**Development of organic ionic plastic crystals as solid-state electrolytes**

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Organic ionic plastic crystals (OIPCs) are a relatively new class of material that have shown increasing promise as solid state electrolytes for energy devices such as lithium or sodium batteries, DSSCs and fuel cells.[1] These materials can be combined with polymer nanofibers or inorganic nanoparticles to further improve their mechanical and transport properties.

OIPCs are crystalline phases found in many of the same organic salt families as ionic liquids but these materials have elevated melting points and exhibit various forms of disorder, which is the origin of their plastic mechanical properties. In addition to their increasing use as solid state electrolytes for electrochemical applications, they represent a new class of material for light gas separation.[2]



Figure 1. An OIPC/polymer composite.

OIPCs display one or more solid-solid phase transition before melting, which is associated with the onset of rotational or translational motions of the ions and thus a progressive transformation from an ordered crystalline phase to an increasingly disordered structure. This disorder is fundamentally responsible for the fast ion conduction of target ions, such as lithium or sodium, and core to their efficient performance as solid-state electrolytes.

Key to the development of OIPCs is expanding the range of cations and anions available, and understanding the resulting structure and dynamics. Here we discuss our development of new OIPC-based materials for energy applications, in particular lithium metal batteries, and insights into the mechanism of ion transport using techniques such as variable temperature solid state NMR. The recent development of new OIPC families based on the *N,N*-diethylpyrrolidinium cation[3] and the hexamethylguanidinium cation[4] will be discussed.

**References**

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