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Electrochemical Energy Storage Devices Comprising Self-Compensating Zwitterionic Polymers

Background

Conductive polymers are used in a wide range of applications because of certain advantages, such as light weight, flexibility and low cost, among other advantages. Conductive polymers are increasingly being proposed as alternative electrode materials for electrochemical devices, such as batteries. Of particular interest is a category of electrically conductive polymers known as redox-active polymers. Redox-active polymers are polymers comprising functional groups capable of reversibly transitioning between at least two oxidation states, wherein the transition between the oxidation states can occur through oxidation (i.e. electron loss) and reduction (i.e. electron gain) processes. However, only some pairs of redox-active polymers are technologically and economically feasible for forming the positive and negative electrodes of the electrochemical cells. For example, only some pairs have a voltage gap between a cathode with higher redox potential and an anode with lower redox potential that is large enough to be technologically and economically feasible. Thus, there is a need to increase the range of "pairable" redox-active polymers that can be used in the electrochemical cells.

Invention Description

Researchers at Arizona State University have developed electrochemical devices comprising self-compensating conductive polymers. In one aspect, electrochemical energy storage device comprises a negative electrode comprising an active material including a redox-active polymer. The device additionally comprises a positive electrode comprising an active material including a redox-active polymer. The device further comprises an electrolyte material interposed between the negative electrode and positive electrode and configured to conduct mobile counterions therethrough between the negative electrode and positive electrode. At least one of the negative electrode redox-active polymer and the positive electrode redox-active polymer comprises a zwitterionic polymer unit configured to reversibly switch between a zwitterionic state in which the zwitterionic polymer unit has first and second charge centers having opposite charge states that compensate each other, and a non-zwitterionic state in which the zwitterionic polymer unit has one of the first and second charge centers whose charge state is compensated by mobile counterions.

This innovation is covered by U.S. Pat. No. 9,882,215.