

Using a hybrid silica sol-gel material and self-assembled monolayers of a common fatty acid, researchers have developed a new capacitor dielectric material that provides an electrical energy storage capacity rivaling certain batteries, with both a high energy density and high power density.

If the material can be scaled up from laboratory samples, devices made from it could surpass traditional electrolytic capacitors for applications in electromagnetic propulsion, electric vehicles and defibrillators. Capacitors often complement batteries in these applications because they can provide large amounts of current quickly.

The new material is composed of a silica sol-gel thin film containing polar groups linked to the silicon atoms and a nanoscale self-assembled monolayer of an octylphosphonic acid, which provides insulating properties. The bilayer structure blocks the injection of electrons into the sol-gel material, providing low leakage current, high breakdown strength and high energy extraction efficiency.

"Sol-gels with organic groups are well known and fatty acids such as phosphonic acids are well known," noted Joseph Perry, a professor in the School of Chemistry and Biochemistry at the Georgia Institute of Technology. "But to the best of our knowledge, this is the first time these two types of materials have been combined into high-density energy storage devices."