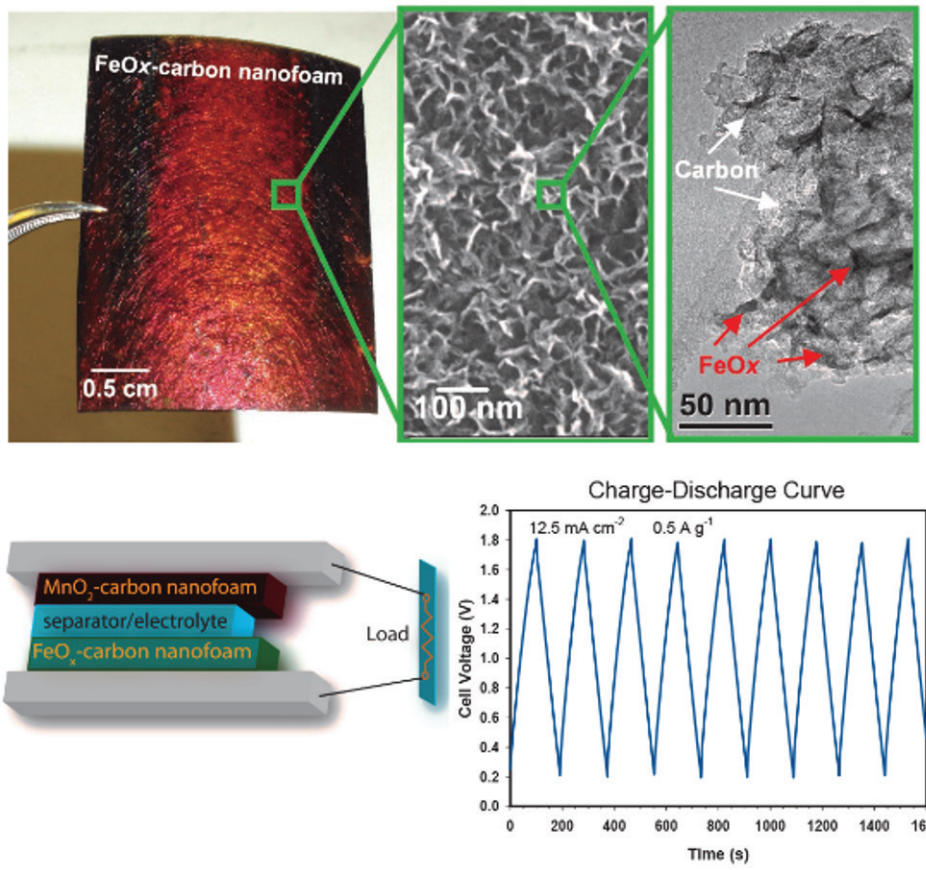
Naval Research Laboratory

The Corporate Laboratory for the Navy and Marine Corps

High Energy Storage Capacitor



Nanoscale metal oxide coatings on 3D carbon nanoarchitectures.

The Naval Research Laboratory (NRL) has developed a method of electroless deposition of conformal ultrathin (< 20 nm) metal oxides on the high-surface-area walls of commercial carbon nanofoam papers, typically 0.1–0.3 mm thick. The resulting ultrathin metal oxides rapidly take up and release electrons and ions, thereby storing energy at 300–600 Farads per gram of oxide, while the carbon nanofoam paper serves as a 3-dimensional current collector and defines a pre-selected porous electrode architecture. The high surface-to-volume ratio of oxide-painted carbon nanofoam enables footprint-normalized capacitances of 1–10 $F \cdot cm^{-2}$ addressable within tens of seconds, a time scale of relevance for hybrid electric vehicles. Pairing MnO_x–carbon nanofoam with FeO_x–carbon nanofoam yields an energy-storage device with an extended operating voltage in mild aqueous electrolytes (~2 V) that provides technologically relevant energy and power density while also being low cost, safe to operate, and environmentally benign.

Advantages

- Device-ready electrode structures that exhibit up to a 10-fold increased electrochemical charge storage.
- The combination of high-performance electrode materials and aqueous electrolytes, results in energy-storage devices that are:
  - composed of inexpensive components
  - safe to operate
  - environmentally friendly
  - relevant in energy and power density

Application Areas

- Hybrid-electric systems
- Bridge and/or back-up power
- Energy recovery

References

"Electroless Deposition of Conformal Nanoscale Iron Oxide on Carbon Nanoarchitectures for Electrochemical Charge Storage," *ACS Nano*, 4 (2010) 4505–4514.

"Incorporation of Homogeneous, Nanoscale MnO_2 within Ultraporous Carbon Structures via Self-Limiting Electroless Deposition: Implications for Electrochemical Capacitors," *Nano Lett.*, 7 (2007) 281–286.

Licensing and Collaboration Opportunities

US Patent No. 7,724,500; 9,058,931; and 9,105,402 are available for license to companies with commercial interest. Collaborative research and development is available under a Cooperative Research and Development Agreement (CRADA).

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