Functional Polymers in Energy Applications: Challenges and Opportunities

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Abstract

Functional polymers are invisible components of many devices used for generating and storage of renewable energy. Examples are hydrogen fuel cells, organic photovoltaic devices and lithium batteries. Polymers were earlier exploited for their insulating or dielectric properties in many of these applications. However, in recent times, it is their functional properties that have made these materials attractive in these applications. Polymers provide the necessary insulating barrier between the anode and the cathode in these devices; however, they also facilitate selective proton and lithium ion transport, light harvesting and conversion to energy as well as act as efficient acceptors for cations in the anode part of a battery system. Polymers have become critical to both the efficiency of such devices as well as safety in their operation. It is, therefore, not surprising that considerable amount of current research is devoted to the identification of suitable polymer substrates, the ability to transform them into functional materials, through chemical and physical methods, as well as better understand the relationship between polymer structure, function and device performance.Functional polymers are poised to play a significant role in the emerging energy generation and storage devices

This lecture will provide an overview of this area of polymer science in terms of nature of polymers that are of interest and their structure function relationship. Methods of modifying the polymers, both, in bulkand at surfaces, will be discussed in relation to their performance in specific devices. The concept of porosity in polymers will be introduced to gain a better appreciation of ion mobility across polymer membranes. Some recent results from the author's laboratory in the synthesis of polymers with intrinsic microporosity as well as porous high temperature resistant polymers will be discussed in applications as separators for lithium ion battery. Identification of an efficient separator polymer material for lithium-sulfur battery is still a challenge. Some early understanding of how to design functional porous polymers that can facilitate lithium ion transport and at the same time inhibit the transport of polysulfide ion will be illustrated. Some early results on the use of functional polymers for use as anodes in lithium ion battery will be presented.