University of California, Davis
Department of Materials Science and Engineering
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1:00 – 2:00 pm, 1065 Kemper Hall

PhD EXIT SEMINAR

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Evaluating the rate-dependence of supercapacitor performance using Peukert's equation

Supercapacitors, a type of energy storage device, are particularly well suited for applications requiring high power/current density. As such, the current-dependence or rate-dependence of their energy storage capacity is a vital device parameter. At higher rates, the capacitance decays, due in part to effects of electrode pore surface accessibility and slow kinetics of pseudocapacitive energy storage. Although critical to device performance, a standard way of parameterizing the rate-dependence has not been established.

This work explores the utility of Peukert's equation to characterize supercapacitors. Peukert's equation is a widely used empirical expression relating the available capacity of a battery to its discharge rate. It has received minimal attention for use with supercapacitors. Through measurements of commercial supercapacitors, analysis of literature data, and simulations of circuit models, Peukert's equation is found to be applicable to supercapacitors. Peukert's constant, determined using the equation, is found to reflect changes in key device parameters like electrode porosity and pseudocapacitance.

Furthermore, a novel method was developed to determine Peukert's constant using impedance spectroscopy. Impedance spectroscopy can be used to measure electrical properties over a broad range of time-scales, making it ideal for the characterization of rate-dependent properties. This aspect of impedance spectroscopy is taken advantage of to simply and quickly determine Peukert's constant, and is shown to be consistent with traditional dc methods.

Other topics in the use of impedance spectroscopy to study interfacial electronic properties will be touched on, including the incorporation of highly ionic-conductive interfaces into solid oxide fuel cell electrolyte materials to improve their performance, and an investigation of the current mechanism at the Schottky barrier in a graphene barristor.