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Anomalous X-ray Scattering Measurements for Obtaining Electron Density Distribution in Liquid Ga

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Introduction

Recently, we proposed an experimental method for determining the electron density distribution of disordered materials by utilizing the anomalous dispersion effect near the absorption edge.[1,2] This method has an advantage that the electron density distribution function can be obtained without any combinations of different scattering techniques of X-rays and neutrons which may induce unavoidable errors arising from their different geometrical factors such as the absorption correction and the angular resolution. The main purpose of this work is to obtain the electron density distribution of liquid Ga in real space through the precise determination of its ion-electron structure factor estimated from the AXS measurements.

Experimental

The AXS measurements for a liquid Ga sample were carried out at BL-7C. The scattering intensities were measured using symmetrical reflection geometry by a Ge solid state detector. The sample was filled in a cell with an X-ray window of Kapton film (7.5 μm thickness). The sample was kept at temperature of 310K, just above the melting point. This sample cell was positioned in the chamber filled with He gas. As an example, Fig. 1 shows the data of scattering intensities for liquid Ga in the cell and for the empty cell, all made at the incident energy of E_1=10.018 keV. After subtracting the contribution from the window of Kapton film, the measured intensities were converted into absolute units.

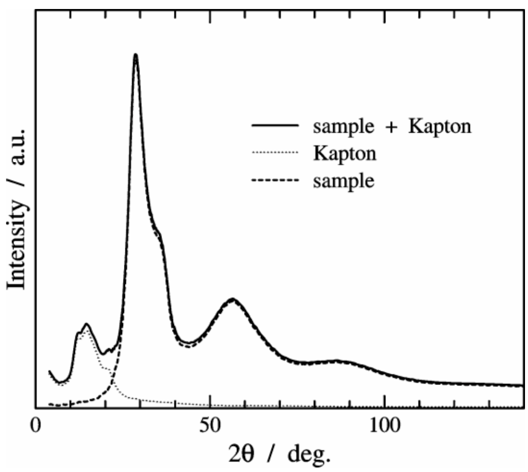

Fig. 1 Scattering intensities for liquid Ga in the cell with an X-ray window of Kapton film and for the empty cell.

Results and discussion

Figure 2 shows the coherent X-ray scattering intensity profiles of liquid Ga measured at the energies of E_1=10.018 and E_2=10.333 keV. These two energies correspond to 350 and 35 eV below the Ga K (10.368 keV) absorption edge. The scattering intensities show distinct energy dependence due to the anomalous dispersion effect. The calculated intensity values of $I_{cal}(Q,E_2)$, defined by $I_{cal}(Q,E_2)=f_a^2(Q,E_2)I(Q,E_1)/f_a^2(Q,E_1)$, are also given in this figure. The profile of $I(Q,E_2)$-$I_{cal}(Q,E_2)$ enables us to provide one way for seeing the deviation of the valence electron distribution between liquid Ga and an isolated Ga atom. As easily seen in the top of Fig. 2, the systematic differences of $I(Q,E_2)$-$I_{cal}(Q,E_2)$ are well appreciated.

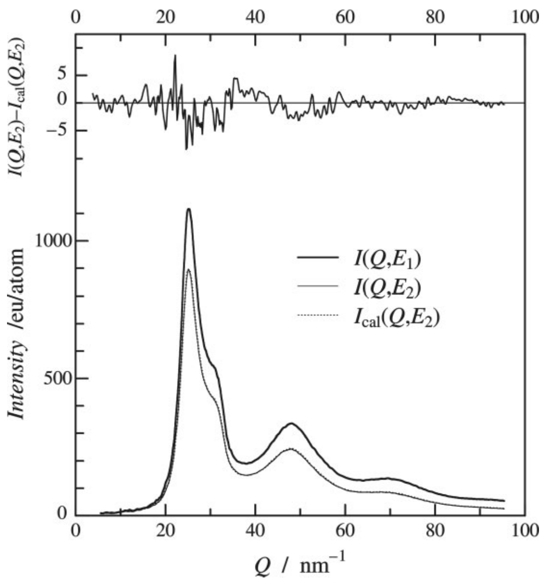

Fig. 2 Coherent X-ray scattering intensity profiles of liquid Ga measured at incident energies of 10.018 and 10.333 keV The difference of $I(Q,E_2)$-$I_{cal}(Q,E_2)$ is given in the top.

References

[1] M.Saito et al., Mater. Trans. JIM 37, 1026 (1996).
[2] M.Saito et al., Mater. Trans. JIM 42, 2071 (2001).

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