Crystallization and Vitrification of Cryoprotectants Studied by Raman Scattering, Brillouin Scattering and THz-TDS

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The vitrifying tendency of cryoprotective solutions on cooling is the important factor for successful cryopreservation of biological substances. The tendency of crystallization or vitrification is closely related to the cooperative motion, steric hindrance, intermolecular and intramolecular interactions of molecules in solution. In the case of propylene glycol, well known glass forming liquid, undergoes a glass transition without crystallization even in slow cooling. It is interesting that the tendency of crystallization or vitrification is affected by not only intermolecular bonding but also the available conformational structure of molecules. In the present study, we examine one of the best candidates of cryoprotectant, ethylene glycol ($HO\text{-}CH_2\text{-}CH_2\text{-}OH$, EG) aqueous solutions by using light scattering technique. EG has a three-dimensional network of hydrogen bonded molecules and it is possible to view as being similar to water. Several studies have been done on EG aqueous solutions and they show good ability to use as ice crystallization inhibitors [1]. The microscopic nature of molecules can be determined by Raman scattering. The Raman scattering measurements provides the information on internal vibrational modes of molecules. The Raman scattering of EG aqueous solutions were investigated to characterize the conformations of molecular structure. The intermediate concentrations of EG solutions easily undergo glass transitions, while the crystallization occurs in the solutions of low and high concentrations of EG. The structural configuration of EG in crystalline phase in pure liquid shows only *gauche* OCCO form of EG which is the lowest energy conformers, while *gauche* and *trans* forms exist in the liquid phase. EG can exhibit stabilization in the lowest energy form of the *gauche* conformers owing to the intramolecular hydrogen bond [2]. The tendency of crystallization and vitrification in EG is related to its capability of forming intermolecular and intramolecular hydrogen bonding. Further dynamical properties from gigahertz to terahertz frequency range are investigated by using Raman scattering, Brillouin scattering and terahertz time domain spectroscopy (THz-TDS).

[1] Y. Seshimo, S. Kojima, Jpn. J. Appl. Phys. (in press).
[2] O.V. Oliveira, L.C.G. Freitas, J. Mol. Struct. Theochem. 728 (2005) 179.