Overview of NASA Ultracapacitor Technology

Curtis W. Hill
Jacobs ESSSA Group
NASA's Marshall Space Flight Center
For TechConnect World Innovation Conference
May 15, 2017

JACOBS
ESSSA Group

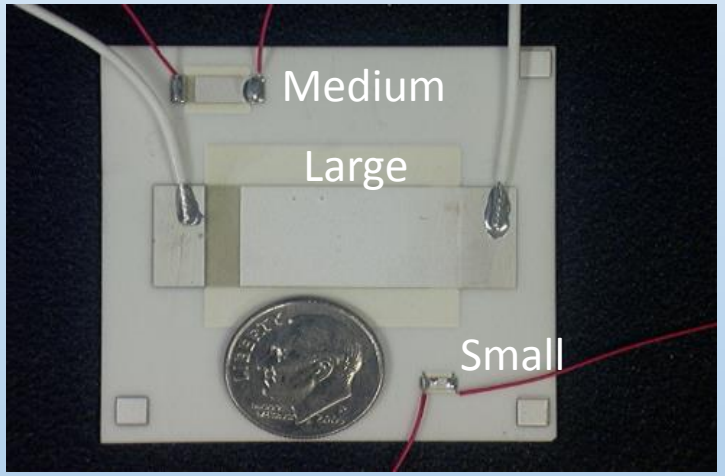
Development of High-Performance Ultracapacitor

- NASA needed a lower mass, reliable, and safe medium for energy storage for ground-based and space applications.
- Existing industry electrochemical systems are limited in weight, charge rate, energy density, reliability, and safety.
- We chose a ceramic perovskite material for development, due to its high inherent dielectric properties, long history of use in the capacitor industry, and the safety of a solid state material.

The figure above a capacitor bank beside two single-cell devices manufactured at MSFC. The two ultracapacitors provide the same voltage and capacitance as the capacitor bank. The capacitor bank weighs 435 grams. The two ultracapacitors together weigh only 15 grams with the substrate. The ultracapacitors are only 30 microns thick, 1.8 cm wide and 2.1 cm long

Advantages of High-Performance Ultracapacitor

- Custom-configurable as “coated” or “co-doped”
- The coated ultracapacitor is:
  - Extremely stable (charge/discharged over 100,000 times at constant temp. with NO change in capacitance)
  - Very high breakdown voltage (2,500V for 90 micron thickness); very rapid charge/discharge; formulated into inks for 3D printing for In Space Manufacturing.
  - Independent industry test data showed our standard sized devices performed better than X7R capacitors in temperature tests from -55 to 125C both with DC voltage (200VDC) and without (0VDC). Our samples curves were more linear over temperature and showed better repeatability.



- The doped ultracapacitor is:
  - Excellent energy density, charges rapidly, no polarity to cross wires, and no toxic chemicals/electrolytes. The humidity sensor is robust, printable, with a VERY fast response time.