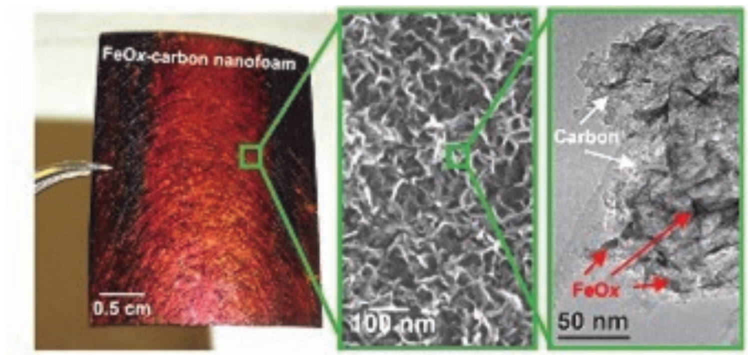
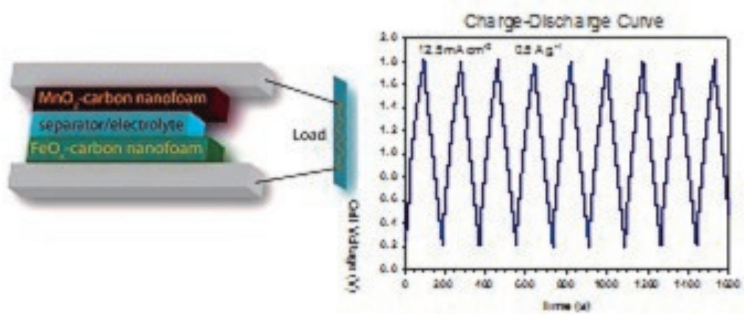
NAVAL RESEARCH LABORATORY

TECHNOLOGY TRANSFER OFFICE

High-performance electrochemical capacitors:

Nanoscale metal oxide coatings on 3D carbon nanoarchitectures





NRL has developed scalable, solution-based benchtop methods to generate conformal ultrathin (<20-nm thick) metal oxides on the high-surface-area walls of carbon nanofoam papers (0.1–0.3 mm thick). The resulting ultrathin oxides of manganese (Mn) or iron (Fe) rapidly take up and release electrons and ions, thereby storing energy at 300–600 Farads per gram of oxide (with typical oxide loadings of up to 50 wt. %), 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 cm^{-2} addressable within tens of seconds, a time scale of relevance for hybrid electric vehicles. Pairing Mn*Ox*–carbon nanofoam with Fe*Ox*–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.

References

Related U.S. patent number 7,724,500 entitled "Electroless deposition of nanoscale manganese oxide on ultraporous carbon nanoarchitectrue for electrochemical capacitor applications." J.W. Long, A. E. Fischer, and D. R. Rolison, issued 25 May 2010

"Incorporation of homogenous nanoscale MNO2 within ultraporous carbon structures via self-limiting electrolessdeposition: implications for electrochemical capacitors," A.E. Fischer, K.A. Pettigrew, D.R. Rolison, and J.W. Long, *Nano Lett.*, 7 (2007) 281-286.

"Electroless deposition of conformal nanoscale iron oxide on carbon nanoarchitectures for electrochemical charge storage." M. B. Sassin, A. N. Mansour, K. A. Pettigrew, D. R. Rolison, and J. W. Long, *ACS Nano,* 4 (2010) 4505-4514.

Licenses are available to companies with commercial interest.

technology

Advantages/Features

Device-ready electrode structures that exhibit up to 10-fold increased electrochemical charge storage.

The combination of high-performance electrode materials and aqueous electrolytes results in energy-storage devices that are:

- **Low Cost**
- **Safe to Operate**
- **Environmentally Benign**
- **Relevant energy and power density**

Applications

Hybrid-electric systems

Bridge/back-up power

Energy recovery

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ENE05