Proc. of the Intl. Conf. on Nanotechnology for Better Living, 2016
Editors K. K. Kar, A. Shah and R. Sharma
Vol. 3, No. 1, p. 188
doi:10.3850/978-981-09-7519-7nbl16-rps-188

Graphene-PLA nanofiber composite paper for Super capacitor application

Pushpendra Singh[1] and Kaushik Pal[1,2*]

[1]Centre of Nanotechnology, and [2]Department of Mechanical and Industrial Engineering,
Indian Institute of Technology Roorkee, Roorkee -247667, India.
*Email: pl_kshk@yahoo.co.in

Flexible energy storage devices can solve many problems of today's portable electronic industry. Graphene paper is a promising 3D structure for such applications as reported in literature [1-3]. In the same context, we have developed graphene-polylactic acid (PLA) nanofiber composite paper for supercapacitor application. The Composite paper was prepared with layer-by-layer assembly of water-soluble, partially reduced graphene oxide and PLA nanofibers.

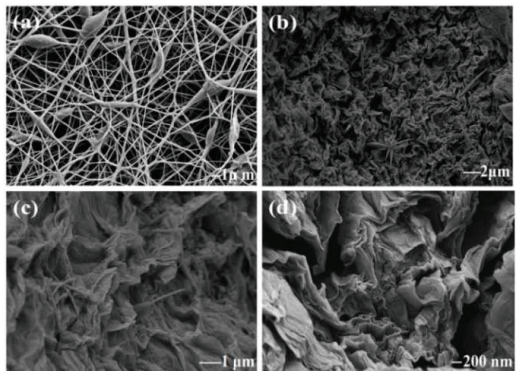

Figure 1: FESEM images of (a) PLA nanofibers. (b),(c),(d) LBL assembled Graphene PLA nanofiber composite at different magnification

As seen from figure 1, inclusion of PLA nanofiber results in wrinkles in the graphene paper surface and avoids restacking of the graphene sheets. The appearance of wrinkles on the surface is due to partially melting and shrinking of nanofibers because of moderate temperature heating during graphene paper synthesis. This temperature was provided by an iron lamp, the process also helped in drying of graphene paper. Wrinkled surfaces and reduced restacking resulted in high surface area and better capacitive performance. Introduction of nanofibers also provided mechanical stability to the electrode.

Electrochemical performance has been evaluated in two-electrode configuration using 6 M KOH as an electrolyte at ambient temperature. Figure 2(a) shows cyclic voltammetry analysis at scan rates of 10 to 40 mV/s. The curve indicates that the capacitance is primarily due to electrolytic double layer (EDLC) phenomenon. The capacitance measured at 10 mV/s is around 120 F/g. Figure 2(b) shows cyclic charge discharge analysis, which predicts that the electrode has high faradic efficiency. Cyclic stability is also demonstrated in figure 2(c), from the curve we found that, the sample has good capacitance retention capability and showed only 10 to 15% decay in capacitance after 10000 cycles. Figure 2(d) shows Ragone plot, the curve suggests that the maximum energy density observed was 4.8 Wh/kg.

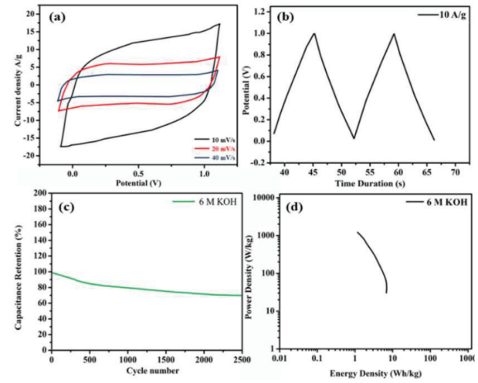

Figure 2: Electrochemical performance of the electrode (a) Cyclic Voltammetry at various scan rates (b) Cyclic charge discharge curve at 10 A/g. (c) Cyclic stability analysis with 6 M KOH as electrolyte. (d) Regone plot with 6 M KOH electrolyte

Thus, we can conclude that the inclusion of PLA nanofiber with layer by layer arrangement not only provided mechanical robustness but also resulted into decent capacitance performance which is due to increase in the surface area of the electrode. Hence, incorporation of PLA in graphene paper could be successfully used in supercapacitor application.

References

1. D-W Wang, F. Li, J. Zhao, W. Ren, Z-G Chen,J. Tan, Z.-S. Wu, I. Gentle, G. Q. Lu, H-M Cheng, ACS Nano 3 (2009) 1745.
2. F. Liu, S. Song, D. Xue, H. Zhang, Adv. Mater. 24 (2012) 1089.
3. X. Zhao, C. M. Hayner, M. C. Kung, H. H. Kung, ACS Nano 5 (2011) 8739.