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Names and affiliations of applicants (* indicates experimentalists):

Y. Katayama* ‘, M.Mezouar*, D.Matinez-Garcia*, J.M.Besson*

Physique des Milieu Condensés, Universite’ P. et M. Curie, 75252, Paris, France

G. Syfosse*

Department des Hautes Pressions. Université P. et M. Curie, 75252, Paris, France

D. Hausermann*, M. Hanfland*

ESRF

[a] permanent address: *Department of Physcs, Keio University, Yokohama 223, Japan*

Report:

First order phase transition in the liquid phases have recently been shown to occur in a number of elements and compounds such as tellurium, selenium, bismuth, tin and gallium antimonide[l]. The existence of a liquid-liquid phase transition in HgTe had been postulated previously[2] and supported by a recent X-ray diffraction study[3]. To understand the transformation processes, precise density variations at the transitions are indispensable. In this study we applied a new method for density measurements[4] and combined it with the intense, high-energy X-ray at ESRF.

The absorption experiments were carried out using a large-volume Paris-Edinburgh press on ID20/BL2 at ESRF. The energy of x-ray was 65 keV and the size of the x-ray beam was 0. lmm x 0. lmm. The incident and transmitted X-ray intensities, I and I_0, respectively, were measured by photodiodes. Figure 1 shows a schematic diagram of the sample container. To keep the sample shape cylindrical, the sample was confined in a ruby cylinder, 0.5 mm i.-d. and 1.0 mm o.-d. We measured the x-ray absorption as a function of sample position, x, and then fitted the data using the following formula:

$$I / I_0 = C \int_{beam} \exp(-\mu \rho l(x))\, dx, \qquad l(x)=(r^2-(x-x_0)^2)^{1/2}$$

with: C, a constant, μ, the mass absorption coefficient of the sample, ρ, the density of the sample, I(x), the length of the path in the sample, r, diameter of the sample, x_0, sample center.

Figure 2 shows an example of the measurements on liquid bismuth(Bi). The circles indicate the experimental data and the line indicates the result of a parameter fitting. We. can clearly see the image of the sample shape. The fitting well reproduces the position dependence of the absorption. Figure 3 shows the temperature dependence of the density of Bi at 1 GPa. A sudden change of density between 180 °C and 240°C corresponds to the melting. The positive jump at the melting is consistent to the negative slope of the melting curve ($dT_m/dP<0$) From the slope in the solid and liquid phases we can evaluate the thermal expansion coefficients of Bi at 1GPa to be $3 \times 10^{-5}\ K^{-1}$ for solid and $1.2 \times 10^{-4}\ K^{-1}$ for liquid. These values are close to the values at ambient pressure, $4 \times 10^{-5}\ K^{-1}$ for solid and $1.1 \times 10^{-4}\ K^{-1}$ for liquid. Further data analysis is now in progress. Unfortunately the density measurements on HgTe were not satisfactory because they were done before optimizations of the experimental setups.

The quality of the data is much better than the previous experiments at Photon Factory[4]. The present result shows that it is now possible to measure densities of disordered phases under high-pressure and high-temperature at ESRF.

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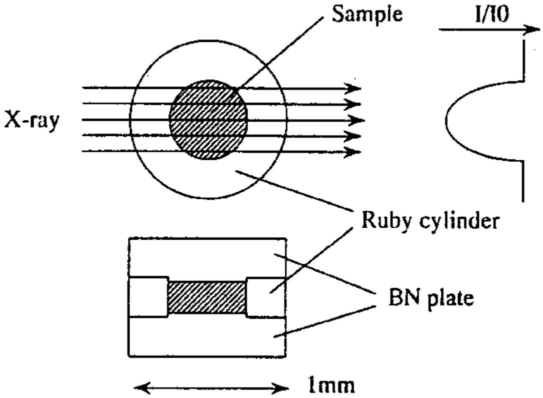

Fig.1 Schematics of sample container

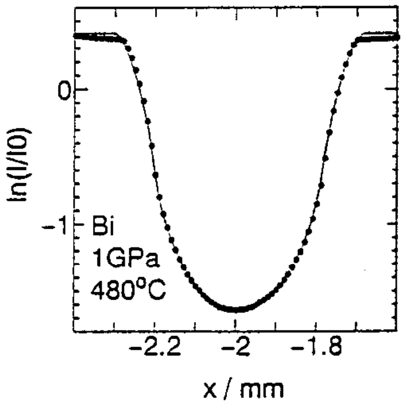

Fig.2 X-ray absorption profile

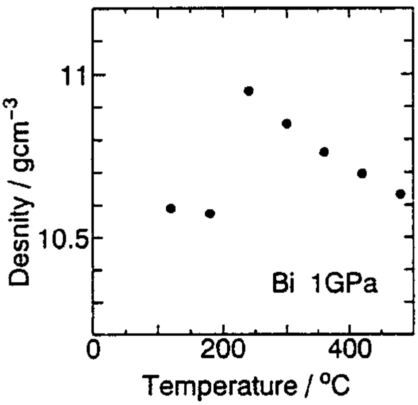

Fig.3 Temperature variation of density of Bi