Abstract Submitted
for the MAR14 Meeting of
The American Physical Society

High Modulus, High Conductivity Nanostructured Polymer Electrolyte Membranes via Polymerization-Induced Phase Separation LUCAS MCINTOSH, MORGAN SCHULZE, MARC HILLMYER, TIMOTHY LODGE, University of Minnesota — Solvent-free, solid-state polymer electrolyte membranes (PEMs) will play a vital role in next-generation electrochemical devices such as Li-metal batteries and high-T fuel cells. The primary challenge is that these applications require PEMs with substantial mechanical robustness, as well as high ionic conductivity. The key to optimizing orthogonal macroscopic properties is to use a heterogeneous composite with well-defined nanoscopic morphology—specifically, long-range co-continuity of high modulus and ion transport domains, which has proven difficult to achieve in commonly-studied diblock copolymer-based electrolytes. We report a simple synthetic strategy to generate PEMs via polymerization-induced phase separation, where the delicate balance between controlled addition of styrene onto a poly(ethylene oxide) macro-chain transfer agent and simultaneous chemical crosslinking by divinylbenzene results in a disordered structure with domain size of order 10 nm. Crucially, both domains exhibit long-range continuity, which results in PEMs that are glassy solids (modulus $\approx$ 1 GPa) owing to the isotropic network of stiff, crosslinked polystyrene, and are highly conductive ($>$ 1 mS/cm at 70 °C) because ions migrate in channels of low T_{g} poly(ethylene oxide).

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Date submitted: 11 Nov 2013 Electronic form version 1.4