Electrical Thin Double Layer Simulation and Micro-electrochemical Supercapacitor Cooling

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Abstract

The deteriorating state of the environment has drawn many people to hybrid electric vehicles. Electrochemical micro-supercapacitors are of interest in this field because of their high power density relative to other micro-power sources. However, little is known about how the properties of the electrolyte used affect the performance of such devices. The first step of this investigation was to use thermoreflectance microscopy to measure the temperature change of the electrodes while charging and discharging supercapacitor samples. The components of these samples were graphitic petal electrodes with a Ti/Au covering (for enhanced light reflectance) on a SiO_2 base, with a PVA and H_2SO_4 polymer gel electrolyte. These experiments showed cooling of over 10°C. In order to better understand these results and the underlying mechanism of supercapacitors, a model to predict their behavior was needed. Therefore, a description of the dynamic and equilibrium behavior of ions in thin electrical double layers was constructed. The most accurate model was found to be the Poisson-Boltzmann equation modified to account for steric effects. MATLAB code was written and tested against previous theoretical research and will be published on nanoHUB. This will later be expanded to account for other supercapacitor features such as pseudocapacitance and high surface area of activated carbon electrodes.