ABSTRACT

The high performing energy devices remain an area of constant research due to very fast ongoing advancements In this regard, lithium ion batteries (LIB), microbial fuel cells (MFC), supercapacitors and similar energy generation and storage devices have been receiving considerable amount of attention in recent years. Therefore, identification of material development exhibiting enhanced electrochemical properties in these applications is an important area of immense potential. Though, high end techniques have been applied in the fabrication of the electrode materials, identification of simple and cost effective routes for development of superior electrode materials for energy devices is always a challenge.

The present work is focused on development of electrode materials for LIB, MFC and supercapacitor. Layered type transition metal dichalcogenide (MoS_2, WS_2, TiS_2)-multiwalled carbon nanotube (MWCNT) hybrids prepared by simple dry grinding in different weight ratio, characterized and evaluated as anode in LIB. The electrochemical characterizations showed that improved performance could be achieved in case of hybrids compared to their individual components. TiS_2-MWCNT (1:1) hybrid delivered a high initial specific capacity of ≈450 mAh g^{-1} (80 % retention, 50 cycles). In case of WS_2-MWCNT (1:1) hybrid, high initial charge capacity (≈483 mAh g^{-1}) and an improved cycling stability were noted. Further, MoS_2-MWCNT (1:1) hybrid exhibited an excellent initial charge capacity of 1214 mAh g^{-1} with ≈85% retention of capacity after 60 charge discharge cycles at different current densities (100 – 500 mA g^{-1}). In addition, graphene/nickel nanofibers hybrids have been fabricated and applied as catalyst for cathode in microbial fuel cell. The maximum power density of ≈34 mW m^{-2} was achieved in 5% Ni fibers loaded graphene. Such enhanced properties have been attributed to the presence of synergistic effect between the individual components. Finally, graphene was prepared by environmental friendly reducing agent and investigated as an electrode in supercapacitor. It exhibited high specific capacity of ≈200 F g^{-1} (Current density: 5 A g^{-1}) and enhanced supercapacitor characteristics. Such performance has been attributed to high surface area and excellent morphology of graphene.

Keywords: Lithium ion battery, supercapacitor, graphene, MWCNT, molybdenum disulfide