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Electrostatic Network Ion Gels Formed from Rigid-Rod Polyelectrolytes and Ionic Liquids LOUIS MADSEN, YING WANG, YING CHEN, ZHOU YU, YADONG HE, Virginia Tech, HYUN GOOK YOON, Deakin University, LIYU JIN, Oxford University, JIANWEI GAO, Delft University of Technology, MARIA FORSYTH, Deakin University, THEO DINGEMANS, UNC Chapel Hill, RUI QIAO, Virginia Tech — Imagine a non-flammable solid with the modulus of bulk PMMA (plexiglass), but where a high density of ions inside move as if they were in a liquid. We will describe such a solid in a new class of ion gels formed using an interfacial ion exchange process between a seed solution of a rigid-rod polyanion (a sulfonated aramid) and an ionic liquid. This gel electrolyte provides an unprecedented combination of tunable properties: transport anisotropy up to 3.5X, ionic conductivity up to 8 mS/cm, widely tunable modulus (0.003−3 GPa) and thermal stability up to 300 deg. C. This material breaks the usual tradeoff between ionic conductivity and modulus in solid-polymer or composite electrolytes, demonstrating its potential to resolve current limitations in Li metal batteries and allow for 2-3X higher energy density than existing Li batteries. This material also promises to enable batteries that can operate over a wide temperature range and are immune to fire. We will describe comprehensive studies of ion transport, morphology, thermal and mechanical properties, and battery testing. We will also discuss our fundamental understanding of the electrostatic network that gives rise to mechanical strength in this completely new type of gel.

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