Load-Bearing, Solid-State Supercapacitor for Multifunctional Use in Structural and Energy Storage Applications

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Summary

A team of Vanderbilt engineers has developed a multifunctional, loadbearing solid-state supercapacitor to simultaneously store energy and withstand static and dynamic mechanical stresses.

Addressed Need

As technology progresses, the need for compact, integrated and functional sources of power delivery becomes of vital importance. Conventional energy technology involves externally situated energy storage devices, but future technological platforms will require more efficient use of systems components for energy integration. By developing a multifunctional, load-bearing solid-state supercapacitor, you can increase the efficiency of energy system components by integrating them into the structure of the building components.

Technology Description

Load bearing capacitors are fabricated using electrochemically etched porous silicon layers. These porous layers are then covered with an ultra-thin layer of graphene-like carbon coating by chemical vapor deposition. A polymer electrolyte is then vacuum infiltrated in between two layers of porous silicon to create a solid-state barrier to block electron flow. This process highly integrates the solid-state electrolyte into the silicon pores to give enhanced mechanical properties.

Technology Features

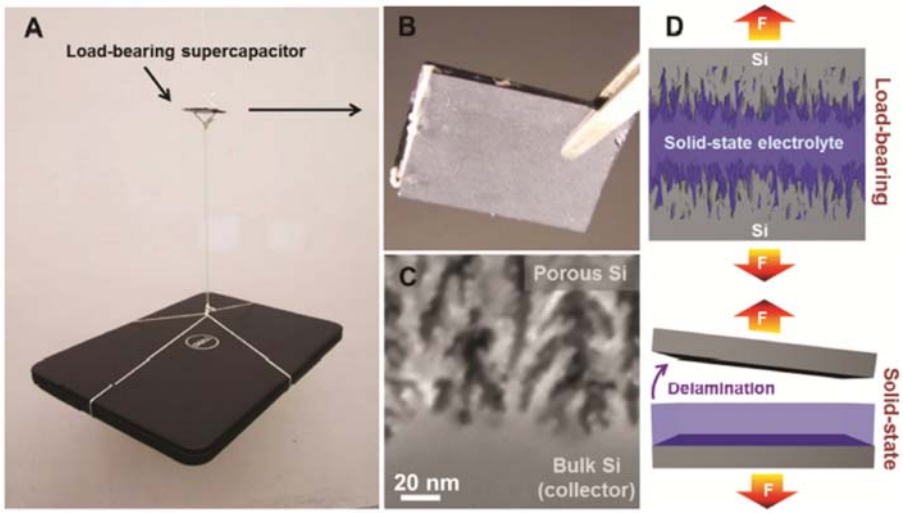
- Observed energy density between 2-10 Wh/kg and power density up to 8 kW/kg
- Little change in capacitance over cyclic force studies.
- Stable capacitive energy density under exposer to over 300 kPa tensile stresses and 80 g vibratory accelerations.
- Excellent reversibility for ideal long term discharge characteristics.

Technology Development Status

The load bearing capacitors have been fabricated and tested for energy and mechanical properties. They have been shown to have similar capacitive properties to traditional solid-state capacitors as well as greatly enhances load bearing properties.

Intellectual Property Status

A patent application has been filed.



(A) Photograph of a load-bearing supercapacitor suspending a laptop (B) Close-up photograph of a silicon-based load-bearing supercapacitor (C) High magnification SEM image of the mechanical-electrical interface in porous silicon that enables a load-bearing device, and (D) Schematic illustrating the difference between the load-bearing supercapacitor developed in this study versus a solid-state supercapacitor.

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