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Guest Editorial

Special Section on 2D Materials for Electrochemical Energy Storage and Conversion

Electrochemical energy storage and conversion are currently one of the most critical challenges due to the increasing energy demand. Therefore, discovering novel materials to develop low-cost and more efficient energy storage technologies is urgently necessary. Among various novel materials, two-dimensional (2D) materials have attracted intensive research activities in multiple fields due to their fascinating physical and chemical properties. The 2D materials having a higher surface-to-volume ratio are beneficial to developing low-cost and large-scale energy storage systems for practical applications. There have been many promising concepts of 2D material-based real-life energy applications recently in batteries, supercapacitors, fuel cells, solar cells, thermoelectric, triboelectric generators, etc. Despite recent progress, significant efforts are still needed to investigate the fundamentals of 2D materials for electrochemical energy storage and conversion. Over the past few years, there has been substantial progress in modeling, theories, and experimental characterizations of 2D materials for energy storage and conversion. This timely Special Section issue addressed some recent advances in this critical area. We have selected eight papers covering a gamut of electrochemical-centric research in 2D materials for energy storage and conversion.

In this issue, Qu et al. reported the electrochemical evaluation of helical carbon nanofibers (HCNFs) prepared by the ethanol flame method as anode materials of lithium-ion batteries. Their results show that HCNFs possess high reversible capacity, good rate performance, and excellent cycling stability. Farma et al. investigated a simple and cost-effective method to generate porous carbon activation from Palmae plant waste biomass, namely, areca leaf midrib (ALM). They showed that the electrochemical properties of activated carbon supercapacitor cells derived from ALM biomass have the highest specific capacitance value and scan rate in a two-electrode system. Arumugam et al. discussed a ternary composite made up of graphene oxide, polyaniline, and zinc oxide as an electrode material for supercapacitors with its structural and electrochemical properties. The ternary composite exhibited the highest specific capacitance. Metzger et al. focused on using graphene-coated proton exchange membrane (PEM) to reduce fuel crossover. They found that the adhesion of graphene on PEMs is insufficient for prolonging fuel cell operation, resulting in graphene delamination at high temperatures and higher fuel crossover values compared to lower temperature testing. Zaidi et al. reported the superior performance of graphene nanosheet (GNS) materials over Vulcan XC incorporated as a cathode catalyst in Li-O_2 battery. The GNS catalysts demonstrated promising performance at higher current densities and with various organic electrolytes. Pandey et al. synthesized a mechanically stable, proton-conducting, and very cost-effective nanocomposite membrane using a simple and scalable phase-inversion approach. The synthesized proton-conducting nanocomposite membrane was demonstrated as a potential advanced functional solid electrolyte for possible application in proton exchange membrane fuel cells. Fauzi et al. reported the thermophysical properties of *N*,*N*-diethylethanolammonium chloride/ethylene glycol-DES (deep eutectic solvent) for the replacement of ionic liquid. They studied the physical properties of DES, which are thermal conductivity, viscosity, and surface tension. Finally, the review article by Zeng et al. provided an overview of the application of conductive diamond in electrocatalytic reduction and outlined the improvement of electrochemical properties by employing metal particles to modify the surface.

We believe that this Special Section issue will be a valuable contribution to the energy storage and conversion literature and open new frontiers for researchers. The interdisciplinary field of 2D material-based energy storage is rapidly evolving. Our Special Section issue will motivate many researchers to implement novel techniques, such as artificial intelligence, digital twins, and automated advanced manufacturing, in this field and initiate new collaborations between experimentalists, theorists, and modelers. We would like to thank all contributors to this Special Section issue for submitting their latest high-impact work. Also, special thanks would go out to the invited reviewers for helping us further enhance the quality of the articles.

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