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Polymer composites for energy storage and conversion

By

Professor G. Tayhas R. Palmore
Engineering, Chemistry, and Medical Science
Brown University

Since their discovery, conductive polymers have been studied extensively because of their fascinating physics and broad potential in technological applications. In this seminar, I will describe our use of doped conducting polymers as materials in energy-related technologies. Conductive polymers can be synthesized via chemical or electrochemical oxidation, producing a polycationic material that requires charge-compensating dopants. A variety of anionic dopants have been used including Cl^-, ClO_4^-, BF_4^-, p-toluenesulfonate, dodecylbenzenesulfonate (DBS), and polystyrenesulfonate (pSS), all of which function to balance the cationic charge of the conductive polymer. More recently, our lab and others have introduced other dopants, which in addition to balancing the charge of the polymer, possess a distinct characteristic that imparts a new property or function to the composite. For example, proteins and peptide dopants impart bioactivity, whereas carbon nanotubes and hydrogen-bonding dopants enhance mechanical strength. Redox-active dopants improve electron transfer between the cathode of a biofuel cell to the active site of enzymes embedded in the conductive matrix, improve the energy density of batteries made from conductive polymers, yield a light-harvesting material, and add new colored states in electrochromic films. The performance of several devices made from conducting polymers will be presented.

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