Functional Porous Polymers as Separator Membranes for Lithium Ion Battery (ILS6_391)

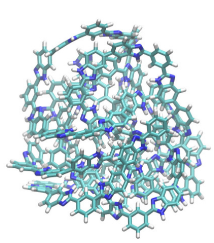
Vikas Kumar Garg[1], Shyambo Chatterjee[1], C. V. Avadhani[1] and S. Sivaram[1, 2]

[1]Division of Polymer Science and Engineering,CSIR-National Chemistry Laboratory, Pune 411008, India
[2]Indian Instituteof Science Education and Research, Pune , 411008, India

s.sivaram@iiserpune.ac.in

Functional polymers play a key role as advanced materials in many renewable energy applications, for both, generation and storage. Examples are selective proton conducting polymers as membrane electrode assembly for use in fuel cells, selective lithium ion transporting separator membranes and as anodes and cathodes in Li-ion batteries. Separator membrane is a critical component of a battery. It provides a barrier between the anode and the cathode while enabling the exchange of ionic charge carriers from one side to the other. Separators currently used in Li-ion batteries are made of polyolefins, either polyethylene or polypropylene. They are rendered porous by a mechanical biaxial extrusion process. As the battery heats up, the protective layer on the anode breaks down, followed by breakdown of electrolytes into flammable gases. This, in turn, causes the polyolefin separators to undergo catastrophic shrinkages above 120° C leading to shorting of cells causing sparks that ignite the electrolyte resulting in a fire. The inherent safety risks threatens the continued advances of Li-ion battery into applications requiring higher and higher energy density, such as, in smart phones and electric vehicles. A safer separator material is needed if devices powered by Li-ion batteries do not become a grenade.

We report herein a novel class of high T_g amorphous and porous polymer, namely, poly(benzimidazole), that has attractive properties as a separator membrane for lithium ion battery.Porosity in polymers can be created either during its synthesis ("bottoms-up") or by modifying preformed polymers ("top-down") techniques. This lecture will present an overview of challenges encountered in creating porosity in such polymers. We will addresstwo on-going themes in our laboratory, namely, synthesis of soluble polymers with intrinsic micro-porosity and creation of meso- and macro-porosity by physical processes as well as examine mobility of lithium ions across such porous membranes to better understand the potential of such materials in this application.



a **b** **c**

Figure: Molecular dynamic simulation of a 28-mer (a) poly (benzimidazole) (b) intrinsically micro-porous poly (benzimidazole) with a spiroibisindane monomer and (c) intrinsically micro-porous poly (benzimidazole) with a