Hindawi
Journal of Nanomaterials
Volume 2019, Article ID 1089842, 2 pages
https://doi.org/10.1155/2019/1089842

Editorial

Nanomaterials for Electrochemical Energy Conversion and Storage Technologies

Suresh Kannan Balasingam,[1] **Karthick Sivalingam Nallathambi**,[2] **Mohammed Hussain Abdul Jabbar**,[3] **Ananthakumar Ramadoss**,[4] **Sathish Kumar Kamaraj**,[5] **and Manab Kundu**[6]

[1]*Department of Materials Science and Engineering, Norwegian University of Science and Technology (NTNU), Trondheim 7491, Norway*
[2]*Electrochemical Materials and Devices Lab, Department of Chemistry, Bharathiar University, Coimbatore 641046, India*
[3]*Department of Materials Science and Engineering, University of Maryland, College Park, Maryland 20740, USA*
[4]*Laboratory for Advanced Research in Polymeric Materials (LARPM), Central Institute of Plastic Engineering and Technology (CIPET), Bhubaneshwar 751024, India*
[5]*Laboratory of the Sustainable Environment, Technological Institute of El Llano Aguascalientes (ITEL)/National Technological Institute of Mexico (TecNM), Aguascalientes C.P. 20330, Mexico*
[6]*Department of Chemistry, SRM Institute of Science and Technology, Chennai 603203, India*

Correspondence should be addressed to Suresh Kannan Balasingam; suresh.k.balasingam@ntnu.no

Received 20 December 2018; Accepted 20 December 2018; Published 11 April 2019

In this modern era, our society faces a serious energy crisis due to increasing human population. Energy consumption starts from small-scale electronic gadgets to high power consuming electric vehicles. To supply power on demand, researchers focus on alternative renewable energy resources including solar energy, wind energy, hydropower, geothermal energy, and bioenergy. Effectively, energy conversion and storage technologies such as solar cells, fuel cells, secondary batteries, supercapacitors, and other self-powered systems are under rigorous investigation. The efficient energy conversion and storage performance of those technologies rely on material properties of their electrode, electrolyte, and other device components. It is recently known that nanostructuring of device components leads to enhanced efficiency in terms of robustness and reliability of the energy conversion and storage systems. Moreover, the nanostructured materials have attracted great interest due to their unique physicochemical and electrochemical properties. Hence, the utilization of such materials in nanodimensions will create enormous impact on the efficiency of various energy conversion and storage devices. The main objective of this special issues is to identify the significant research paradigms of nanomaterials and their potential impacts on applications. In particular, focus of this issue is on the synthesis and characterization of nanostructured materials for various applications such as supercapacitors, batteries, photoelectrochemical, and thermal enhancement systems.

The highlights of the published articles are summarized as follows. In this special issue, Y. Yuan et al. synthesized the porous activated carbon materials from Pleurotus eryngii-based biomass material *via* carbonization, followed by KOH activation and utilized it for supercapacitor applications. The as-prepared activated carbon presented a large specific area with high porosity which exhibited a maximum specific capacitance of 195 F g^{-1} with 93% capacitance retention after 15000 cycles. It is known that Pleurotus eryngii is one of the readily available sources of carbon materials, potentially suitable for supercapacitor applications. Also, this biomass can be the resource for development of porous activated carbon for other energy conversion and storage devices in the future. Further, B.-X. Zou et al. synthesized hierarchical porous N, O-doped carbon composites by combining low molecular weight phenol resin and silk fibers in various combinations using a hydrothermal method and carbonization process. The as-prepared electroactive materials showed a low resistance and good surface area with hierarchical porosity. The low molecular phenol resin and silk fiber combination increases the surface area and enhanced the electron transport within the active materials. The fabricated symmetric device delivered a maximum energy density of 7.4 Wh kg^{-1} and power density of 90.1 W kg^{-1} using aqueous electrolyte.

L. T. N. Huynh et al. prepared the $LiFePO_4$@carbon composite material by hydrothermal method followed by thermal treatment for lithium-ion battery application. The different calcination processes did not affect the olivine structure; however, the surface morphology, the quality of carbon coating, and the electrochemical properties were significantly changed. The sample annealed at 700°C showed a good specific capacity of 170 mAh g^{-1} and the decent cyclic stability up to 120 cycles due to an optimum amount of carbon coating over olivine material. In another lithium-ion battery article, P. M. Nogales et al. developed a new method to estimate the ageing evaluation of Li-ion batteries in a shorter time. The authors present the numerical analysis method using columbic efficiency and capacity loss rate that could determine the cyclic stability of electrode material within a shorter evaluation time.

Y. Liu and coworkers investigated the effect of surface defects density of zinc oxide films on the photoelectrochemical water splitting reaction. The surface defect density of zinc oxide photoanodes was tuned by annealing the electrodes at various temperatures. The surface photovoltage of ZnO films was obtained by Kelvin probe force microscopy. The sample annealed at 450°C showed minimum surface photovoltage, which confirmed that the low surface defect density sample showed enhancement in photoelectrochemical water oxidation. The applied bias photon-to-current efficiency of annealed ZnO photoanode reached to 0.237%, about 7.4 times higher than that of unannealed ZnO photoanode. This work provided a potential method to design innovative photoanodes for photoelectrochemical water splitting.

S. Razvarz et al. performed the experimental research on thermal enhancement related to the heat pipe (with Al_2O_3 nanopowder) at different title angle. The important observation is the increase in heat transfer coefficient with the increasing heat flux of the evaporator. While adding Al_2O_3 nanoparticles to pure water, the thermal efficiency of the heat pipe enhanced considerably. Optimizing the quantity of the Al_2O_3 nanopowder assists in thermal efficiency enhancement. Also, the heat pipe thermal efficiency enhanced with increasing nanoparticle concentrations and tilt angles.

Conflicts of Interest

We declare that there is no conflict of interests or private agreement with companies regarding our work for this special issue. We have no financial relationship through employment, consultancies, and either stock ownership or honoraria with industry.

Acknowledgments

We would like to thank all the contributed authors and referees of this special issue, also grateful to the editorial board for the smoother process flow and rapid publication. The lead editor would like to thank all the editors for their time spent in reviewing and assigning reviewers for the submitted manuscripts.

Suresh Kannan Balasingam
Karthick Sivalingam Nallathambi
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Manab Kundu