviation from the elastic linear line. It is also noticed that such difference between [200] and [111] grains is much remarkable in the high nitrogen bearing steel.

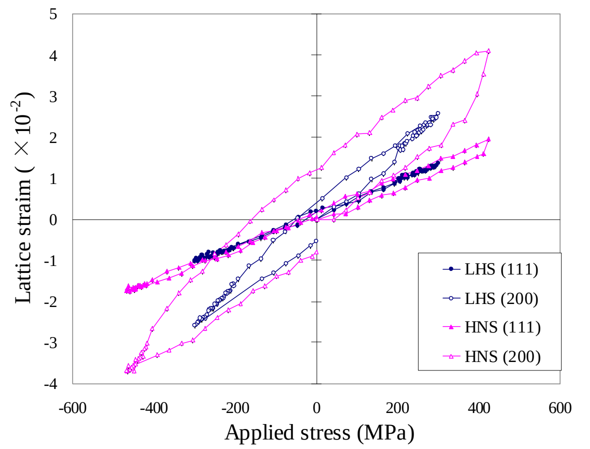

Fig. 1 Lattice strain determined in the axial direction as a function of the applied stress under cyclic loading.

Similarly to Fig. 1 for the fcc alloys, tension-compression behavior in bcc ferrite phase was presented in Fig. 2. As seen, the difference between [200] and [110] grains is not so distinguished compared with Fig.1. Although the difference in lattice elastic constant is commonly confirmed in Fig. 2, the deviation from the elastic linear lines is not so different between the two [hkl] grains. With increasing the number of loading cycle, the width of the hysteresis loop seems to become a little wider. This may imply that the tension and compression plastic flow concentrates in certain grains leading to increase the plastic misfit strain that enlarge intergranular stresses. The repeatedly deformed grains or regions inside a grain would lead to the fatigue crack initiation. The influence of graphite size is not clear but a little difference is found in Fig. 2.

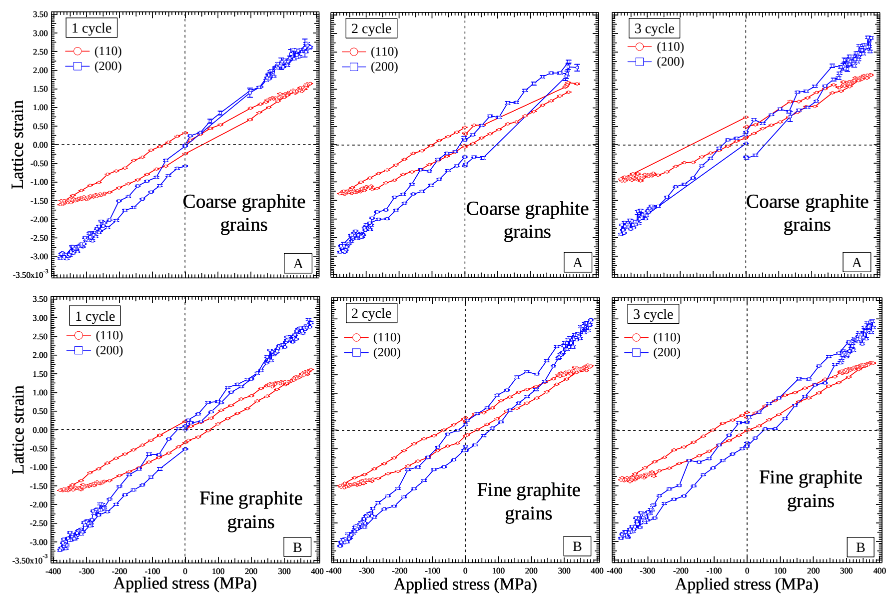

Fig. 2 Lattice strain vs applied stress hysteresis at the first, second and third cycle in the two cast irons.