Presentation Abstract 1

Title: Next-generation Li-S batteries using three-dimensional porous graphene foam current collectors.

Authors information:

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Presentation Keywords: Energy storage, electric vehicles, batteries, graphene, nanomaterials

Abstract: The automotive industry has embraced rechargeable lithium-ion batteries (LIBs) as "the component" for battery packs because they provide the highest energy density of all commercially available battery chemistries. However, for maximizing electrification of the road transportation system, drastic improvements in the performance of today's battery pack are needed. In this regard, this Stimulus Research Program (SRP) project has been focusing on the development of prototypes that represent a new lithium battery technology, i.e., lithium-sulfur battery (LSB) which is fundamentally different from LIBs. In order to achieve the targeted energy density (~300-500 Wh/kg), all three critical cell components of a LSB must be simultaneously optimized viz., (1) the composition of electrolyte must be tuned such that it can simultaneously form a bilateral solid-electrolyte interface (SEI) layer on both the cathode and the anode; (2) the sulfur cathode must be redesigned for high capacity, lightweight, and cycle stability. This requires a high S-loading (> 7 mg/cm^2) on lightweight current collectors (CC); (3) the Li anode thickness must be optimized and stabilized with an areal density ~6 mg/cm^2 to enable high cycle-life and safety. During the first year of this project, this team successfully identified novel electrolytes that facilitate bilateral SEI in (1). Subsequently, in the second year, this team focused on increasing S-loading and simultaneously decreasing CC weight without increasing detrimental polysulfide formation. Specifically, we used three-dimensional porous graphene foam networks that allow S-loadings as high as ~14 mg/cm^2. This talk will present our results on LSBs fabricated using graphene foam, which showed a capacity as high as ~700 mAh/g_{sulfur} in the presence of our optimized electrolyte capable of bilateral SEI formation. Additionally, our efforts on SEI layer modeling and the development of electrochemistry modules will also be presented.

Presentation Abstract 2

Title: In situ synthesis of sulfur doped activated carbon cathode for Li-S batteries

Authors information:

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Presentation Keywords: Energy storage, lithium, batteries, sulfur, nanomaterials

Abstract: Lithium-sulfur (Li-S) batteries have at least 3-5 fold higher theoretical energy density than state-of-art lithium-ion batteries. However, the commercialization of Li-S battery has been impeded by a lack of cathodes that inhibit lithium polysulfide formation with a long cycle life. Unlike existing carbon/sulfur composites where sulfur is present in its elemental form, we used a new sulfur polymer i.e., poly(phenylene sulfide) or PPS as ther precursor to synthesize highly porous S-doped activated carbon. Our preliminary results on PPS-derived sulfur cathodes will be presented.

Presentation Abstract 3

Title: Bucky-Si-Bucky sandwiched structured anode for Li-ion battery

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Presentation Keywords: Energy storage, lithium, batteries, anode, nanomaterials

Abstract: Silicon anodes have been of great interest due to their higher theoretical capacity (4200 mAh/g) compared to traditional graphite electrodes (~372 mAh/g). Although Si has a higher capacity, its full potential has not yet been realized due to pulverization of Si anode upon lithiation. Conventionally, Si anodes are made by casting a slurry consisting of Si powder, conductive carbon additives, and a binder on a Cu foil. In such anodes, pulverization of Si particles leads to film delamination from Cu foil ensuing in battery failure. To overcome this challenge, we developed a new sandwich-structured anode by encapsulating ~100 nm Si nanoparticles in between two porous carbon nanotube buckypapers. The buckypaper is a conductive porous structure, which can incorporate active material better than Cu foil facilitating increased mass loading. More importantly, this sandwich-structured anode provides improved electrical contact even under repeated pulverization of Si nanoparticles leading to higher cyclability. We were able to achieve capacities as high as ~700-1200 mAh/g with a stable performance for >100 cycles.

Presentation Abstract 4

Title: Batteries and Electrochemistry- Hands-on course modules for training next-generation workforce

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Presentation Keywords: Energy storage, electrochemistry, workforce, training, education

Abstract: A major goal of this stimulus project is the development of a new energy storage certificate program for independent development/integration into existing programs at SC community colleges and HBCUs. This is an important strategy that not only provides a gateway to higher education but also increases access and diversity of the workforce pipeline. Our team has been working with industrial manufacturers in SC and identified both the typical and advanced skills expected in energy industry under five broad categories: 1) Math and Spatial reasoning; 2) Fundamentals of electrochemical energy storage; 3) Automotive battery manufacturing technology including automation and assembly; 4) Advanced materials for composites; and 5) Quality and Business Acumen. Our target is to train underrepresented minorities (URMs) for positions, which require broad-based knowledge about a multi-step process to successfully troubleshoot and solve problems beyond the scope of typical "machine operators". This talk will present our efforts in developing a hands-on electrochemical energy storage course.