

Structural Change of Liquid Ge-Te alloys on Pressure-Induced Liquid-Liquid Transitions

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Introduction

In liquid Ge-Te alloys, temperature-induced structural change was reported from atomic volume measurements [1]. In this liquid, atoms are covalently bonded with anisotropic interaction, and pressure is expected to cause microscopically anisotropic contraction similar to liquid Te and liquid GeTe [2, 3].

Experimental

X-ray diffraction patterns were taken by an energy-dispersive method using the synchrotron radiation. From the measured diffraction intensities, the static structure factors $S(Q)$ and the pair distribution function $g(r)$ of liquid metals were deduced.

Results and discussion

We have studied the pressure dependence of the structure of liquid $\text{Ge}_{33}\text{Te}_{67}$ and found a gradual but large change in $g(r)$ with increasing pressure [4]. We confirm that the structure does not take the $\text{Ge}(\text{Te}_{1/2})_4$ tetrahedral network structure in any pressure up to 9 GPa, which is in contrast to liquid $\text{Ge}_{33}\text{Se}_{67}$ and $\text{Ge}_{33}\text{S}_{67}$.

Figure 1 shows the $S(Q)$ of liquid $\text{Ge}_{0.15}\text{Te}_{0.85}$ at several pressures [5]. With increasing pressure, the height of the second peak decreases and the height of the first peak increases. Simultaneously, the first peak position slightly shifts towards higher Q values.

Since the heights of the first and the second peaks of $S(Q)$ change remarkably with temperature and pressure, the ratio $S(Q_1)/S(Q_2)$ of the heights of the first and the second peaks of $S(Q)$ is investigated as a function of temperature and pressure. Fig. 2 shows the ratio of $S(Q_1)/S(Q_2)$ along the melting curve as a function of pressure. The slope of the ratio changes around 1.2 GPa.

From measurements along several paths at constant pressure and at constant temperature, the boundary between the low-temperature and the high-temperature phases was determined for liquid $\text{Ge}_{0.15}\text{Te}_{0.85}$ and liquid $\text{Ge}_{0.2}\text{Te}_{0.8}$ alloys. The boundary has negative slope in a P-T phase diagram for both alloys. Since the high-temperature (high-pressure) phase has a smaller volume than that of the low-temperature (low-pressure) one, it is concluded from the Clausius-Clapeyron equation that the high-temperature (high-pressure) phase has larger entropy than the low-temperature (low pressure) one. These transitions are similar to the transition of liquid pure Te at supercooled temperature. For eutectic alloys the melting

temperature is lower than that of pure Te and the liquid-liquid transition was observed above the melting temperature.

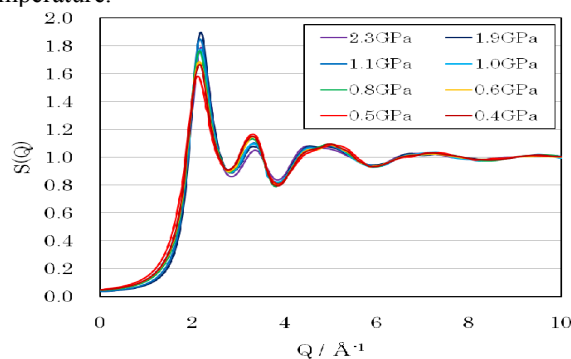


Figure 1. $S(Q)$ of liquid $\text{Ge}_{15}\text{Te}_{85}$ at several pressures.

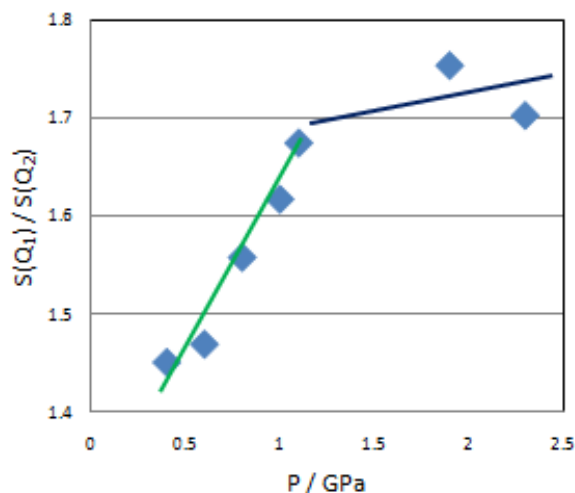


Figure 2. Pressure dependence of the ratio of $S(Q_1)/S(Q_2)$ along the melting curve for liquid $\text{Ge}_{0.15}\text{Te}_{0.85}$ alloy.

References

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