Fabrication of Flexible Energy Storage Device using MnO_2@Graphene Composite Synthesised by Electrochemical Exfoliation Method

Himadri Tanaya Das, Sreejith P. Babu and Perumal Elumalai*

Electrochemical Energy and Sensors Lab, Department of Green Energy Technology, Madanjeet School of Green Energy Technologies, Pondicherry University, Puducherry-605014, India

Abstract

Transition metal oxides are considered as ideal electrode materials in various energy storage devices, owing to their unique features. However, it suffers from many drawbacks, such as, low electronic conductivity and capacity fading with number of cycles. To address these shortfalls metal oxides are, usually, embedded within a conductive carbon-based matrix (for example graphene). The use of graphene would afford easy pathway for electron movement and increases the surface area for higher interaction of active electrode materials with electrolyte.

In this work, we report a facile and economic approach to produce manganese oxide nanorods amalgamated on the graphene sheets (MnO_2@G) powders with an aim to achieve improved electrochemical activity. This electrochemical exfoliation strategy demonstrates a synthesis scheme from the graphite sheets at a constant voltage of 10 V in the $MnSO_4$ bath solution, the outcome of which are the black shinny flaky powders. The physiochemical and electrochemical properties were tuned by varying concentrations of $MnSO_4$ solutions. Interestingly, it was found that the degree of graphitisation of graphene as well as the performance of MnO_2@G governed by the concentrations of salt solution. Further, the electrochemical performances of MnO_2@G were examined in a three electrode set-up. It was discovered that the MnO_2@G composite prepared using 0.1M $MnSO_4$ solution has a delivered better electrochemical performance. To realise the practical applicability of the MnO_2@G composite, flexible light-weight solid-state prototype asymmetric supercapacitor was fabricated using MnO_2@G as positive and graphene as negative electrode. The fabricated devices exhibited ample storage capacity along with high energy density and powder density which were capable of powering consumer electronics applications. Thus, in the present work we have developed a cheap and effective electrochemical preparation of exfoliated MnO_2@G composites in high yield. This scheme could serve as precedent to the development of potential electrode materials for energy storage devices.

Recent Publications

1. **Himadri Tanaya Das, S. Saravanya and P. Elumalai**, *Chemistry Select*, 2018, 3(46), 13275-13283.
2. **E. Duraisamy, Himadri Tanaya Das, A. Selvasharma and P. Elumalai,** *New J. Chem.*, 2018, 42, 6114-6124.
3. **Himadri Tanaya Das, K. Mahendraprabhu, T. Maiyalagan and P. Elumalai,** *Sci. Rep.*, 7: *15342* DOI:10.1038/s41598-017-15444-z.
4. **Md. S. Uddin, Himadri Tanaya Das, T. Maiyalagan and P. Elumalai,** *Appl. Surf. Sci.*, 2017, 449, 445-453.
5. **E. Duraisamy, P. Gurunathan, Himadri Tanaya Das, K. Ramesha and P. Elumalai,** *J. Power Sources*, 2017, 344, 103-110.



Biography

Himadri Tanaya Das, senior research fellow, pursuing Ph.D degree at Pondicherry University, India. It is my growing passion to work with Energy Storage Systems and this urges me to pursue research in Hybrid Supercapacitor and Batteries. I aspire to become an expert in the field of Renewable Energy Resources research, with focus on energy storage and energy conversion for hybrid electronics, so that I may make a meaningful commercial contribution to the "SDG 7: Affordable and Clean Energy".

With a growing need to hone the features of energy storage devices, researches are tending towards high energy density and power density of hybrid supercapacitors which will surpass batteries not only in cycle life but also in commercial electronics. My emphasis is on experimentally demonstrating the solid-state hybrid supercapacitor with high energy density. In the current ongoing work, our team has seen interesting results which have been published in reputed international journals.

Email: himadritanaya1991@gmail.com

Notes/Comments:

I am eagerly looking forward to be a part of the international conference on the Advance and Energy Material, 2019 which not only help me to exchange ideas with similar research minds but also inspire me to be dedicated more into my work. Thanking in advance to the organizer and members.