Graphene-derived Materials for Electrochemical Energy Storage: An Overview

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We present an overview of work in the Ruoff group on graphene-based and graphene-derived materials. The high electrical conductivity and surface area of graphene make it a promising candidate as an electrode material for supercapacitor (ultracapacitor) and lithium (and other) batteries.[1-7]

Various graphene-based materials have been reported for such applications, including: chemically reduced graphene oxide,[1] thermally reduced graphene oxide,[2] microwave exfoliated graphite oxide (MEGO),[3] and a new material derived from graphene, activated microwave-expanded graphite oxide ('a-MEGO').[4]

Our recent work based on a-MEGO, a highly porous graphene-derived carbon material demonstrated that exceptionally high specific surface area of up to 3100 $m^2 g^{-1}$ and powder electrical conductivity values of up to 500 S m^{-1} can be obtained, and a-MEGO showed significantly improved performance in terms of gravimetric capacitance and energy density for electric double layer (EDL) capacitors, with an energy density comparable to that of conventional lead-acid batteries.[4]

Other types of graphene-derived carbon electrode materials as well as their hybrids with inorganic nanostructures for supercapacitors and lithium hybrid battery devices [5-7] will also be presented, along with current efforts in our group on graphene-based and graphene-derived materials for electrical energy storage.

REFERENCES

1. Stoller, M.D., et al., *Graphene-Based Ultracapacitors.* Nano Letters, 2008. **8**(10): p. 3498-3502.
2. Zhu, Y.W., et al., *Exfoliation of Graphite Oxide in Propylene Carbonate and Thermal Reduction of the Resulting Graphene Oxide Platelets.* Acs Nano, 2010. **4**(2): p. 1227-1233.
3. Zhu, Y.W., et al., *Microwave assisted exfoliation and reduction of graphite oxide for ultracapacitors.* Carbon, 2010. **48**(7): p. 2118-2122.
4. Zhu, Y.W., et al., *Carbon-Based Supercapacitors Produced by Activation of Graphene.* Science, 2011. **332**(6037): p. 1537-1541.
5. Stoller, M.D., et al., *Activated graphene as a cathode material for Li-ion hybrid supercapacitors.* Physical Chemistry Chemical Physics, 2012. **14**(10): p. 3388-3391.
6. Zhang, L.L., et al., *Highly Conductive and Porous Activated Reduced Graphene Oxide Films for High-Power Supercapacitors.* Nano Letters, 2012. **12**(4): p. 1806-1812.
7. Zhao, X., et al., *Incorporation of Manganese Dioxide within Ultraporous Activated Graphene for High-Performance Electrochemical Capacitors.* Acs Nano, 2012. **6**(6): p. 5404-5412.