Density of Liquid Te and Bi under High Temperature and High Pressure

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Recent high-pressure x-ray diffraction studies on liquid metals have revealed that each liquid exhibits characteristic change under pressure. Density is one of the most fundamental values to study those changes. However there were few studies on density of liquids under high-pressure owing to technical difficulties. We have developed a new method for density measurements under high-pressure by means of x-ray absorption. In this study we carried out a feasibility test at the SPring-8.

Measurements on the proposed samples, bismuth and tellurium, were not possible because sufficient high-energy x-ray was not available with Si(111) crystals. So that we changed the sample to selenium, which has much less x-ray absorption coefficient. A large-volume Paris-Edinburgh press was used to generate pressure. A sapphire cylinder, 0.5mm i.d., 1.0 mm o.d. and 0.5 mm thick, was used as a sample container. It was surrounded by a BN capsule. The pressure was determined using a NaCl pressure marker put in the sample assembly. The diffraction from the marker was measured with an IP detector. Experiments were carried out at high pressure station on BL10XU. The energy of the monochromatic x-ray was 35 keV. The size of the x-ray was reduced to 0.1 x 0.1 mm^2 by slits. The intensity of the incident and transmitted x-rays were measured by two photodiodes. They were measured as a function of sample position.

Figure 1 shows an example of the x-ray absorption profile. The shape of the sample was clearly observed. The density of the sample was obtained by a parameter fit. The solid line indicates the result of the fit. It well reproduced the experimental values. Figure 2 shows the density of Se at 1.6 GPa as a function of temperature. The absolute value of density was not adjusted. The abrupt change at 200°C corresponds to crystallization of amorphous sample. This result indicates that the method is capable of detecting density change at phase transitions. Unfortunately the density of liquid Se could not be measured because liquid Se penetrate through the BN capsule. A Search for better materials is currently under way.

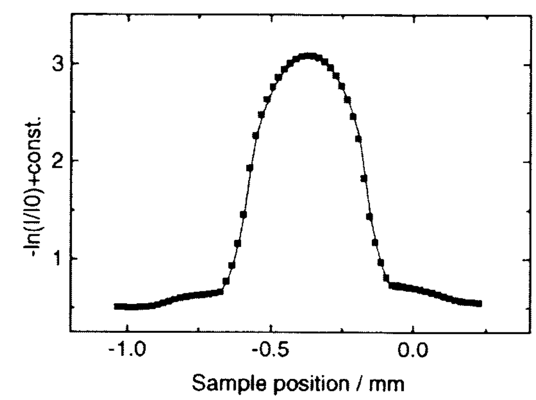

Fig.1 Absorption profile of selenium at 1.6 GPa and 500 °C

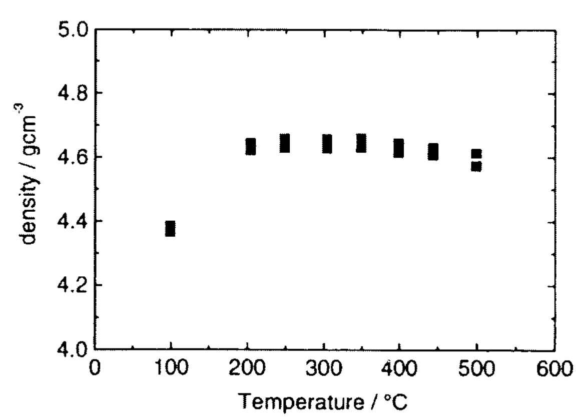

Fig.2 Density of selenium at 1.6 GPa