（ ※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。 ）

MLF Experimental Report	提出日 Date of Report 2017/5/12
課題番号 Project No. 2016B0114 実験課題名 Title of experiment Phase Transformation and Texture Development during Hot Deformation in High-Strength Ti Alloys 実験責任者名 Name of principal investigator Nobuhiro Tsuji 所属 Affiliation Kyoto 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 2017/2/19-21, 23

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.

Ti-6Al-4V (mass%) alloy

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.

Titanium (Ti) and Ti-alloys are widely used in aeroplane and space applications due to their excellent strength to weight ratio, high-temperature strength, and corrosion resistance. The most widely used high-strength $\alpha + \beta$ type Ti alloy is Ti-6Al-4V having α phase of hexagonal close-packed (HCP) structure and β phase of body centered cubic (BCC) structure. Aeroplane parts of Ti-6Al-4V alloy are fabricated through hot forging at high temperatures, i.e., thermomechanical processing, after melting and casting. The hot deformation (forging) is carried out in β single-phase region as well as in $\alpha + \beta$ two-phase region, so that complicated microstructures that affect their mechanical properties are obtained.

In the present experiment, the transformation behaviors and development of textures in the Ti-6Al-4V alloy were studied by *in-situ* neutron diffraction using the newly developed thermomechanical processing simulator (**Figure 1**). This simulator can heat specimen up to 1200 °C by induction heating system under vacuum condition or gas atmosphere, and can apply precisely controlled compression deformation at a maximum deformation rate of 100 mm s^{-1} with a maximum load of 30 kN.

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

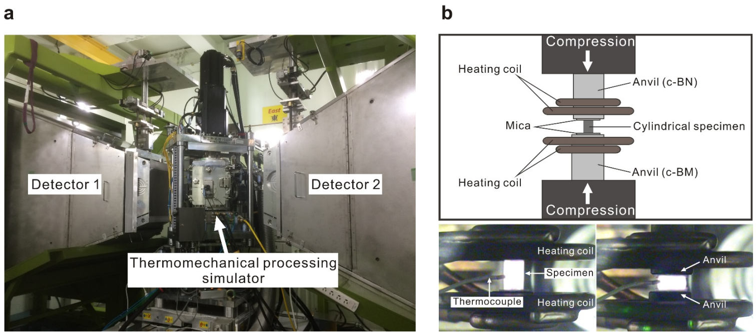

Figure 1. (a) Appearance of the thermomechanical processing simulator installed on BL19 TAKUMI, and (b) a schematic illustration and snap shots in a hot-compression experiment in the simulator.

The cylindrical specimens 11 mm in height and 6 mm in diameter were heated up to the temperatures ranging from 900 °C to 1050 °C and held isothermally for 600 s. Then, the specimens were deformed in compression up to 50 % reduction in height, and cooled immediately at a cooling rate of 1 °C. During the thermomechanical processing, the pulsed neutron beam was irradiated to the specimen from the direction perpendicular to the compression axis, and the diffracted neutron beam was corrected by the two time-of-flight (TOF) detectors which were located at the positions perpendicular to the incident neutron beam, i.e., the diffracted planes in the specimen were parallel to the compression axis.

Figure 2 shows neutron diffraction profiles obtained (a) before the compression and (b) at the later stage of the compression, respectively. The diffraction profiles were analyzed by Rietveld method using Z-Rietveld software. Five peaks in α phase ($(10\text{-}10)_{\alpha}$, $(0002)_{\alpha}$, $(10\text{-}11)_{\alpha}$, $(10\text{-}12)_{\alpha}$, $(2\text{-}1\text{-}10)_{\alpha}$) and three peaks in β phase ($(110)_{\beta}$, $(200)_{\beta}$, $(310)_{\beta}$) were used to investigate the changes in orientation during the hot compression.

Figure 3 summarizes the relative intensity of several diffracted planes in (a) α phase and (b) β phase. I_0 and I_1 indicate the intensities before the compression and at the later stage of the compression, respectively. The intensity of $(0002)_{\alpha}$ plane and $(110)_{\beta}$ plane increased after the hot

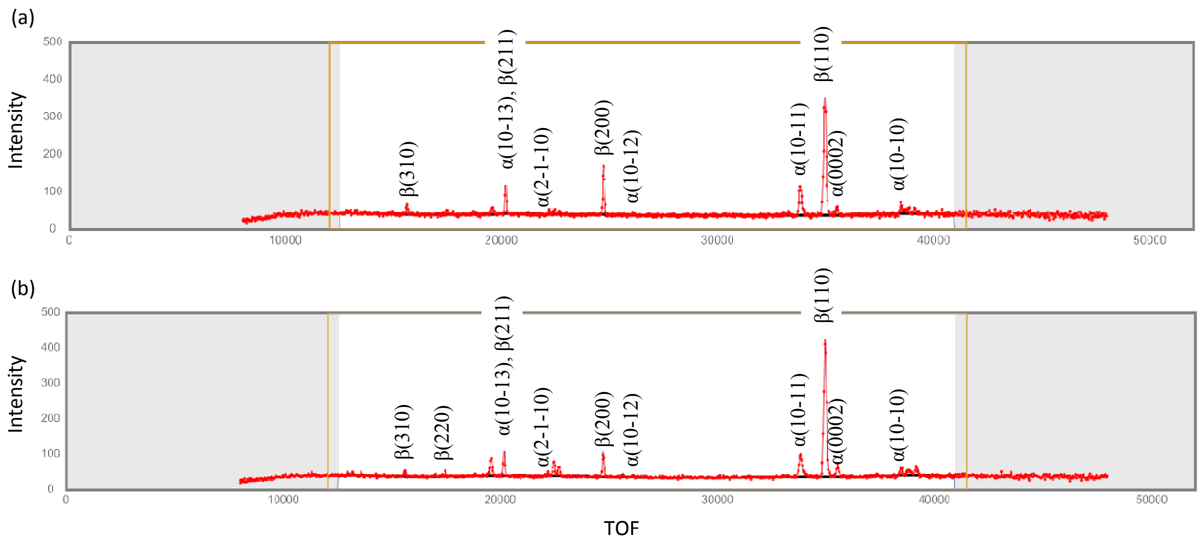

Figure 2 Neutron diffraction profiles obtained (a) before the compression and (b) at the later stage of the compression, respectively.

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

compression. This indicates that $(0002)_\alpha$ and $(110)_\beta$ planes tended to rotate parallel to the compression direction. At the deformation temperature, α phase (referred to as primary α) and β phase exist, and a volume fraction of β phase is about 70%. But almost all β phase transform to α phase (referred to as secondary α) after cooling to room temperature. Through the conventional microstructural observation at room temperature, it is very difficult to understand the orientation change of β phase during the hot deformation. The present *in-situ* neutron diffraction analysis during the hot compression successfully revealed that $(110)_\beta$ plane was rotated perpendicular to the compression direction as well as $(0002)_\alpha$ plane.

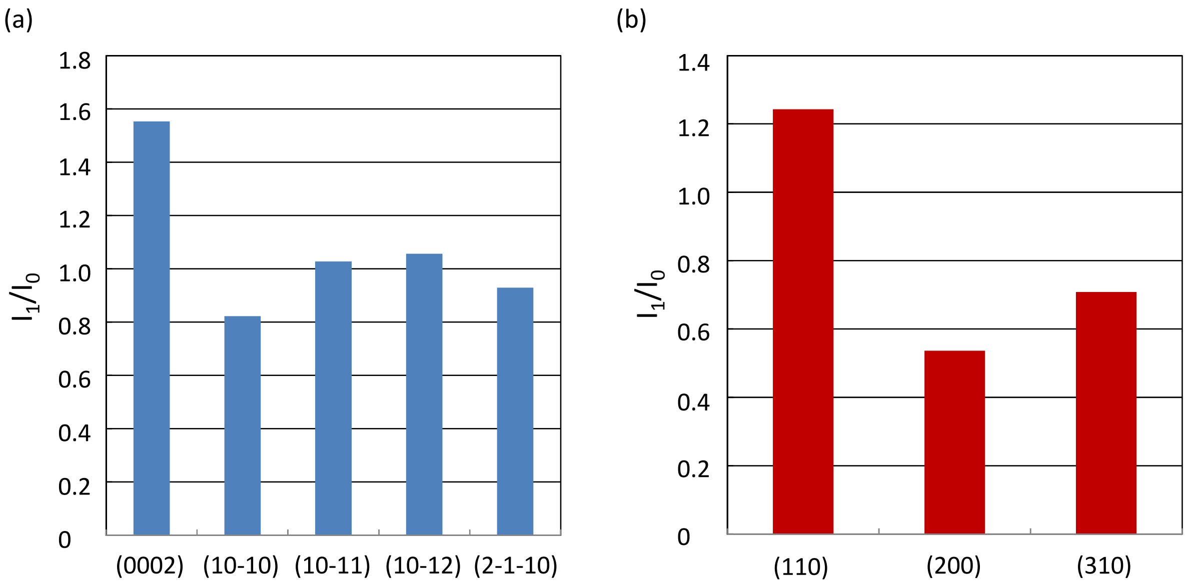

Figure 3 The relative intensity of several diffracted planes in (a) α phase (HCP) and (b) β phase (BCC). I_0 and I_1 indicate the intensities before the compression and at the later stage of the compression, respectively.