Thermal and structural properties of polyzwitterions, with research opportunities for deaf and hard of hearing interns

Peggy Cebe, Tufts University

Background: A polyzwitterion (PZI) is a polymer whose fundamental repeat unit contains a positive and negative charge. Zwitterionic polymers have drawn interest for use in energy storage devices due to their high electrical charge density. However, their charges tend to bond to each other making the PZI rigid at high temperature.

Objective: We synthesized a series of PZIs and studied ways to disrupt the bonds formed between the charges. We studied the addition of LiCl salt and its effect on the glass transition temperature of one PZI with the chemical structure shown in Fig. 1B (inset). We also studied the step height of the transition as different amounts of LiCl were added.

Results: With no added salt PZIs, display exceptionally high transition temperatures, near 200 ºC(Fig. 1A). As salt is added, the transition temperature decreases and levels off at ~164 ºC. The step height of the transition increases (Fig. 1B) and levels off when the amount of salt is at a 1-to-1 match with the PZI side groups. Both trends indicate that salt addition produces more mobile, less rigid, PZI molecules.

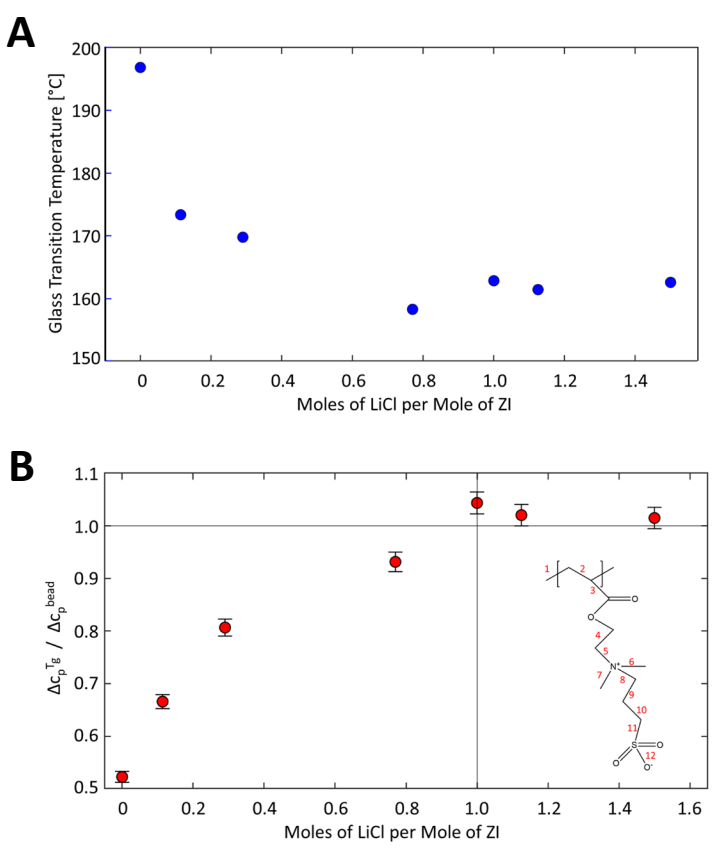

Figure 1. PSBA properties vs. molar LiCl salt content. A.) Glass transition temperature; B.) Measured heat capacity change divided by heat capacity change calculated from a bead model of polymers based on the chemical structure of PSBA, shown in the inset. Rotatable bonds are numbered from 1 to 12. Black crosshairs show the expected value if all rotatable bonds contribute to the heat capacity change. *Data from*: *J. Thomas, S. Chum, W. Deucher, A. Mondal, A. Asatekin, P. Cebe. "Thermal and structural properties of polyzwitterions: Effects of monomer chemistry and salt addition." Thermochimica Acta, submitted.*

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The Cebe Research Group (Physics and Astronomy Dept.) seeks to broaden participation in the STEM disciplines of students from under-represented groups especially Deaf and hard of hearing (DHH) undergraduates. The figures show the activities of this summer's research team. Co-PI Prof. Ayse Asatekin (Chemical and Biological Eng. Dept.) served as the academic advisor to students in the Bridging Engineering Success at Tufts program, run by the Center for STEM Diversity. She served on the department Diversity Equity and Inclusion Committee and has also been closely involved in the Graduate Society of Women Engineers chapter, where she serves as the faculty co-advisor.

Figure 2. A.) Emily Rabinowitz, Tufts undergraduate physics major, is putting a sample into the X-ray diffractometer. Emily was selected for a Tufts sponsored 2023 Summer Scholar's Award. B.) DHH summer interns and their teachers are shown in front of their poster. See Alternative Text for list of participants in the figure. C.) Physics graduate student, Anuja Jayasekara (left) explains his poster at the 2023 conference of the North American Thermal Analysis Society.