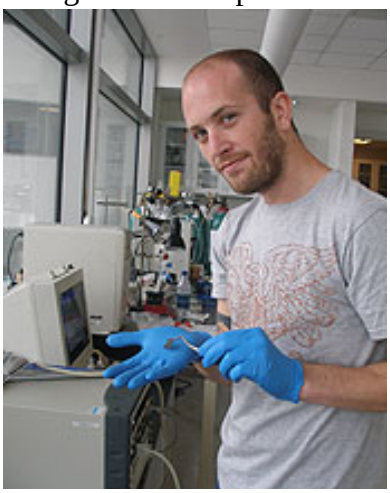
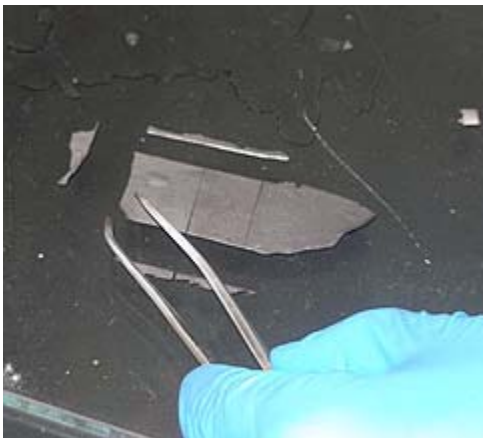
Optimizing Supercapacitor Electrodes for a Green Energy Future

With the help of his advisor, Yury Gogotsi, chair of the A.J. Drexel Nanotechnology Institute, doctoral student John Chmiola is performing groundbreaking work on high efficiency energy storage devices known as supercapacitors. Supercapacitors, like common capacitors, have an infinitely long lifespan, but supercapacitors have an unusually high energy density that may enable the use of new handheld devices, hybrid vehicles, and alternative energy sources.

Supercapacitors exploit the electrostatic separation between electrolyte ions and electrodes with high surface area. The electrodes of most electrochemical capacitors are made of base-activated carbons, but Chmiola is investigating the alternative material carbide-derived carbon (CDC). Using traditional porous carbon synthesis techniques, Chmiola is trying to precisely tailor the carbon structure and properties of CDC. Historically, research on supercapacitor carbon aimed to produce carbon with the largest pore size possible. In a surprising result, Chmiola found that pores smaller than one nanometer seemed to perform better than larger pores. When the pore size precisely matched the ion, a 50-percent improvement in performance was achieved. Chmiola continues to search for the optimal pore size for supercapacitor performance, while minimizing the effects from constricting the ions to small pores.



John Chmiola holds an electrochemical capacitor's electrode. Credit: John Chmiola, Department of Materials Science and Engineering, Drexel University.



Electrochemical capacitor electrodes from titanium carbide-derived carbon (TiC-CDC). Credit: John Chmiola, Department of Materials Science and Engineering, Drexel University.

Chmiola, J., G. Yushin, Y. Gogotsi, C. Portet, P. Simon, P. L. Taberna, "Anomalous Increase in Carbon Capacitance at Pore Sizes Less Than 1 Nanometer," *Science* 22 September 2006: **313** (5794): 1760–1763. DOI: 10.1126/science.1132195 (originally published in *Science* Express on 17 August 2006)

"Research Highlights: Materials science: Shrink to fit" *Nature* 24 August 2006 **442**, 850–851. doi:10.1038/442850a; Published online 23 August 2006

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