NPS Defense Energy Program Presents:

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Graphene Electrodes For Supercapacitor and Battery Devices

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Abstract:

In this seminar we will describe the efforts made by our NPS team to fabricate, characterize and test graphene as electrode material in supercapacitor and battery devices. It is well known that the methods used to fabricate and process materials largely determine the characteristics of the resulting products and are therefore key to achieve the desired properties and performance. Graphene, the two dimensional material consisting of an atom thick layer of carbon in a sp^2 hexagonal arrangement, and its derivatives, are no exception.

In recent years, the number of reports attempting to tailor graphene properties has grown at stunning rates. One of the common routes used to generate graphene uses graphite oxide (GO) as feedstock. While graphene produced from GO has been reported as a material with a promising electrochemical performance when used for the manufacture of supercapacitor and lithium ion battery electrodes, its practical energy storage capacity is still well below the theoretical values. There are, however, strategies to improve electrochemical properties and specific capacitance/capacity of graphene, including the incorporation of heteroatoms (e.g., N, B and O), which are known to be electron donors capable to modify the electronic structure of graphene. Unfortunately, the majority of these methods suffer from high cost, low yield, and/or use of toxic precursors, or involve sophisticated equipment that makes scalability impractical.

Our group recently introduced the reduction expansion synthesis (RES) using urea as an inexpensive, simple, and easily scalable process to generate nitrogen-doped graphene in a single step. The process can be conducted in a tubular furnace or in a microwave plasma environment. We provide evidence that the amount of urea in the precursor mixture has a profound effect on the structure and composition of the produced graphene, and may be used to control the level of doping or specific surface area of the material. We demonstrate the importance of these findings by reporting the performance of the as-produced graphene as supercapacitor and lithium ion battery electrodes.

Abridged Biography:

Dr. Luhrs has more than 16 years of experience working for diverse academic institutions and for industry in areas related to Materials Science and Engineering with emphasis in nanosystems and their characterization. She has more than 45 international peer reviewed journal publications, 42 presentations in specialized scientific meetings, has advised more than 20 student theses and has 10 issued patents.

Dr. Luhrs research interests focus on nanostructured functional materials from tailored synthetic pathways for their preparation (i.e. plasma/aerosol and chemical methodologies), the characterization of their structures, and properties to their failure mechanisms. Her work aims to understand the correlations between structural features and the materials reactivity, thermal, electrical and mechanical properties. Her research experience includes the generation and application of micron and nanosized metal, ceramic/metal and metal/carbon particulates. Application projects with Naval relevance include the generation of thermally stable materials for sensors, batteries, supercapacitors and structural components.

She earned her Ph.D. in Chemistry, Materials Science Program (1997) and her M.S in Materials Science (1995) from the University of Barcelona, Spain. She holds a B.S. – Chemistry from Instituto Tecnologico y de Estudios Superiores de Monterrey (ITESM).

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