Curvature effects in carbon nanomaterials:
Exohedral versus endohedral supercapacitors

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Achievement

The beneficial electrochemical properties of nanometer sized, dense carbon nanoparticles (carbon onions or tubes) are shown to derive from the easy access of ions to the carbon/electrolyte interface. Exohedral carbons are much less limited by mass transfer kinetics and we show that this results in smaller series resistance and better rate performance compared to endohedral nanoporous carbons.

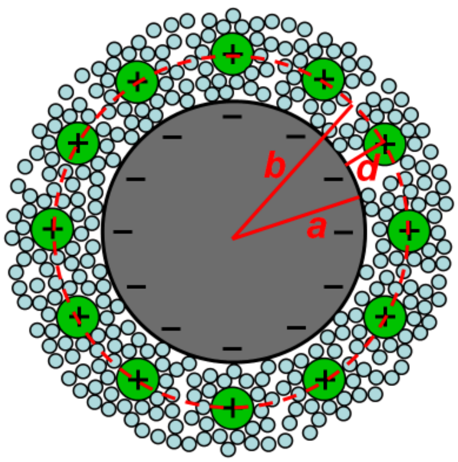

Fig. 1: Exohedral formation of the electrochemical double layer around a carbon onion.

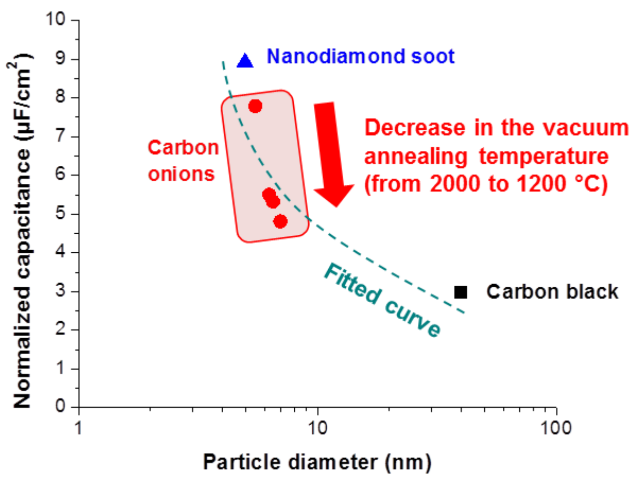

Fig. 2: Correlation between the size of solid carbon nanoparticles and the capacitance.

Significance

Most electrodes for supercapacitors are composed of porous carbon. Pores have a negative curvature and cause ion desolvation below a certain pore size threshold resulting in the break-down of the double-layer theory. Carbon nanomaterials with a positive curvature like carbon onions or nanotubes have been shown to yield superior electrochemical performance and improved rate performance and our paper provides a theoretical basis to explain these beneficial properties.

Credit

Reference: J. Huang, B. G. Sumpter, V. Meunier, G. Yushin, C. Portet and Y. Gogotsi, Journal of Materials Research, 2010, 25, 1525 - 1531. The effort at Drexel University is based upon work supported as part of the Fluid Interface Reactions, Structures and Transport (FIRST) Center, an Energy Frontier Research Center funded by the U.S. Department of Energy, Office of Science, Office of Basic Energy Sciences under award no. ERKCC61.