Research & Development

Extended Abstract

Carbon Congress 2018: Electrochemical performance enhancement by using graphene for energy storage and catalysis - Jae-Jin Shim - Yeungnam University

Abstract

Metal oxide or sulphide nanomaterials have been developed for energy storage (supercapacitor), photo catalysis and sensor applications. Their performances have not been satisfactory and are being improved by several different ways. Two or three transition metals have been employed or reaction conditions have been tuned to get the best results. Transition metal oxides or sulphides have low thermal conductivities that result in low super capacitive and catalytic performance. To overcome this limitation, various materials that can improve the conductivity such as graphene and carbon nanotubes have studied extensively. Owing to their large surface area and high electrical conductivity, synergistic effects of excellent conductivities of graphene and high electrical properties of metal oxides or polymers have improved the overall electrochemical performances tremendously. In this study, graphene (natural or synthesized), graphene oxide, reduced graphene oxide, highly reduced graphene oxide has been tested for improving performances as a super capacitor, sensor and photocatalyst. Other methods have also been used such as doping of graphene with nitrogen or sulphur, using metal sulphides instead of metal oxides and using highly porous materials as substrates. In the synthesis of those materials, a cleaner technology has been employed. Since its first isolation in 2004, graphene has become one among the most well-liked topics within the field of materials science, and its highly appealing properties have led to a plethora of scientific papers. Among the various affected areas of materials science, this 'graphene fever' has influenced particularly the planet of electrochemical energy-storage devices. Despite widespread enthusiasm, it's not yet clear whether graphene could really cause progress within the field. Here we deliberate the foremost current applications of graphene both as a active material and as an inactive component from lithium-ion batteries and electrochemical capacitors to developing technologies such as metal–air and magnesium-ion batteries. By critically analysing state-of-the-art technologies, we aim to address the benefits and issues of graphene-based materials, as well as outline the most promising results and applications so far.

The enormous request of energy and depletion of fossil fuels has concerned a sufficiently interest of scientist and researchers to develop materials with excellent electrochemical properties. Among these materials carbon-based materials like carbon nanotubes, graphene, activated charcoal and conducting polymers have gained wide attention thanks to their remarkable thermal, electrical and mechanical properties. On this account, this review summarizes the history of ESDs and therefore the basic function of varied sorts of ESDs. Further, the varied nanomaterials utilized in energy storage devices for the past few years have also been discussed intimately. In addition, the longer-term trend within the development of highly efficient, cost-

effective and renewable energy storage materials have also been highlighted.

Nanomaterials of metal oxides and conducting polymers have been developed for energy storage (supercapacitor), sensor, and photocatalyst applications. They have shown good electrochemical performances but are not satisfactory. Various materials like graphene and carbon nanotubes have studied to reinforce the electrochemical properties due to their large area and high electrical conductivity. Synergistic effects of fantastic conductivities of graphene and high electrical properties of metal oxides or polymers have improved the general electrochemical performances tremendously. In this study, graphene (natural or synthesized), graphene oxide, reduced graphene oxide, highly reduced graphene oxide has been tested for improving performances as a super capacitor, sensor, and photocatalyst. Other methods have also been used such as doping of graphene with nitrogen or sulphur, using metal sulphides instead of metal oxides, and using highly porous materials as substrates. In the synthesis of those materials, a cleaner technology has been employed. Nanomaterials have been employed to improve the performance of the energy storage devices (supercapacitor), sensors, and photocatalysts. Especially, oxides and sulphides of transition metals have been getting attention as they have good electrochemical performances. However, their performances are not satisfactory. Various materials like graphene and carbon nanotubes have studied to reinforce the electrochemical properties due to their large area and high electrical conductivity. Synergistic effects from excellent conductivities of graphene and high electrical properties of metal oxides or sulphides have improved the overall electrochemical performances tremendously. Doping of graphene with nitrogen or sulphur, using metal sulphides instead of metal oxides, and using highly porous materials as substrates also contribute towards performance improvement. Graphene/metal oxide nanocomposites have been developed for energy storage applications such as supercapacitors, catalysts, sensors, and batteries. Electrochemical performance of the nanocomposites has been improved so much due to the synergistic effect of excellent conductivities and mechanical properties of graphene sheets and the high pseudo capacitance of metal oxides. For the applications of these nanocomposites to the real supercapacitors, a huge enhancement in capacitance, cycling stability, energy density, and power density should be achieved, resulting in an excellent performance as an electrode material for supercapacitors. In this study, we have tested several methods to enhance the supercapacitor performance, such as doping of graphene with other elements and using mixed metal oxides and conducting polymers. We have achieved high surface area, high conductivity, and remarkable electrochemical properties (specific capacitance of over 4,000 F/g). Cleaner synthetic methods have also been involved within the synthesis process.

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