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AVENUES TO HIGH POWER DENSITY IN POLYMERIC MATERIALS

J Bernholc
North Carolina State University, Raleigh, North Carolina, USA

In many energy applications there is an urgent need to store and quickly discharge large amounts of electrical energy. Since capacitors can be discharged far quicker than batteries and fuel cells, they have much higher power densities. At present, highly insulating polymers with large breakdown fields, such as polypropylene, are the dielectrics of choice in high-power capacitors. However, their energy densities are quite low because of small dielectric constants. This talk will review the various ways to increase the dielectric constant and achieve high power density. In particular, we will focus on highly polar polymers and discuss two novel mechanisms: (i) phase transformation in PVDF-based polymers, where the admixture of small amounts of copolymers leads to a dramatic, non-linear increase in energy density, and (ii) free volume effects in strongly dipolar polyurea polymers, by which a large increase in the dielectric constant can be achieved through by introducing disorder, packing frustration by blending, or morphology changes during growth. The enhanced polyureas remain low-loss and maintain high temperature stability, making them excellent candidates for high-performance capacitor materials. The uncovered avenues to increased energy storage capacity are general and can be used to enhance the performance of other classes of materials.

Biography

Jerry Bernholc is Drexel Professor of Physics at North Carolina State University. Since 2002, he also serves as a Visiting Distinguished Scientist at Oak Ridge National Laboratories. He is a Fellow of American Physical Society, American Association for the Advancement of Science, and Materials Research Society; and a recipient of IBM's Outstanding Innovation Award, NCSU Alumni's Outstanding Research Award, NSF's Creativity Award, and Beams Award for Outstanding Research from the American Physical Society. Bernholc received his PhD from the University of Lund, Sweden, was a Postdoctoral Fellow at IBM T J Watson Center and a Senior Physicist at Exxon Research and Engineering Company.

bernholc@ncsu.edu