Polymer-ceramic-glass electrolyte composites: progress toward achieving stable and safe lithium metal anodes

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To ensure safe, efficient and extended cycling of lithium metal anodes requires an electrolyte that can completely protect and stabilize the lithium interface. A thin solid electrolyte membrane with robust mechanical properties and adequate lithium ion conductivity will likely provide the best solution, as this can avoid roughening and side reactions that are hard to eliminate when using liquid electrolytes. Because no single material has the requisite mechanical and transport and electrochemical stability to serve this role for standard vehicle and commercial batteries, we are investigating composites of two or more electrolyte materials where in principle the structure can be engineered to optimize ion transport and mechanical integrity.

Laminate, dispersed and sintered composites of a variety of polymer and ceramic components are being investigated experimentally. These are compared to, and guided by our estimates using effective medium models. [1] Both experiment and modeling have been focused largely on the garnet lithium lanthanum zirconate ceramic electrolyte [2] and on typical polyethylene oxide polymer electrolytes with dissolved lithium salt. Knowledge and control of the ionic conductance attributed to the polymer ceramic interfaces [3] and also the grain boundaries for ceramic electrolytes [4] are important factors for many composite structures. Impedance and conductivity of selected interfaces and composites with blocking and lithium metal contacts will be presented.

Acknowledgement: This work was supported by the Assistant Secretary for Energy Efficiency and Renewable Energy, Office of Vehicle Technologies of the U.S. Department of Energy and by the U. S. Army Research Office.

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