Pressure-Induced Structural Transformation in Liquid Metals

Tsuji K., Hattori T., Narushima T. and Kinoshita T.

Department of Physics, Keio University, 3-14-1, Hiyoshi, Kohoku, Yokohama 223-8522, Japan, E-mail: tsuji@phys.keio.ac.jp

X-ray diffraction for various liquid metals has been measured under pressure using synchrotron radiation. Pressure dependences of static structure factor S(Q) and pair distribution function g(r) were obtained. Different pressure dependences of the local structure were observed in liquid group 14 elements, liquid III-V, II-VI and I-VII compounds, liquid chalcogens and liquid iodine [1-8].

Systematic studies of the structure of liquid group 14 elements under high pressure reveal that the pressure dependences are different for liquid silicon, liquid germanium and liquid tin: Liquid silicon contracts with increasing pressure without significant changes in the local structure up to 8 GPa, and then transforms to a denser structure between 8 and 14 GPa [3]. An anisotropic contraction of local structure occurs continuously in liquid germanium up to 25 GPa. In liquid tin, it contracts almost uniformly although it still has anisotropic local structure [4]. These pressure dependences are different from that of liquid alkali metals, in which atoms have only spherical metallic bonds and their local structures contract almost uniformly [1].

Liquid III-V compounds (liquid GaSb, liquid InSb and liquid InAs) show different pressure dependences from those in the crystalline phase. The local structure contracts non-uniformly and is described by the mixture of the local structures (beta-tin-like and bcc-like local structures). The fraction of each form varies with pressure. Two local structures coexist over a wide pressure region [5-8].

For liquid CdTe, a remarkable structural change was observed in a narrow pressure region (1.8-3.0 GPa). The local structure in the low pressure region is similar to the zincblende structure, while it is similar to the rocksalt structure in the high pressure region. Another structural transformation occurs above 9 GPa. Results for liquid ZnSe and liquid AgI are also presented.

A remarkable increase with pressure in the bond length was observed in liquid iodine and in liquid tellurium. It reaches 7 % for liquid iodine at 10 GPa and 5 % for liquid tellurium at 6 GPa [2]. No abrupt change was observed in liquid iodine around the pressures where non-metal to metal transitions were reported [9].

These pressure dependences of the local structure of liquid metals are discussed in terms of the dimensionality of bonding network and the nature of the chemical bonds, comparing the pressure-induced structural phase transitions in the crystals.

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