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Novel solid state electrolytes - enabling future energy technologies

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Significant progress has been made, in recent years, in the development of solid state ionic conductors based on polymer electrolytes, polymer gels, organic ionic plastic crystal materials and composites, driven by a continued need for high conductivity solid state electrolytes for a range of electrochemical devices. The research in this field covers many aspects including synthesis of new materials, fundamental understanding of the structural and transport properties in these materials in both the pure state and as gels or composites, and the development of these materials as electrolytes in devices such as lithium batteries, sodium batteries, dye sensitised solar cells and fuel cells. We will discuss the history and the advances of a number of novel solid electrolytes and their future prospects in solid state device applications.

Some examples will include the design of new sodium ion conducting polymer electrolytes based on polyelectrolyte copolymers and their self-plasticization by quaternary ammonium cations, new composite materials based on organic ionic plastic crystals (OIPC) and dendrimers (Figure 1) as well as OIPC/ polymer fiber electrospun mats. These latter composite electrolytes are easily formed into thin, flexible and mechanically robust films which can have desirable properties for device applications.

Figure 1 An SEM image (upper) of an organic ionic plastic crystal composite based on ethyl, methyl pyrrolidinium tetrafluoroborate and a dendrimer (hyperbranched bis MPA polyester-64-hydroxyl, generation 4) composite and ionic conductivity (below) of the composite material compared with the pure OIPC. A significant enhancement in conductivity can be observed.

