Unique Material May Allow Capacitors to Store More Energy

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Imagine an electric car with the same acceleration capability as a gas-powered sports car, or ultrafast rechargeable "batteries" that can be recharged a thousand times more than existing conventional batteries. According to physicists at North Carolina State University, all of these things are possible, thanks to their research on a polymer – or plastic material – that when used as a dielectric in capacitors may allow the capacitors to store up to seven times more energy than those currently in use.

NC State physicists Vivek Ranjan, Liping Yu, Marco Buongiorno Nardelli and Jerry Bernholc discovered how the electromechanical properties of the commonly used polymer polyvinylidene fluoride (PVDF) can be enhanced when combined with another polymer called CTFE.

Their findings, which explain an earlier observation of high energy density in these materials and point out ways to improve energy storage, will be published in the July 26, 2007, edition of *Physical Review Letters*.

Capacitors, like batteries, are a means of storing energy. Unlike batteries, capacitors don't rely on a chemical reaction to produce the energy being stored. Instead, capacitors use polarization, the separation of positively and negatively charged particles, for energy storage. Part of this process involves applying an electric field to a dielectric material within the capacitor.

Dielectric material is usually a solid material that isn't a good conductor of electricity – like ceramic, glass or plastic – but that will support an electrostatic field. When voltage is applied to a dielectric, an electrostatic field is created. The atoms within the material polarize, enabling the capacitor to store energy that can be quickly released on demand.

This ability to release large amounts of energy quickly makes capacitors especially useful in anything requiring quick acceleration times.

Physicists have long been interested in the electrical properties of the polymer PVDF, because it is known to be a dielectric material. In its solid state, PVDF can be either polar or non-polar, and it doesn't change states when an electrical field is applied, leading to small energy storage. The researchers discovered that if they introduced "impurities" in the form of CTFE into a non-polar phase of PVDF, the resulting polymer had the ability to switch phases from non-polar to polar, enabling it to store and release much larger amounts of energy with a smaller electric field.

"Essentially we are moving atoms within the material in order to make the polymer rearrange with the least voltage," Ranjan says. "We believe that we can tailor the atomic structure of the polymer to get the best performance in the presence of different electric fields as well."

Source: NC State University