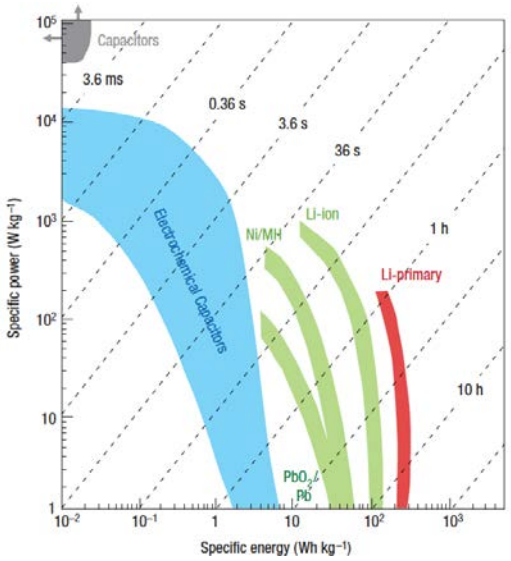
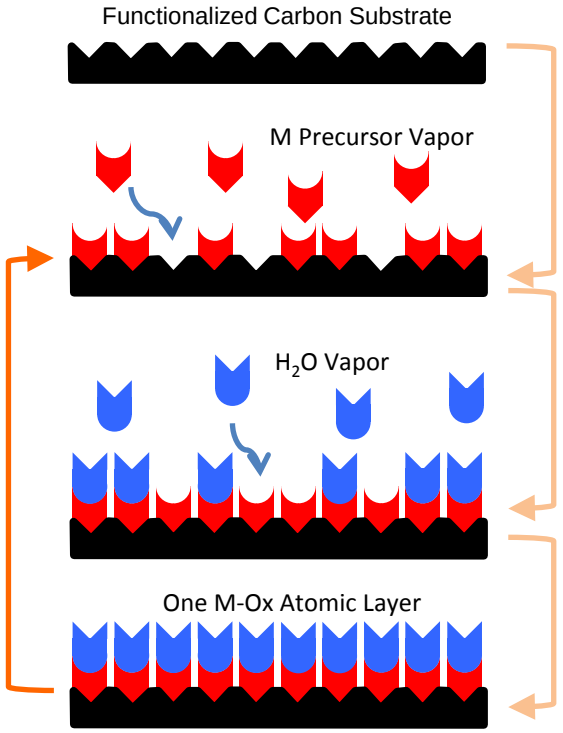
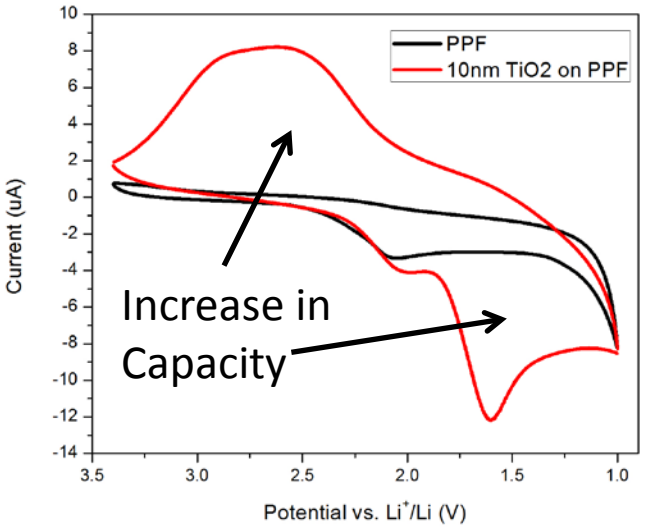
Supercapacitors have a lot of potential to provide high power energy dense electrochemical storage. Currently, though, the best supercapacitors only achieve at most about 10% of the energy density of Li-Ion batteries. It has been shown that mixed mechanism metal oxide/carbon hybrid electrodes can boost the energy density of supercapacitor materials by combining faradaic pseudocapacitive charge transfer at the electrode surface with faster non-faradaic EDLC-based charge storage.



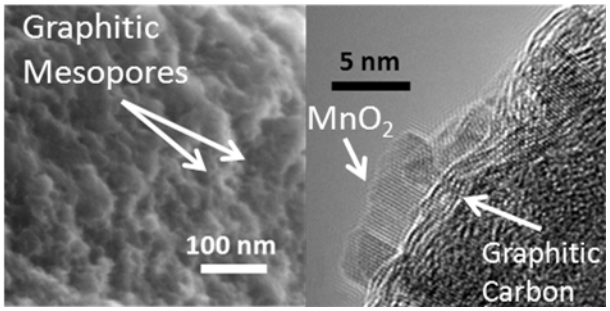
Simon, P. and Y. Gogotsi (2008). Nat Mater **7(11): 845-854.**

Schematic of Atomic Layer Deposition Process





In this research, **Atomic Layer Deposition (ALD)** is being used to create thin conformal coatings of various metal oxides onto various carbon substrates to be used as composite supercapacitor electrodes. ALD creates uniform thin films layer by layer with precise control by alternating two or more self-limiting vapor exposure steps. By growing films one atomic layer at a time, the thickness of these films can be controlled on an angstrom scale.



Patel, M. *et al. submitted, 2011.*

Recently, members of the Stevenson group have shown that the incorporation of redox active MnO_2 to the surface of conventional carbon EDLC electrodes significantly increased the gravimetric capacitance of the system through the introduction of pseudocapacitive redox-type energy storage processes

As seen in the cyclic voltammograms to the left, addition of 10 nm of anatase TiO2 onto a planar carbon electrode significantly increases the capacity during a Li insertion process. The peak currents of the insertion as a function of scan rate showed a square root dependence, meaning that this increase in energy is related to a pseudocapacitive mechanism rather than purely intercalation charge storage.