Testing Aspects of Superdielectric Behavior

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With Lecturer Jon Phillips

Research Professor, Physics Department, Naval Postgraduate School

Jon Phillips

Abstract:

To test a theory of the recently discovered phenomenon of superdielectric behavior, the dielectric constants of several 'pastes', composed of porous alumina powders filled to the point of incipient wetness with water containing dissolved sodium chloride, were measured. The dielectric constants of some of the pastes were greater than 1010, which is dramatically higher than that of any material ever reported. These results are consistent with this recently postulated model of superdielectric behavior in porous, non-conductive materials saturated with ion-containing liquids. Upon the application of an electric field, ions dissolved in the saturating liquid contained in the pores will travel to the ends of pore filling liquid droplets creating giant dipoles. The fields of these giant dipoles oppose the applied field, reducing the net field created per unit of charge on the capacitor plates, effectively increasing charge/voltage ratio, hence capacitance. Other observations reported herein include, i) the impact of ion concentration on dielectric values; ii) a maximum voltage similar to that associated with the electrical breakdown of water; iii) the loss of capacitance upon drying; and iv) the recovery of capacitance upon the addition of water to a dry super dielectric material. All observations are consistent with the earlier proposed model of the super dielectric phenomenon. An extrapolation of results suggests this technology can lead to energy density greater than the best lithium ion battery.

Abridged Biography:

At Penn State (1981–1999) Dr. Phillips advised ten successful PhD candidates and seventeen successful MS candidates. The group made contributions to the understanding of catalytic etching, bimetallic catalyst particle structure, unique catalytic chemistry of bimetallic catalysts, coal catalysis/gasification, adsorption kinetics, carbon surface chemistry, hydrogen spillover, lithium 'combustion', plasma interactions with materials, modification of aerosol particle structure and chemistry in plasmas, transport in plasmas, even the chemistry and structure of lubricants. A lasting impact from this work was the invention of the Aerosol-Through-Plasma method to make catalysts. Dr. Phillips was awarded support for two sabbaticals abroad, one year as a Poste Rouge to be a staff scientist at a CNRS facility in Lyon, France (1990–91), and one year as a Fulbright Fellowship to work as a faculty member at Ben Gurion University in Beersheva, Israel (1997–98).

From 1999 until 2011 Dr. Phillips served as a staff scientist at Los Alamos National Lab, and as a National Lab Professor at the University of New Mexico. During that time he was the advisor to nine postdoctoral fellows. A major focus of the work was plasma/materials interactions. One result: patents for making a variety of structures using plasmas including carbon nanotubes, nanometal and nanooxide particles and 'engineered' multi-layer nanoparticles for use in batteries.

In April of 2011 Dr. Phillips accepted his current position as Research Professor at the Naval Post-Graduate School (NPS). Dr. Phillips teaches courses, primarily thermodynamics, and directed the thesis work of four MS students. His chief research interest is developing uses for reduction-expansion synthesis.