

POROUS MATERIALS IN ENERGY APPLICATIONS: THE FASCINATING WORLD OF INVISIBLE POLYMERS

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ABSTRACT

Porous functional polymers play a key role in many renewable energy applications, for power generation and storage. They include areas such as selective proton conducting polymers in fuel cells, selective lithium ion transporting separator membranes as well as anodes and cathodes in Li-ion batteries.

Porosity is a profound, yet, ubiquitous concept that is inherent to many materials, both, natural and synthetic. Biomaterials (skin, alveoli in the lungs), inorganic frameworks (zeolites, carbon, silica, clay), organic frameworks (supramolecular assemblies), plant materials (bamboo) and synthetic polymer membranes (water desalination membrane, kidney dialysis membrane) are all notable for their exquisite porous architectures, which are critical to its structure and functions. Porosity in polymers can be created either during its synthesis or by modifying pre-formed polymers using techniques, such as, phase inversion, templating with inorganic nanoparticles, self assembly and electro spinning.

This lecture will present an overview of challenges encountered in creating porosity in polymers. The talk will address four ongoing themes in our laboratory:

1. Synthesis of functional polymers with intrinsic microporosity (PIM's);
2. Creation of meso/macroporous polymer membranes by physical processes and their application as separators for lithium ion batteries;
3. Surface modified porous polyolefins as membranes for lithium ion transport in lithium-sulfur batteries;
4. Functional polymers as anode materials in lithium ion battery.

We will examine strategies used to create porosity, examine mobility of lithium ions across such porous membranes and understand the role of surface functionalities in facilitating the selective transport of lithium ions and at the same time inhibiting the transport of polysulfide anions in Li-sulfur battery. Furthermore, we will examine the possibility of a polymer-based anode for lithium ion battery and the intriguing possibility to create an all polymer battery.