First results of high-pressure neutron experiments at TAKUMI in J-PARC

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Introduction

High-pressure neutron experiments have been limited so far due to the small flux of neutron source. Now, the intense pulse neutron source offered from J-PARC opens up the opportunity. Then, we are trying to do high-pressure neutron experiments, which offers information that have been not obtained so far, such as position of light elements and atomic dynamics.

Now we could manage to get fund to construct the high-pressure beamline, and for its training we have just started the TOF neutron experiments in another beamline already constructed. In this talk, we reports first high-pressure TOF results taken at the engineering materials diffractometer TAKUMI in J-PARC, and discuss the future prospect on high-pressure neutron diffraction.

Engineering Materials Diffractometer, TAKUMI

Engineering Materials Diffractometer TAKUMI is the beamline specially dedicated for the detection of strain in engineering materials. It possesses 90 degree banks and offers highly accurate d-values with the precision of delta d/d˜0.5%. The characteristic feature of this beamline is the ability to obtain the information in the restricted area in the sample by using radial collimators. This device is also effective in obtaining information of the tiny sample under high pressure, which contributes to the high S/N ratio even for high-pressure sample. We brought two types of high-pressure devices [Paris-Edinburgh cell (PE-cell) and Palm Cubic multi-anvil cell (Palm Cubic cell)] into this beamline, and obtained TOF data.

High-Pressure experiments

At first, we intend to estimate the intensity decrease due to the high-pressure devices. Experiments were done at the source power of 20kW, which is 1/50 times of the full power designed for J-PARC (1MW). Neutrons are detected with ZnS scintillation counter units. One unit covers detection angle of 10 degree in a horizontal plane and 5 degree in a vertical plane. In this experiment, we used three units which were already installed. The sample we used is lead with a dimension of 6phi ∗3t for PE-cell experiments and 3phi∗3t for the Palm Cubic cell experiments. Figure 1 shows the TOF data taken at two types of high-pressure devices, as well as those for bare sample.

Roughly speaking, the reduction in the intensity by high-pressure cells is 1/20 for PE-cell at a few GPa, and 1/8 for Palm cubic cell at ambient condition. Considering the future increase in neutron source power and the full installation of detectors, the 350 times gain is expected. This will offers the detection performance of the counting rate of ten thousand counts per hour even at high pressures.