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Concept and Development of Solid State Ionic Capacitor

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Development of a new energy storage device that can replace lithium ion batteries is one of the most important subjects for the future of human. Capacitors have an advantage over batteries with respect to the endurance for charge - discharge recycling. Electric double-layer capacitor (EDLC) has been used for some applications but they are still restricted because of relatively low energy density of EDLC in comparison with lithium ion battery and the leakage of liquid electrolyte from packages. Another issue on capacitors is the limit of capacitance density of multi-layered ceramic capacitors (MLCCs). MLCCs are currently used for many electronic devices. The capacitance density of MLCC has been increased one million times by reducing thickness of dielectric layer down to 1 micron in 40 years. However, very serious problem that restricts the capacitance density of MLCC has come up in these 5 years. The problem is known as the size effect barium titanate where dielectric constant of barium titanate somehow decreases with the size of grains sin ceramics.

Those problems can be solved if we can make new solid state capacitors with very high capacitance and energy density. We have been studying new concept of solid state ionic capacitors where long-range ionic motion is use for interfacial polarization. Solid state lithium ion conductors are used for dielectrics. Accumulation of huge amount of charge was observed in charge-discharge cycle of capacitors. A composite of strontium titanate and solid state lithium ion conductor was prepared to confirm a new concept of MLCC material using interfacial polarization.