SYNTHESIS AND ENGINEERING OF GRAPHENE BASED ELECTRODES FOR ENERGY STORAGE AND CONVERSION APPLICATIONS

In the present study, various two-dimensional and three-dimensional graphene based electrodes were fabricated for potential use in electrochemical energy storage and conversion applications. Electrochemically reduced porous graphene oxide networks were developed on copper foam modified copper wire for the development of flexible wire-based high-rate supercapacitors for wearable applications. Few-layer graphene-like nanosheets were extracted from no-value waste biomass *via* solvent-assisted exfoliation technique for developing electrochemical double layer capacitors with improved energy density. In order to explore the role of solvents, a number of solvents of different chemical nature have been studied and its effect on enhancing the storage performance of the as-obtained few-layer graphene material was investigated. Electrochemically customized assembly of polydopamine-reduced graphene oxide based three-dimensional xerogel architecture was developed *via* combined covalent and non-covalent interaction to be used as redox active electrode. The as-developed pseudo capacitor shows excellent overall rate-performance and cycling stability. Device architecture plays a dynamic role to further improve the energy density. Electrochemically reduced graphene oxide-polypyrrole hybrid material on nanoporous gold substrate was utilized to fabricate an in-plane flexible supercapacitor device for portable electronic applications with high volumetric energy density. Simultaneously, graphene-based composite structures were used for the development of glucose-air fuel cell. Co-electrodeposited assembly of cobalt oxide-reduced graphene oxide composite decorated on nickel foam as glucose oxidation catalyst and hetero-atom doped biomass-derived activated carbon as oxygen reduction reaction catalyst were explored for the fabrication of a membrane-less glucose-air fuel cell.