MLF Experimental Report	提出日 Date of Report May 15, 2013
課題番号 Project No. 2012B0002 実験課題名 Title of experiment Mechanism of a large elastic strain in Fe3Pt 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 March 22 - March 25

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 $L1_2$-type Fe_3Pt (Fe-25at.%Pt alloy), which was grown by a floating zone method. A parallelepiped single crystal with dimensions of 9.8 mm x 2.5mm x 2.6 mm was used for the present experiment. The single crystal was heat-treated for homogenization at 1373 K for 24 hours followed by ordering heat-treatment at 923 K for 100 hours. The long range order parameter determined by X-ray diffraction was 0.75. The martensitic transformation temperature of this specimen was approximately 90 K, which was measured by a SQUID magnetometer beforehand. The edges of the specimen was parallel to [001], [110] and [-110] 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 in a dice with pistons, which are made of an aluminum alloy. Then the specimen with dice and pistons are set into a compressing stage attached to a cold stage. The specimen is compressed in the [001] direction in TAKUMI (BL19). We need to apply the minimum stress of -6 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 were detected by the SOUTH BANK and those with scattering vector parallel to the [110] direction were detected by the NORTH BANK. We measured the position and peak separation of (002) peak in the SOUTH BANK and (220) peak in the NORTH BANK. The slit condition used in TAKUMI was 3 mm in height and 5 mm in width.

(1) Temperature dependence of lattice parameters under -6 MPa and -100 MPa.

When the specimen was cooled under the stress of -6 MPa applied in the [001] direction, no peak separation was observed above 90 K and a clear peak separation due to the formation of the tetragonal martensite was observed below 90 K. The volume of unit cell increased with decreasing temperature, which is characteristic feature of the Invar alloy. These results are consistent with previous experiments made under zero stress by x-ray diffraction.

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

When the specimen was cooled or heated under -100 MPa applied in the [001] direction, no peak separation was observed in the whole examined temperature range (83 K to 264 K). Figure 1 shows temperature dependence of lattice parameters *c* and *a* obtained under -100 MPa. There is distinct difference between the lattice parameters *a* and *c* even above the transformation temperature of 90 K. The gradual deviation between *a* and *c* on cooling is due to the lattice softening of this alloy. It should be noted that there is no discontinuous change in *a* and also in *c* in the cooling process. This result implies that martensitic transformation in Fe_3Pt probably disappears by the application of compressive stress of -100 MPa. The volume of unit cell (a^2c) under -100 MPa showed negative temperature dependence as that under -6 MPa.

(2) Stress dependence of lattice parameters

When the stress was applied at 90 K, the (002) peak in the south bank and (220) peak in the north bank were essentially regarded as one peak in the stress range of -6 MPa and -280 MPa at 90 K. Figure 2 shows stress dependence of lattice parameters *a* and *c* obtained by the peak positions of the (002) and (220) peaks. The strain in the [001] direction calculated form this lattice parameter coincides with the strain obtained by strain gage attached at the surface of the specimen. This means that the elastic strain of about 6%, which appears in the stress-strain curve of this alloy, is essentially caused by lattice strain. When the stress exceeds about -280 MPa, there arises a large jump in lattice parameter. This jump is due to the martensitic transformation to the bct phase. The tetragonality of the bct martensite is approximately 0.80. This tetragonality is consistent with the bct martensite phase which forms in Fe_3Pt with low degree of order.

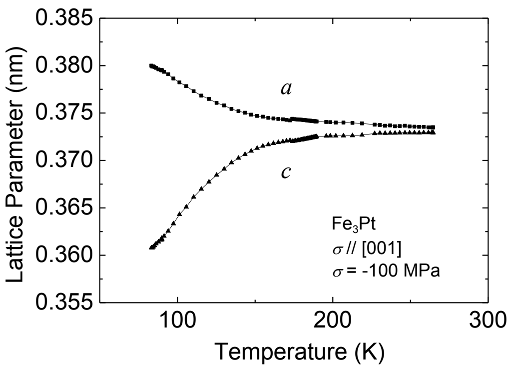

Figure 1 Temperature dependence of lattice parameters of Fe_3Pt under -100 MPa.

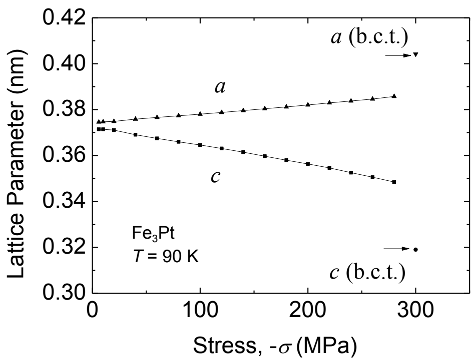

Figure 2 Stress dependence of lattice parameters of Fe_3Pt at 90 K.

(3) Temperature dependence of lattice parameter of the bct martensite

As the bct martensite phase was formed by the application of stress at 90 K, we measured temperature dependence of the unit cell volume of of the bct martensite phase under -6 MPa. As a result, we found that volume increases with increasing temperature. That is, the Inver effect diminishes in the bct martensite phase.

In summary, we have confirmed by using TAKUMI (BL19) that Fe_3Pt exhibits an extremely large elastic strain of approximately 6% appear at 90 K in Fe_3Pt due to lattice distortion under compressive stress applied in the [001] direction. In addition, it is confirmed that the bct martensite appears when the strain exceeds about 6%.