Relation between High Ionic Conductivity and Boson Peak in Superionic Glass

M. Arai[1], H. Iwase[1], M. Nakamura[1], E. Kartini[2], T. Otomo[3], S. J. Levett[4], S. M. Bennington[4]
[1]Neutron Science Research Center, JAERI, Tokai, Ibaraki 319-1195, Japan
[2]R&D Center for Materials Science and Technology, BATAN, Serpong, Tangerang 15314, Indonesia
[3]Institute of Materials Structure Science, KEK, 1-1 Oho, Tsukuba 305-0801, Japan
[4]Rutherford Appleton Laboratory, ISIS, Chilton Didcot, Oxon OX11, UK

High ionic conductivity of superionic glasses at room temperature is significantly attractive for many solid electrolyte applications. Despite their technological needs, the mechanism of high ionic conductivity in disordered structures remains unsolved.

In this study, we carried out the inelastic neutron scattering measurements of superionic glass system $(AgI)_x(Ag_2S)_x(AgPO_3)_{1-2x}$. The ionic conductivity at room temperature of $(AgI)_x(Ag_2S)_x(AgPO_3)_{1-2x}$ glasses varies in the range of 10^{-7} S/cm (x=0.00) to 10^{-2} S/cm (x=0.50)[1, 2]. We have obtained the $S(E)$ spectrum by total integration of the dynamical structure factor $S(Q, E)$. Figure 1 shows the dopant salt concentration (x) dependence of $S(E)$ spectra for $(AgI)_x(Ag_2S)_x(AgPO_3)_{1-2x}$ glasses at 20 K, which were corrected by Bose factor. For all $S(E)$ spectra, we can observe broad peak around 3 meV, the so-called boson peak. The boson peak intensity successively increases with dopant salt concentrations.

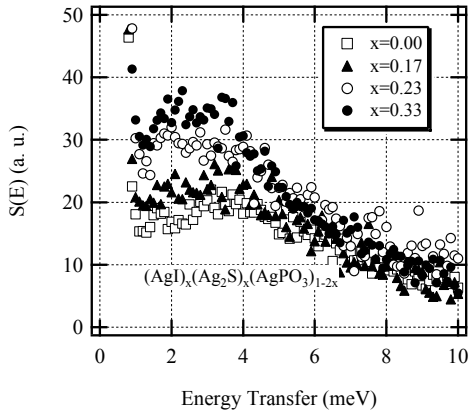

Figure 1: The E-dependences of dynamical structure factor, $S(E)$, are plotted for $(AgI)_x(Ag_2S)_x(AgPO_3)_{1-2x}$ glasses with x=0, 0.17, 0.23, and 0.33.

Figure 2 gives a comparison of dopant salt concentration dependence of both integrated intensity at 20 K and ionic conductivity at 300 K. It seems reasonable to consider that an excess of low energy excitation closely related to the ionic conductivity in superionic glass. Previously, we proposed a model for the origin of boson peak from inelastic neutron scattering measurement of vitreous silica and different forms of SiO_2[3], where the boson peak intensity has close relation to the fraction of void spaces. Our scenario for the boson peak in SiO_2 glass in terms of void spaces can be applied to the behavior of the boson peak in superionic glass. We should stress the *dynamical* properties involved void spaces to realize high ionic conductivity.

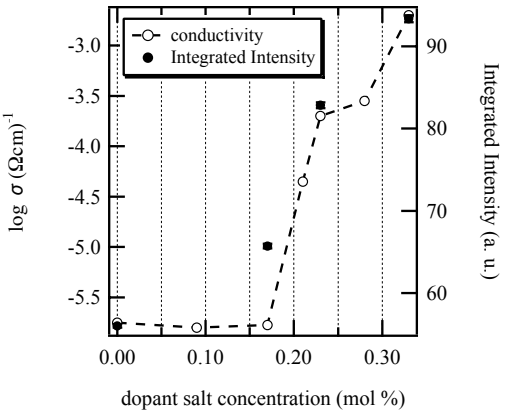

Figure 2: The room temperature ionic conductivity for $(AgI)_x(Ag_2S)_x(AgPO_3)_{1-2x}$ glasses are plotted against the dopant salt concentration. The integrated intensities of $S(E)$ from 2 meV to 5 meV for $(AgI)_x(Ag_2S)_x(AgPO_3)_{1-2x}$ glasses are also shown by linear scale.

References

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[2] E. Kartini *et al.*, J. Non-Cryst. Solids **312-314** (2002) 628.

[3] M. Nakamura *et al.*, Phys. Rev. B **66** (2002) 024203 : and references therein.