Department of Mechanical and Biomedical Engineering

Date: June 7, 2016 (Tuesday)
Time: 2:30pm – 5:30pm
Venue: B6619 (MBE Conference Room), 6/F, AC1 (Lift 4)

Seminar 1 : Sulfur Impregnated N, P-doped Hierarchical Porous Carbon as Cathode for High Performance Li-S Batteries

Mr. CAI Junjie

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Abstract

Lithium-Sulfur (Li-S) batteries show great potential to satisfy a wide range of high-energy demands of applications, ranging from portable electronics to electric vehicles and large-scale grid energy storage because sulfur have a high theoretical specific capacity of 1675mAh g^{-1} and energy density of 2600 Wh kg^{-1}. Although Li-S batteries have been considered as a promising candidate for the next generation high-energy density rechargeable batteries, there are still some serious challenges associated with its large-scale practical applications. First problem is originated from the intrinsic electric and ionic insulativity of sulfur would inevitably result in low utilization of active-sulfur material, low capacity, and limited rate performance of Li-S batteries. Second, more severe challenges are caused by the highly soluble lithium polysulfides intermediates (Li_2S_n, $4 \leq n \leq 8$) would be generated in organic liquid electrolytes during electrochemical reduction reaction. These dissolved polysulfide ions shuttles between the sulfur cathode and the metallic lithium anode. Partial of polysulfides are further reduction and finally precipitation of insulating Li_2S/Li_2S_2 on both electrode surfaces. Additionally, an 80% volume expansion of the transformations between sulfur and Li_2S during charge/discharge process, results in the pulverization and exfoliation from the current collector. The loss of sulfur active materials from the cathode leads to poor cycling capability and low coulombic efficiency.

In this talk, we demonstrate a novel nitrogen and phosphorus co-doped hierarchical porous carbon (N, P-HPC)/sulfur nanocomposite as cathode to solve aforementioned problems and towards to high performance Li-S batteries. The N, P-HPC was in-situ doping by simply pyrolysis of nitrogen and phosphorous containing pre-cursors and follow by an activation treatment for creating hierarchical porosity on carbon. Taking the advantages of suitable hierarchical porosity, high conductivity, fast ion transportation, physical and chemical adsorption of the N, P-HPC, the as-fabricated Sulfur/N, P-HPC composites have exhibited high capacity and considerable enhancements in cycling stability as well as rate capability.

About the Speaker

Mr. CAI Junjie is a Ph.D. candidate in Department of Mechanical and Biomedical Engineering at City University of Hong Kong. He obtained his Master degree (2012) in the school of Physics and Engineering, Sun Yat-Sen University in China. His current research interest is focusing on fabrication of nanomaterials for electrochemical energy storage.

Seminar 2 : Supercapacitive behavior investigation of the activated microporous carbon derived from almond shell

Mr. YANG Shaoran

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Abstract

Carbon supercapacitors have outstanding attributes of low weight, very fast charging/discharging kinetics, and bipolar operational flexibility. Today, most of the carbon electrode materials used for supercapacitors are obtained from the complex chemical products, which introduces the high cost and side effects to the environment. To overcome the environmental and cost constraints, waste materials derived from nature can be a good choice for the engineering electrode used for the renewable energy storage. Prepared from

the pyrolysis of biomass feedstock including peanut shell, banana peels, cotton and wood, biochar activated carbon has received extensive attention for supercapacitor investigation in recent years. However, these carbon materials used as electrode for supercapacitors are not satisfactory due to their low power and energy density. To solve the problem, development of asymmetric supercapacitor combining a Faradic positive electrode and a capacitive negative electrode to increase the potential window is a very promising direction.

This seminar reports the preparation of activated microporous carbon (AMC) derived from natural waste almond shell through the activation processes with KOH and HNO_3, respectively. Moreover, the asymmetric supercapacitor devices based on AMC negative electrodes and Zn-Ni-Co ternary oxide (ZNCO) positive electrode are fabricated. Both of these two AMC electrodes exhibit high specific capacitance and good rate capability. Furthermore, the device delivers superior power density and excellent cycle stability. The method to prepare the AMC is facile, safe, and easy for mass production. Therefore, it can provide a kind of renewable and low-cost electrode materials for high energy density supercapacitors.

About the Speaker

Mr. YANG Shaoran is a Ph.D. candidate in Department of Mechanical and Biomedical Engineering at City University of Hong Kong. He obtained his Master degree (2014) at City University of Hong Kong in the major of Advanced Technology Management. His current research interest is nanostructure materials for energy storage application.

Seminar 3 : Nanoforest of Hierarchical Core/Shell CuO@$NiCo_2O_4$ Nanowire Heterostructure Arrays on Nickel Foam for High-performance Supercapacitors

Ms. WU Chun

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Abstract

Recently, Faradaic capacitors using the transition metal oxides electrode materials have attracted much attention because they show higher specific capacitance than the conventional electrochemical double layer capacitors due to their fast and reversible redox reaction. Much work has been performed to investigate 3D core/shell heterostructured nanowire array electrode materials for supercapacitors. However, there is no report about the synthesis of $NiCo_2O_4$ nanosheets on pre-synthesized CuO nanowire arrays on nickel foam via thermal oxidation of e-beam evaporated Cu film, and applications of these nanostructures as binder free electrodes for supercapacitors.

In this work, we report a facile and environmental-friendly strategy to prepare nickel foam supported core/shell structured $CuO@NiCo_2O_4$ nanoforests. The smart hybridization of CuO nanowires and $NiCo_2O_4$ nanosheets into hierarchical core/shell array configuration results in remarkably enhanced electrochemical performances with high specific capacitance, excellent rate capability and good cycle performance compared with nickel foam supported $NiCo_2O_4$ nanosheets. The excellent electrochemical performances demonstrate that the nickel foam supported hierarchical core/shell $CuO@NiCo_2O_4$ nanowire heterostructure arrays are highly desirable for application as advanced supercapacitor electrode.

About the Speaker

Ms. Wu Chun is a PhD student in Department of Mechanical and Biomedical Engineering at City University of Hong Kong. She received her B.E. degree (2014) in Xiangtan University. Her current research interests are electrode materials for supercapacitors.

All are welcome!

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