72d Nano-Structures of Polyurea Synthesized in Room Temperature Ionic Liquids

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Recent reports on nano-size morphological features such as flower-like or shuttle-like crystals or interconnected nano-porous structures of inorganic compounds synthesized in room temperature ionic liquids (ILs), including ZnO, TiO_2, and silica, have intrigued the community to explore the molecular interactions and alignments mediated by the ILs during the synthetic reactions rendering nano-structures, and the possibility in applications. In this work, we present exotic nano-porous structures observed in polyurea synthesized by interfacial polymerization between n-hexane (with 2,4-toluene diisocyanate, TDI) and a series of 1-alkyl-3-methylimidazolium tetrafluoroborates and 1-alkyl-3-methylimidazolium hexafluorophosphates (with ethylene diamine or 1,4 diaminobutane).

Depending on the ionic liquids and diamines, polymer fibrils of sizes around 50 nm forming porous structures with pore size ~ 300 nm were observed under scanning electron microscopy (SEM). Other morphologies including volcano, coral reef, or sphere (~100nm) were also observed. Results from small angle x-ray scattering (SAXS) demonstrate the porous structures with characteristic lengths around 30~40 nm. Micrographs from transmission electron microscopy (TEM) have been used to confirm the structures. Fourier Transform Infrared (FTIR) spectra of the products and their thermal properties from differential scanning calorimetry (DSC) show the same characteristics as those synthesized without ILs, indicative of insignificant/ or no changes in the chemical structures of the products. The interconnected porous structures can be modified for applications such as membranes or solid substrates for catalytic reactions.

We will also discuss briefly some speculated explanations on the physical origin and the role of ILs in the formation of the exotic polymer morphology from the view point of molecular interactions, particularly, hydrogen bonding, π-π interactions, and molecular orientations due to ionic interactions and polarity. Evidences from our recent results in neutron diffraction (ND) and wide angle x-ray scattering (WAXS) will be incorporated in the discussion to link the scenarios from local molecular scale to the mesoscale of interests.