Low photoelastic tin phosphate glasses: structure and optical properties

Akira Saitoh
Graduate School of Science and Engineering, Ehime University, Japan

Tin phosphate glasses have a wide compositional range with low melting and viscous temperatures, which makes them useful candidates for precise optical devices, and the low melting characteristics are optimum for tolerable templates of metal mold for glass shaping. The tin phosphate glasses are regarded as isotropic materials. However, when mechanical or thermal stress is induced, the tin phosphate glasses, except for certain composition, become anisotropic for refractive index, appearing the so called stress-induced birefringence in connection with the photoelastic constant (PEC) that primary depends on composition [1]. Optical devices such as a fiber current sensors, polarization beam splitters and LCD projectors need more precise control of polarized light. One of the solutions is to decrease PEC of an optical glass without PbO, which leads to a decrease of the anisotropy of the refractive index, for maintaining stable and desired polarization of the propagating light through the fiber or glass.

A series of $ZnO-SnO-P_2O_5$ glass compositions exhibit low PEC, low glass transition temperature, and high refractive index [2]. However, a ternary glass with xZnO−(67-x)SnO−33P_2O_5 composition in molar %, for instance, has a very low PEC at x = 18.5 [2], though it does not provide sufficient durability in aqueous environments. On the other hand, the substitution of P_2O_5 by B_2O_3 in xZnO−(67-x)SnO−(33-y)P_2O_5−$y$$B_2O_3$ glasses is much more effective for improving the chemical durability having very low PEC, for x = 19 and y = 3 [3]. The improvement of chemical durability is due to the existence of $PO_4-BO_4-PO_4$ connections which might lead to a lower dissolution of the PO_4 tetrahedral units when immersed in water. In this talk, very low photoelastic $ZnO-SnO-P_2O_5$ glass systems will be introduced with respect to the phosphate and/or borate structures and their optical properties.

[1] Cha *et al*., J. Ceram. Soc. Jpn., 116, 915 (2008). [2] Yamamoto *et al*., Opt. Lett., 37, 4203 (2012). [3] Saitoh *et al*., APL Mat., 3, 046102 (2015).