X-ray Diffraction Measurements for Expanded Fluid Mercury

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Liquid Hg is transformed to an insulating state when it is expanded to liquid-vapour critical point (the critical data of Hg [1]: Tc=1470 ℃, pc=1673 bar, dc=5.8 g/cm^3). Many investigations have been made over the last decades, focused on the metal-nonmetal (M-NM) transition in fluid Hg. To understand the M-NM transition it is very important to investigate how the atomic arrangement is changed when liquid Hg is expanded. Recently x-ray diffraction measurements using an in-house x-ray source were made for expanded fluid Hg, giving information on the first neighbour coordination [2]. In this report the first experiments of the x-ray diffraction measurements using synchrotron radiation, extending from the liquid to the dense vapour region. are described.

We have performed energy-dispersive x-ray diffraction measurements for expanded fluid Hg using the spectrometer installed at the BL-04B1 in SPring-8. The storage ring was operated at 8 GeV with 20mA. White x-rays were generated through the bending magnet ranging energy up to 150 keV. The incident x-ray beam was collimated down to 0.2×0.2 mm^2 using the horizontal and vertical slits located at the upper stream. The beam was directly introduced into the high pressure vessel through the Be window and the transmitted beam was blocked using a lead stopper outside the vessel. As a result the background noise due to the secondary x-rays in the hutch was substantially reduced. It took several days to set up the high pressure vessel and to adjust the incident x-ray beam into the exact sample position in the vessel. After this procedure the good experimental condition was achieved.

The fluid Hg was contained in the specially designed sapphire cell being transparent to x-rays and resistant to chemical corrosion by the hot fluid Hg [2]. The sample thickness was 30 μm and 60 μm in the experiments. The outgoing x-rays scattered from the sample pass through the Be windows and the intensity is detected at the fixed 2θ of 5, 10, 20 and 33 deg. using Ge solid state detector. We obtained the x-ray scattering spectra of the empty sapphire cell before loading the sample. The x-ray diffraction measurements were carried out in the temperature and pressure ranges up to 1520 ℃ and 1775 bar along the saturated vapour pressure curve. The density ranges from 13.55 to 1.8 g/cm^3.

After the data analysis [2], the interference function, *S(k)*, of fluid Hg at each temperature and pressure are obtained. The *S(k)* seems to change systematically with decreasing density. The pair distribution function are obtained from Fourier transform of the *S(k)*. Further analysis is now in progress.

[1] W. Gotzlaff, PhD Thesis, University of marburg, 1998.
[2] K. Tamura and S. Hosokawa, J. Non-Cryst. Solids, **150** (1992) 29-34.