One-dimensional Nanomaterials for Energy Storage

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Recommendation: This program is designed for students interested in energy science and technology and energy storage devices for electric vehicles and hybrid electric vehicles.

Abstract:
Because of the decrease of fossil fuel and the ever-growing need for a clean and secure energy, there has been an increasing demand for developing a new generation of electric energy storage for powering low or zero emission electric vehicles (EVs), hybrid electric vehicles (HEVs), and others. Among all types of batteries, lithium battery has gained a continuously growing scientific interest because its theoretical energy/power density is the highest for all solid electrodes. It, however, is very difficult to be employed in industrial area due to the internal short circuiting caused by the formation of dendritic lithium, resulting in a catastrophic failure and unsatisfactory cycling life of battery. Recently, Lithium/sodium-ion batteries (YIBs, Y=L and N), lithium/sodium-sulfur batteries (YSBs) and supercapacitors (SCs) have attracted many attentions in view of their long cycling life, rate capability, safety issue.

One-dimensional (1D) carbon-based composite nanostructures have been considered as promising electrodes for advanced electrical energy storage systems, such as rechargeable batteries, and supercapacitors, because of their high conductivity, good mechanical integrity, and large surface area. Electrospinning is a simple, low cost, scalable technology to synthesize 1D carbon-based nanocomposites with tailored nanostructures and compositions. These electrospun carbonaceous nanomaterials not only can be directly used as electrodes but also as a substrate with benefits of supporting active materials such as metal, metal oxide, and sulfur, improving structural stability upon cycling, and enhancing the conductivity of the whole electrodes.

This program will focus on the basis of the configuration and mechanism of these energy storage devices, and will show the electrospinning parameters and post-electrospinning treatments on the influences of structural, compositional, and morphological features of resulting electrospun nanocomposites. Current developments of electrospun carbon-based hybrids for emerging applications in Li/Na-ion batteries, Li/Na-S batteries, and supercapacitors will also be introduced. *In situ* technique such as *in situ* TEM (Transmission electron microscope) for the study of electrochemical reaction will be sought. Next, the conclusion and outlook on current challenges and future research of these 1D carbon-based hybrid electrodes are given. At the end of the program, students are encouraged to choose one application and write a 2-3 page review report.