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Nonlinear polarizability in dielectrophores

Statement of the Problem: Efficient energy storage is crucial both for everyday operations and for the long-term sustainability of human civilization. Electrochemical storage units, such as batteries, have large energy density but small power density and, moreover, can degrade relatively fast. Electrostatic storage units, such as capacitors, have the advantages over the batteries in almost all areas but have much smaller energy density. We proposed to use molecular film capacitors where the energy is stored in highly polarizable aromatic cores, *dielectrophores*, enveloped in resistive structure by aliphatic tails which provide high dielectric strength. We believe that if the induced dipole depends nonlinearly on the external electric field, at high operating voltage such structure can have the energy density comparable with that of the batteries and even exceed it.

Methodology: Thin films based on organic molecules were grown by the cascade crystallization procedure. Three samples with the P032, P033, and P036 molecular units, see Fig. 1, were charged using corona poling method, and compared to the polypropylene film (PP). The surface potential was measured by the Kelvin probe technique with the bottom electrode grounded. The dependencies of the surface potential on the introduced charge are shown in Fig. 1.

Findings: While the PP film exhibits the linear relation between the charge and voltage, the corresponding dependence is highly nonlinear for our organic films for elevated voltages. Our estimations demonstrate that the stored energy for the P036 molecular compound can exceed that of the PP film up to 3000 times.

Conclusion & Significance: We demonstrate organic-molecules-based thin films which can be used for the energy storage applications. With high energy density and large breakdown voltage, they can eventually replace the electrochemical batteries.

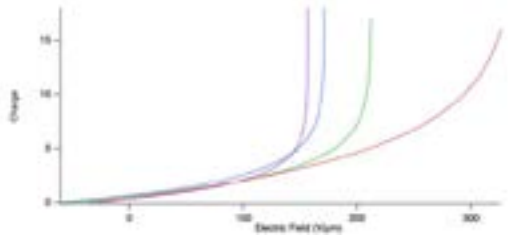

Figure 1. Dependence of the surface potential on the introduced charge for several compounds shown in the right in comparison to the polypropylene film (PP)

Biography

Pavel Lazarev is the inventor of Capacitor Sciences' high permittivity technology and founder of the Company. He also is the founder of Cryscade and inventor of the company's Donor-Bridge-Acceptor technology. He received his Masters from Moscow State University, Ph.D. in Crystallography and Dr. of Science Degree in Biophysics from the Russian Academy of Science. Previously, Pavel founded Nanotechnology MDT (www.nt-mdt.com), Akvion (www.akvion.ru), Optiva Inc., Ribtan Inc. (www.ribtan.com) and Crysoptix KK, (www.crysoptix.com). Pavel was an editor of International Journals 'Molecular Engineering', 'Nanobiology' and 'Molecular Materials'. Pavel has published several books, over 150 technical publications and over 200 inventions with emphasis on the R&D and production of functional crystalline films based upon coatable lyotropic liquid crystals.

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