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SOLVING ENERGY LOSS IN SUPERCAPACITIVE ENERGY STORAGE

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Supercapacitors, also called Electrochemical Capacitors, are charge storage systems which store energy, such as that produced from alternative energy power sources (such as windmills and solar cells). Supercapacitors store charge in the boundary between the electrode and the electrolyte and also through very fast redox reactions. Storing charge at an electrode/electrolyte interface necessitates a very large surface area and therefore a porous surface. These pores may lead to a loss of voltage over time through a process called charge redistribution. Similarly, voltage loss over time may be a result of redox reactions occurring on the surface. These two separate processes combine to result in an overall self-discharge of the cell, meaning that a supercapacitor may not be able to store charge for long times. The mitigation of these self-discharge processes is the focus of this talk.

Charge distribution arises because of inequalities in the charging of the surface in the pores of the electrode material, since the surface at the mouth of the pore charges more rapidly than the surface at the base of the pore. After charging, when the EC electrode is placed on open-circuit, the potential of the electrode appears to fall with time (an apparent self-discharge) as the charge at the pore mouth moves deeper into the pores to equalize the electrode potential. The effect of charge redistribution on the self-discharge profile of porous electrodes is modeled and the effect of pore diameter, length and shape is elucidated. It will be shown that the highly porous carbon electrodes in sulphuric acid electrolytes used in this work undergo charge redistribution for several hours, much longer than had been previously predicted.

When self-discharge is caused by redox reactions the exact reaction and mechanism depends on the type of electrode and electrolyte used in the system. In our work, we concentrate on carbon-electrode, sulfuric acid-electrolyte systems. A number of possible self-discharge reactions have been studied in these systems, including: reaction of a Fe-impurity, water decomposition, carbon corrosion, oxygen reduction, and the reaction of carbon surface functionalities. It will be shown that self-discharge at the negative electrode is governed by oxygen reduction. At the positive electrode, self-discharge is related to Fe-contaminants, but only at iron concentrations of greater than 1 mM. At lower concentrations, it is suggested that both carbon corrosion and the reaction of a carbon surface functionality governs the self-discharge at this electrode. The identification of this active carbon functionality is key to mitigating self-discharge, and research into this identification will be shown.

Biography



Heather Andreas received her Ph.D. degree in Electrochemistry from the University of Calgary in 2004. She pursued her Postdoctoral studies at the University of Ottawa with an emphasis on electrolyte-related issues of supercapacitors. In 2006, she transferred as Assistant Professor to Dalhousie University in Halifax, where she received NSERC University Faculty and CFI New Opportunities Awards. In July 2011 she accepted a position as Associate Professor at Dalhousie. Her research focuses on the use of electrochemical methods to study and optimize alternative energy storage with an emphasis on supercapacitors.