National Science Foundation

Materials World Network: An International Collaborative Educational and Research Program in the Study of Mixed Glass Former Phenomena in Materials

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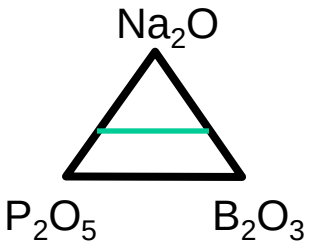
Background: Mixing two glass formers at constant alkali content produces logarithmic changes in the ionic conductivity and in the thermal and mechanical properties. Such improved glasses are attractive solid electrolytes in next generation sodium batteries.



Objectives: Using an international collaboration between the US and Germany, the atomic-level structural origins of the MGFE are being examined.

Results: ^{31}P & ^{11}B NMR, Raman, X-ray scattering, and RMC modeling were used to determine the atomic level structures of $0.35Na_2O + 0.65[xB_2O_3 + (1\text{-}x)P_2O_5]$ glasses. As B is added to the Na P glass, it preferentially forms low trapping energy $NaBO_{4/2}$ groups. Fig. 1 shows that the conductivity maximizes. and the activation energy minimizes at x ~ 0.4. ^{31}P NMR, Fig. 2, and the other techniques were used to develop an atomic level model of the charged structures of these glasses, Fig. 3. $NaBO_{4/2}$ (B^4) concentration and the conductivity maximize at the same concentration, Fig. 4.

Conclusions: This is the first report of the atomic level understanding of the positive MGFE in glass.

Fig. 1

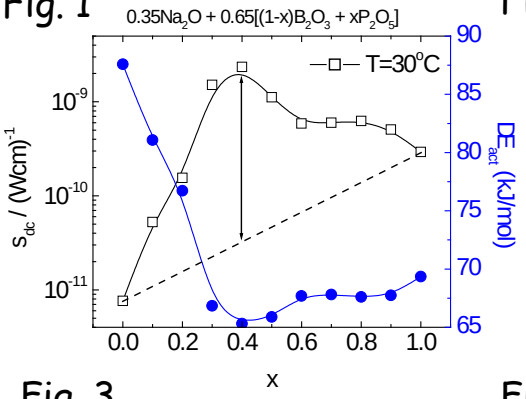


Fig. 2

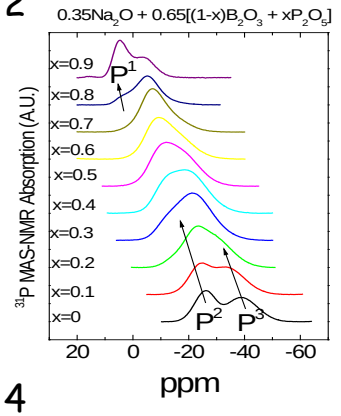


Fig. 3

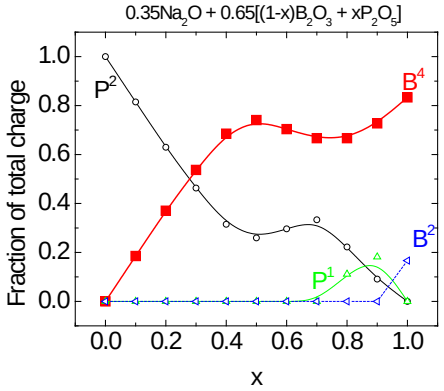


Fig. 4