（ ※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。 ）

J-PARC MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2014B0014 実験課題名 Title of experiment Grain-orientation dependent evolution of dislocation structure and twinning in a high-entropy-alloy by in-situ deformation neutron diffraction line profile analysis 実験責任者名 Name of principal investigator Prof. Xun-Li Wang 所属 Affiliation City University of Hong Kong	装置責任者 Name of responsible person Dr. Stefanus Harjo 装置名 Name of Instrument/（BL No.） BL19 実施日 Date of Experiment 21-Feb-2016 to 26-Feb-2016

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.

$CoCrFeNiMo_x$(x=0-0.3) high entropy alloys in plate tensile bar shape, solid state.

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.

Experimental method:

Deformation mechanisms of $CoCrFeNiMo_x$(x=0-0.3) high entropy alloys are studied by in-situ neutron diffraction method on BL19. Measrement details are as follows:

1. Continuous tensile loading at a strain rate of ~ 10^{-5}/s until 40% applied strain. Patterns were taken as load was applied to the samples.

2. Step loading and loading-unloading strategy. The samples of each composition were loaded at 10 steps with a step size of ~10% of its elastic limit and held for 20min. Then they were loaded at a strain rate of ~ 10^{-5}/s and unloaded at multiple plastic strain values and held for 30 min. Patterns were taken as load was applied to the samples.

Experimental Results

Dislocation structure evolution is analyzed in the current stage. Diffraction patterns as a function of time during continuous tensile loading are shown in Figure 1-3. It is clearly observed that the texture changes in all samples in loading process.

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

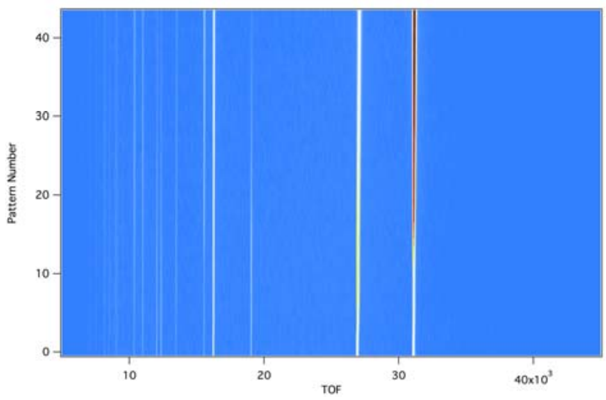

Fig.1 Diffraction patterns of $CoCrFeNiMo_{0.1}$

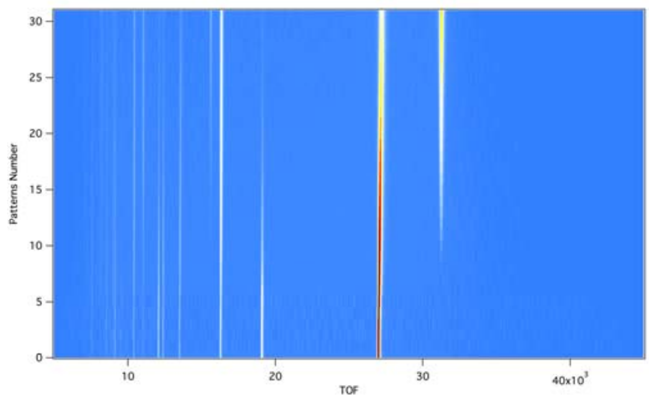

Fig.2 Diffraction patterns of $CoCrFeNiMo_{0.2}$

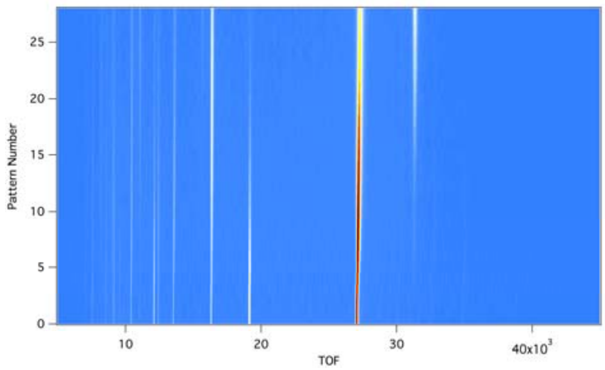

Fig.3 Diffraction patterns of $CoCrFeNiMo_{0.3}$

Z-Rietveld software is adopted to determine the peak positions and lattice strains. Lattice strain ε_{hkl} is related to peak position TOF_{hkl} by the following equation:

$$\varepsilon_{hkl}=(d_{hkl}-d_{hkl,0})/d_{hkl,0}=(TOF_{hkl}-TOF_{hkl,0})/TOF_{hkl,0}$$

The plots of lattice strain and true stress for CoCrFeNi and $CoCrFeNiMo_{0.1}$ are presented in Fig.4 and Fig. 5, respectively. Strong elastic anisotropy is shown as the lattice strain changes highly dependent on hkl orientations. Young's moduli of different orientations are also presented in the figures.

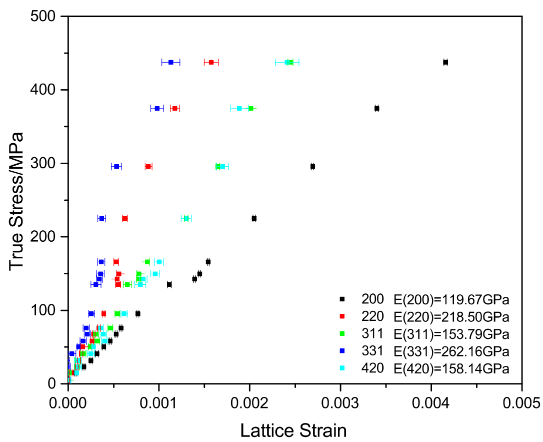

Fig.4 Lattice strain-true stress plot of CoCrFeNi

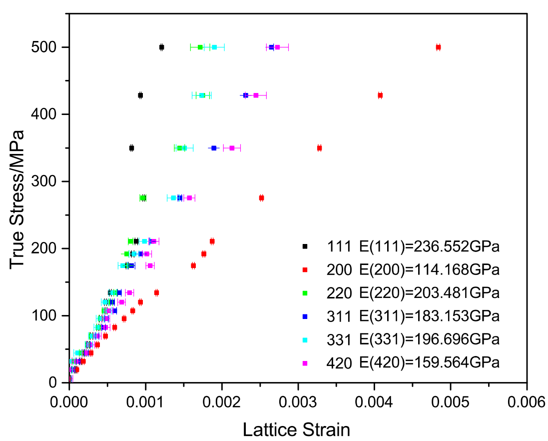

Fig. 5. Lattice strain-true stress plot of $CoCrFeNiMo_{0.1}$

CMWP method is applied to diffraction patterns for analysis of dislocation evolution. CMWP refers to Convolutional Multiple Whole Profile method, which fits the measured pattern by a model

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

based on initial assumption of experimental data and convoluted with instrumental effects. The measured pattern is fitted by a calculated model taking into account of size broadening, strain broadening and planar defects effect. Instrumental effect is determined for certain instrument by patterns of standard samples. Background is manually selected in CMWP GUI, and could be adjusted when needed. Peak intensity and position are fitted as free parameters in this method. The goal is to use Levenberg-Marquardt nonlinear least square method to obtain the minimum difference between $I_{hkl}^{Measured}$ and $I_{hkl}^{Theoretical}$. In CMWP, strain broadening is considered mainly caused by dislocation.

The physical values of integral breadth calculated from physical patterns obtained from CMWP method follow modified Williamson-Hall plot well as shown in Fig.6.　Detailed analysis is being carried out and will be presented.

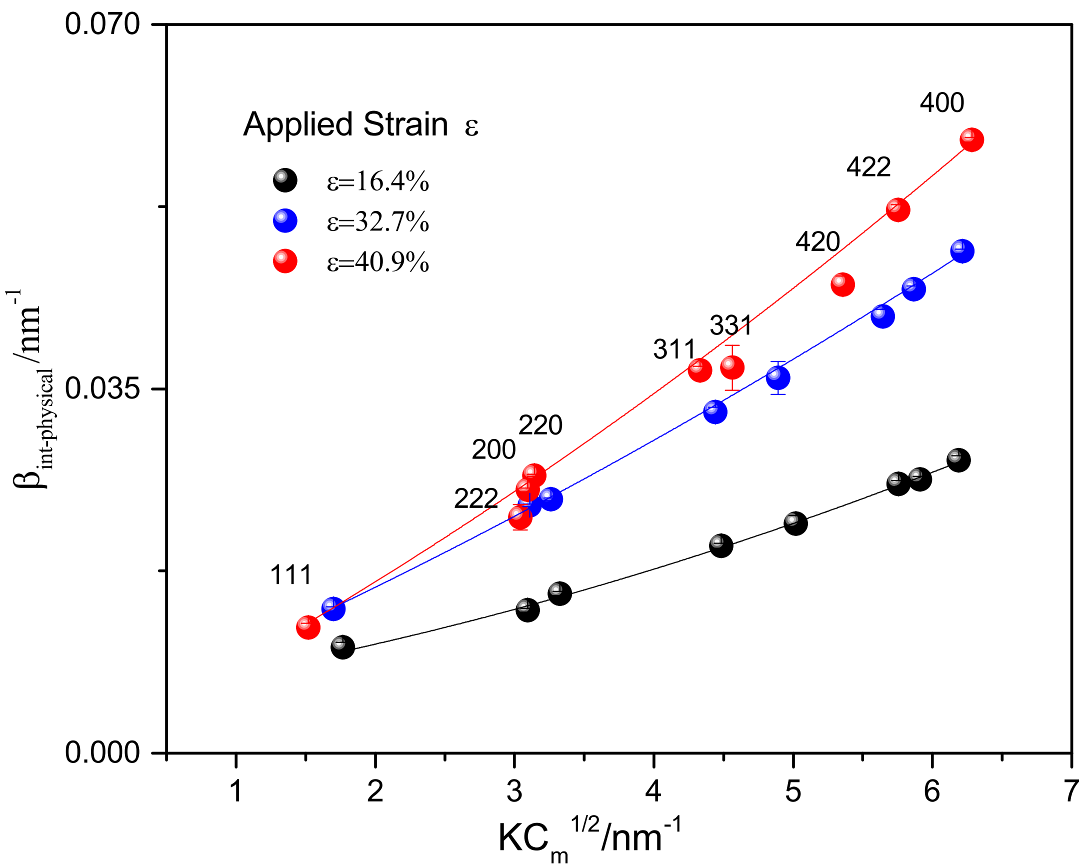

Fig.6 Modified Williamson-Hall plots at different loading stages