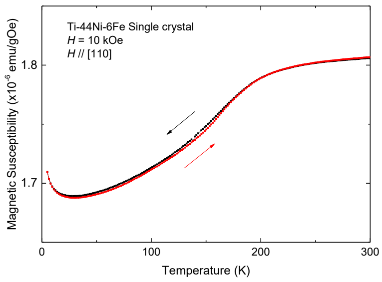
MLF Experimental Report	提出日 Date of Report
課題番号 Project No. 2015A0194 実験課題名 Title of experiment Stress-Induce martensitic transformation from the C-phase to the R-phase in Ti-Ni alloys 実験責任者名 Name of principal investigator Takashi Fukuda 所属 Affiliation Osaka University	装置責任者 Name of responsible person Kazuya Aizawa 装置名 Name of Instrument/（BL No.） BL19 実施日 Date of Experiment 03/14/2016-03/18/2016

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.

The sample used in the present study was a single crystal of Ti-44Ni-6Fe (at%) alloy. The alloy was prepared by arc melting and the single crystal was grown by a floating zone method. The magnetic susceptibility of the specimen exhibits a gradual decrease in the cooling process below 200K and a small hysteresis appears around 150 K. This implies that a gradual phase transformation occurs in the specimen.



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.

Method:

The specimen was compressed in the [110] direction using a jig made of an aluminum alloy. The orientation relationships between incident beam, the specimen, stress and detectors are shown in Figure 1. The lattice spacing in the compressive direction (d_{110}) was detected by the +90° detector, and that normal to the compressive direction (d_{111}) was detected by the -90° detector. The temperature of the specimen was controlled by the piston to which the jig was attached. The temperature of the piston was controlled by the flow of liquid N_2 and a heater. The temperature of the specimen was monitored by a thermocouple attached to the jig. Also, the macroscopic strain was monitored by the strain gage attached on the surface of the specimen.

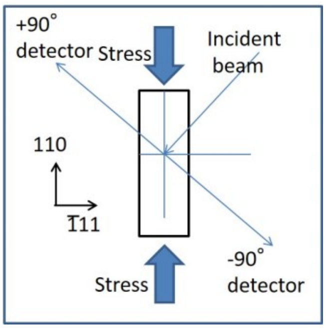


Fig. 1 Experimental set up for BL19.

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

Results and discussion:

First, we examined the temperature dependence of diffraction pattern under the absence of applied stress. At 170 K and higher temperatures, only the 110_{B2} and its higher-order reflections were detected by the +90° detector, and 111_{B2} and its higher order reflections were detected by the -90° detector. Below 160 K, a satellite with larger *d*-value appeared in both the +90° and -90° detectors. The *d*-values evaluated by fitting the peaks using Lorentzian functions are shown by blue marks in Figs 2 and 3. The appearance of the satellite suggests that the R-phase appears below 160 K. Considering the lattice correspondence between the B2-phase and the R-phase, we may regard that the $(110)_{B2}$ separates into $(-122)_R$ and $(300)_R$ reflections, and the $(111)_{B2}$ reflection separates into $(003)_R$ and $(-241)_R$ reflections, respectively.

Next, we examined the temperature dependence of diffraction pattern under 100 MPa. Under the stress, the satellite appeared only in the -90° detector. The peak in the +90° detector exhibited a significant peak shift without peak separation. The red mark in Fig. 2 is the d-value evaluated from the peak position. The *d*-value shows significant contraction below 180 K. It is contracted by 0.47% under 100 MPa compared to that under 0 MPa. If we assume this change is caused by elastic deformation, the Young's modulus in the $[100]_R$ direction is evaluated to be about 20 GPa. This value is extremely small compared with typical Young's modulus (70 GPa) of Ti-Ni based shape memory alloy. The red marks in Fig. 3 shows the *d*-values evaluated by the peaks detected by the -90° detector. The *d*-values in Fig.3 under 100 MPa is slightly larger than that under 0 MPa, especially below 160 K. At 110 K, the value of d_{003R} under 100 MPa is by 0.11 % larger than that under 0 MPa. Since the contraction in the $[100]_R$ direction is 0.47%, and the expansion in $[001]_R$ direction is 0.11%, the Poisson's ratio of the R-phase is evaluated to be about 0.23. This value is significantly small compared with typical Poisson's ratio (0.3) of Ti-Ni shape memory alloys. Since the Young's modulus at 110 K of the present specimen is much smaller and Poisson's ratio is significantly smaller than conventional Ti-Ni based shape memory alloys, we may regard that the deformation at under the compressive stress is not conventional elastic deformation. (Poisson's ratio is usually large when the Young's modulus is small.) One explanation for this behavior is that a kind of phase transformation occurs by the application of the stress. That is, the phase under 100 MPa could be different from that under 0 MPa. Further analysis on the experimental results is now in progress.

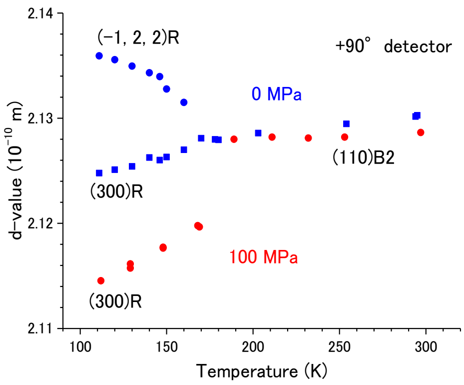


Fig. 2 *d*-values detected by +90° detector

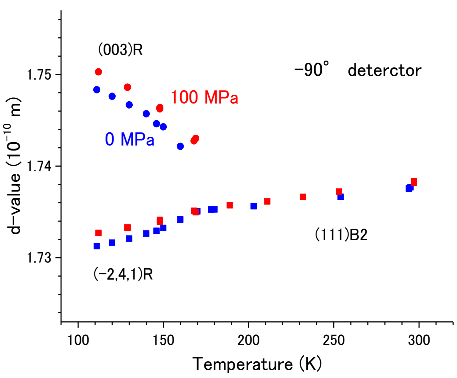


Fig. 3 *d*-values detected by -90° detector