MLF Experimental Report	提出日 Date of Report December 14, 2014
課題番号 Project No. 2014A0025 実験課題名 Title of experiment Detection of critical point in martensitic transformation of an Fe-Pd alloy 実験責任者名 Name of principal investigator Takashi Fukuda 所属 Affiliation Osaka University	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 November 4 - November 8

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 specimen used in this experiment was a single crystal of A1-type Fe-30.7at.%Pd alloy, which was analyzed by ICP. A single crystal of the alloy was grown by a floating zone method. A parallelepiped single crystal with dimensions of 26.8 mm x 2.7mm x 2.7 mm was used for the present experiment. The single crystal was heat-treated for homogenization at 1373 K for 24 hours followed quenching into ice water. The martensitic transformation temperature of this specimen was approximately T_0 = 270 K, which was measured by a SQUID magnetometer beforehand. The edges of the specimen was parallel to [001], [100] and [010] directions.

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 was inserted between two pistons, which were made of an aluminum alloy. Then the specimen with pistons were set into a compressing stage attached to a cold stage. The specimen was compressed in the [001] direction in TAKUMI (BL19). We needed to apply the minimum stress of -4 MPa to hold the specimen for the measurements. Here the minus sign on stress means compressive stress is applied on the specimen. The diffraction patterns with the scattering vector parallel to the [001] direction (load direction) were detected by the SOUTH BANK and those with scattering vector parallel to the [100] direction (perpendicular to the load direction) were detected by the NORTH BANK. We measured the position and peak separation of (002) peak in the SOUTH BANK and (200) peak in the NORTH BANK. The slit condition used in TAKUMI was 3 mm in height and 3 mm in width.

(1) Change in peak profile by the application of stress

Figure 1 shows stress dependence of the peak profile of the 002 reflection (load direction). At 370 K (= T_0 + 100 K), which is by 100 K above the transformation temperature T_0, the peak gradually shift to left. There is no peak separation and broadening of the peak by the application of the stress. The result implies that the specimen

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

deforms elastically at this temperature. At 330 K (T_0 + 60 K), we notice a broadening of peak between 74 MPa and 114 MPa. The broadening suggests the onset of phase transformation. At 280 K (T_0+10 K), we notice the broadening of the peak even at 35 MPa, and the peak width is almost constant up to 154 MPa. This implies that phase transformation occurs between 4 MPa and 35 MPa at 280 K. At 240 K (= T_0 - 30 K), the peak becomes sharp with increasing stress. Presumably, the broad peak at 240 K is due to the coexistence of several variants. With increasing stress, selection of variants occurs, and results in the sharping of the peak. Similar results were obtained for the 200 reflection (perpendicular to the load direction) although the peak shifted to right side with increasing stress.

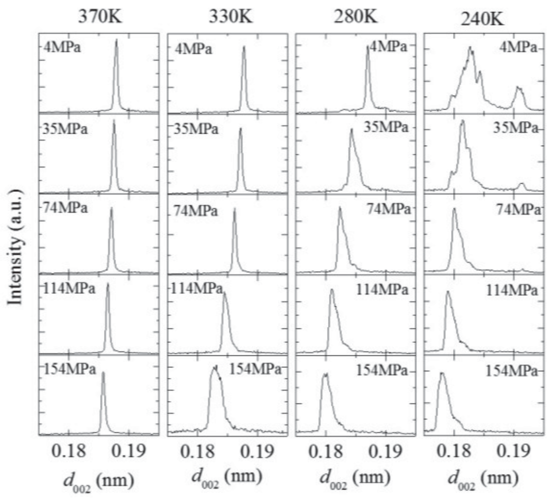

Figure 1 Peak profile from the SOUTH BANK. Compressive stress indicated in each panel is applied in the [001] direction. Measurements were made in the stress applying process.

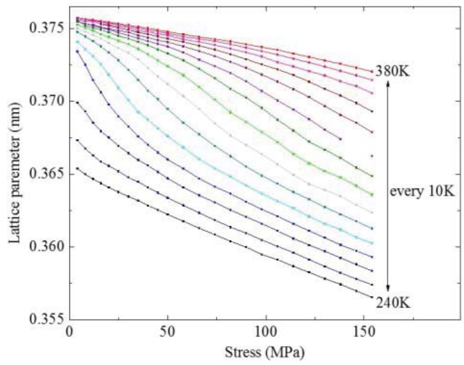

Figure 2 Stress dependence of lattice parameter *c*. Evaluation of *c* was made by fitting the 002 reflection using Gaussian function.

(2) Stress dependence of lattice parameter

Figure 2 shows stress dependence of lattice parameter *c* evaluated by fitting peaks shown in Figure 1 by Gaussian function. At 380 K and 240 K, the lattice parameter *c* decreases nearly linearly as stress increases. This is characteristic feature of elastic strain. The average Young's modulus is about 16 GPa at 380 K, and 6 GPa at 240 K. At intermediate temperatures, the temperature dependence of the lattice parameter *c* is not linear. In particular, at temperatures of 280 K, 290 K, 300 K, and 310 K, which are above T_0 = 270 K, we notice an inflection point. The inflection point also suggests that phase transformation occurs near the point. On one hand, when the stress is below the inflection point, the lattice softening occurs as stress increases. On the other hand, when the stress is above the inflection point, the lattice hardening occurs as stress increases. At temperatures below T_0, there is no softening of lattice. Similar results were obtained for lattice parameter *a*, which were evaluated by the peak profile of the 200 reflection (perpendicular to the load direction) although *a* increased with increasing stress.

Summary

In the present experiments, clear peak separation was not observed for the stress-induced martensitic transformation. It seems that the first order nature weakens or disappears by the application of compressive stress. This will be one aspect of the critical phenomena of martensitic transformation in Fe-Pd system.