Synthesis, characterization and applications of nanocomposites of graphene and polyaniline

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Abstract

Graphene has attracted considerable research interest in different fields of research due to its unique properties such as high electrical conductivity, good mechanical flexibility, and high thermal and chemical stability. These unique properties make them very suitable for energy related applications such as fuel cells, supercapacitors etc. In this work, we have fabricated nanoribbons of graphene oxide by chemical oxidation of multiwall carbon nanotubes. The synthesized graphene nanoribbons were structurally and electrochemically characterized. The shift of (002) peak in graphene nanoribbons compare to MWCNT confirms unzipping of MWCNT and its exfoliation. MWCNT and graphene nanoribbons were electrochemically characterized using cyclic voltammetry and galvanostatic charge-discharge methods. Cyclic voltammetry was performed at various scan rates to understand the charge transport mechanism. The specific capacitance of the graphene nanoribbons decreases with increasing scan rate. The overall charge storage capacity of the graphene nanoribbons was higher than that of MWCNT. The higher charge storage capacity of graphene nanoribbons is due to enhance surface area. We are in process to synthesize and characterize the nanocomposites of graphene nanoribbons and polyaniline for their possible application as an electrode material for supercapacitors.

Experimental

- Graphene nanoribbons were synthesized using multiwall carbon nanotubes (MWCNTs) with outer diameters of 110-170 nm.
- 1 g of MWCNTs was reacted with potassium permanganate (10 g) in a vigorously-stirred mixture of concentrated sulfuric acid (280 ml) and concentrated phosphoric acid (32 ml) (9:1 acid ratio) at 65 C for 4 h.
- The reaction mixture was then cooled to room temperature and poured over ice water (800 ml) containing hydrogen peroxide (40 ml, 30 %).
- The resulting mixture was congealed overnight then filtered (0.2 mm mesh PTFE from Millipore), and washed in succession with hydrochloric acid (30 %), ethanol (100 %), and diethyl ether (anhydrous).
- The final black material was dried at low heat (65 C) in a vacuum oven overnight.
- Electrochemical measurements were performed using three electrode system.
- Platinum and Ag/AgCl was used as counter and reference electrodes, respectively.

Results and Discussion

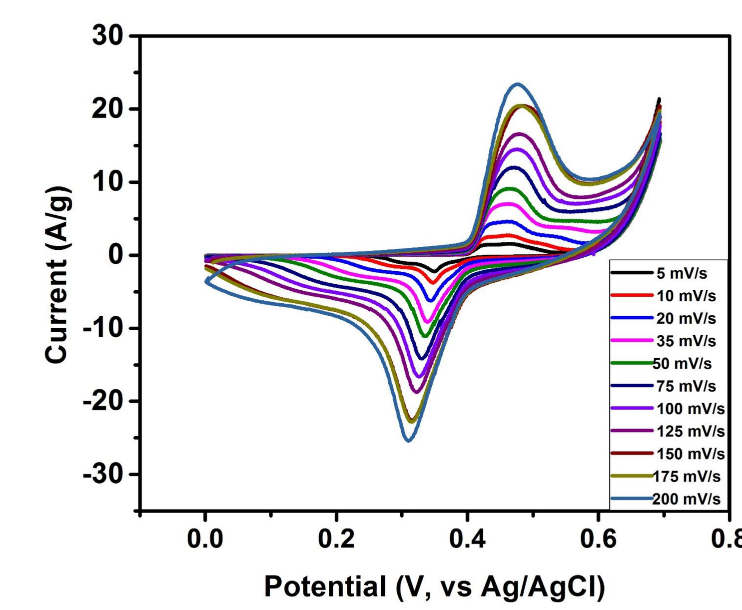

Fig. 1: CV curves of CNT at various scan rates.

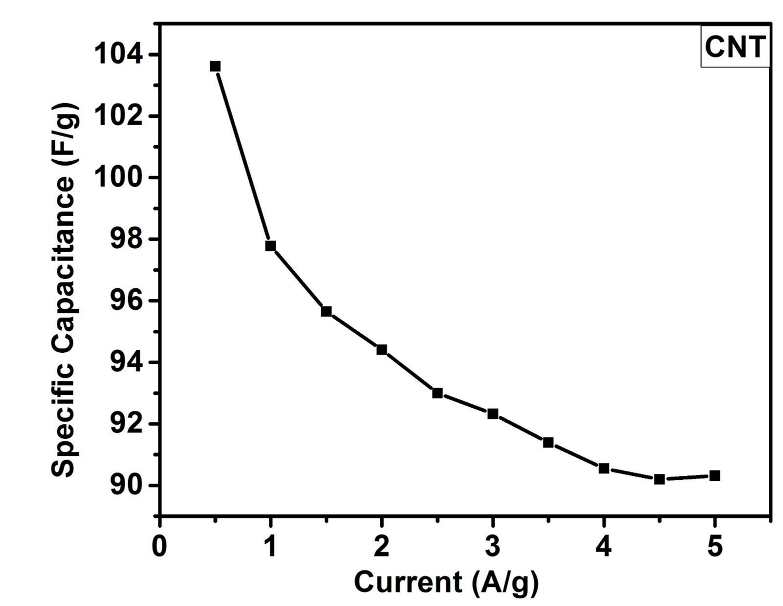

Fig. 2: Variation of specific capacitance vs applied current.

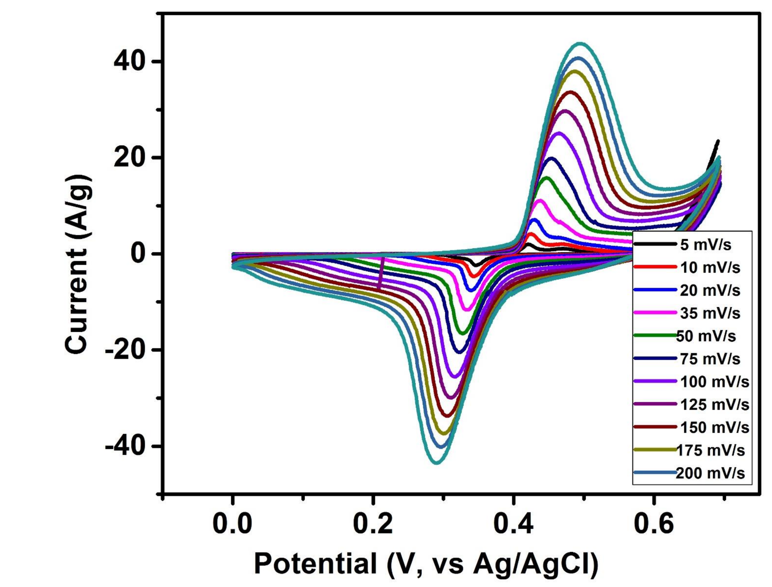

Fig. 3: CV curves of graphene nanoribbon at various scan rates.

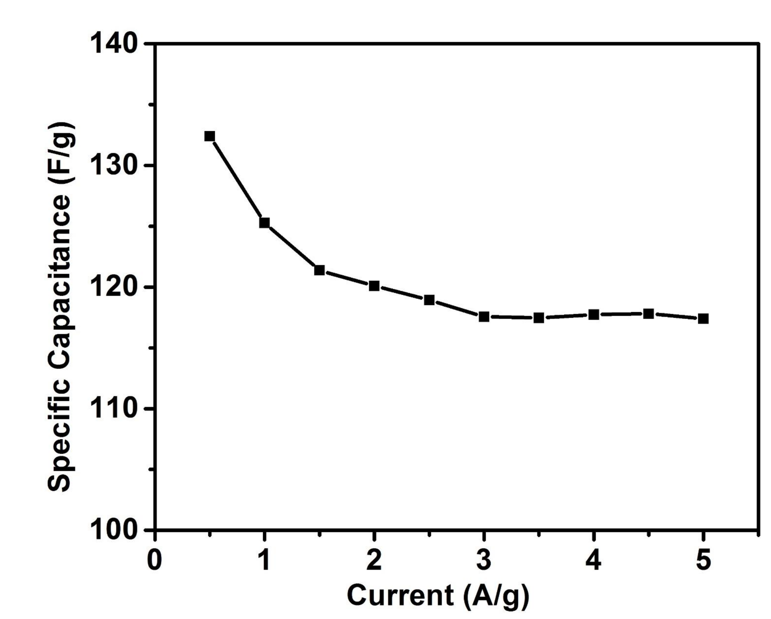

Fig. 4: Variation of specific capacitance vs applied current for GNR.

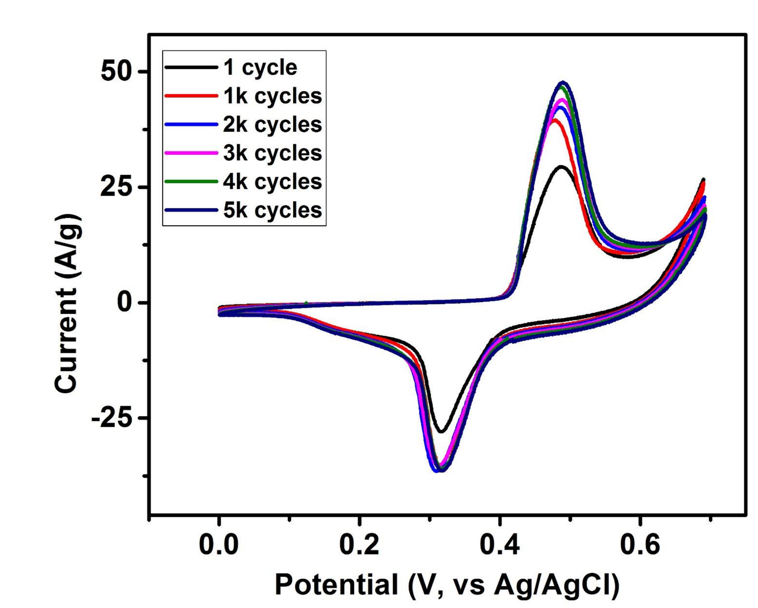

Fig. 5: Cyclic stability of GNR at various cycles.

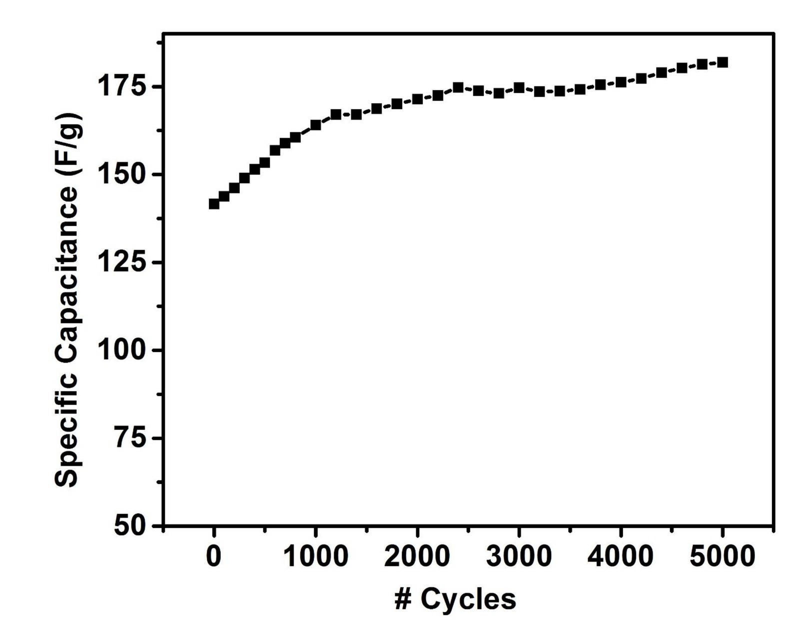

Fig. 6: Variation of sp. Capacitance with # of cycles.

Summary

- Graphene nanoribbons were successfully synthesized using multiwall carbon nanotubes (MWCNTs).
- Graphene nanoribbons and multiwall carbon nanotubes were used for energy storage applications.
- Graphene nanoribbons showed better charge storage capacity compared to multiwall carbon nanotubes.
- Specific capacitance derived from charge-discharge measurements showed decrease in charge storage capacity with increase in discharge current.
- Graphene nanoribbons showed high cyclic stability.
- Nanocomposites of graphene nanoribbons with polyaniline will be synthesized.