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Abstract View Online

Functionalized graphene with both physical and chemical adsorptions of charges for high-performance supercapacitors

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Abstract

Carbon-based supercapacitor is also called electric double-layer capacitor that store energy via physical adsorption and desorption of ions from the electrolyte. Pseudocapacitors based on metal oxides or conductive polymers store energy via a redox process and generally have higher specific capacitance compared to the EDL type. Graphene has been regarded as an ideal candidate for supercapacitor applications, while the specific capacitance achieved so far in the lab, normally 200-300 F/g, is much lower than its theoretical value of 550 F/g. In order to enhance the charge storage capacity of graphene, we functionalized reduced graphene oxide by N-doping and adsorption of small molecules of hydrolysized polyimide (PI). In N-doped graphene, the N-O bonds are responsible for the enhanced capacitance owing to their pseudo capacitive property [1]. Further, we found that the hydrolysis of PI can release small molecules into water solution, and these aromatic molecules adsorbed onto graphene via π-π interaction have a significant effect in increasing the capacitance. With merely 3% weight increase after adsorption, the specific capacitance is about 40% increased. High capacitance over 420 F/g can be easily achieved from the functionalized graphene electrode in H_2SO_4 aqueous electrolyte, even the electrode has high mass loading around 5 mg/cm^2. In Li_2SO_4 aqueous electrolyte that can extend the operation voltage window to 1.6 V, the specific capacitance also remains high around 400 F.

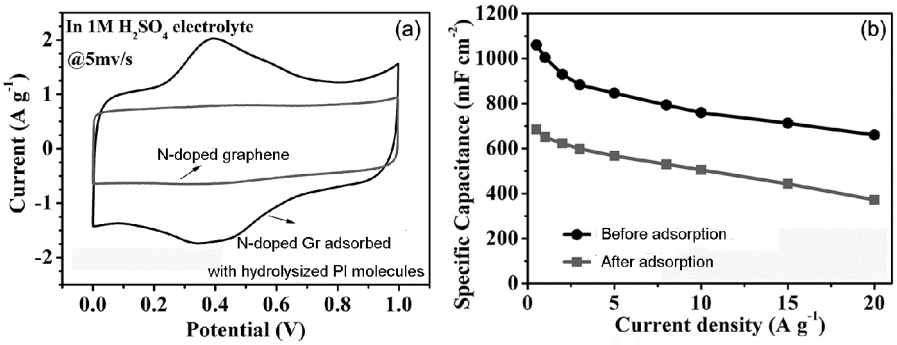

Figure 1. (a) Comparison to the electrochemical performance of N-doped graphene electrode before and after adsorption of hydrolysized PI molecules. (a) CV curves. (b) Capacitance Vs. discharging current density in galvanostatic CD measurement.

References

[1] T. Lin; I.-W. Chen; F. Liu; C. Yang; H. Bi; F. Xu; F. Huang. Nitrogen-doped mesoporous carbon of extraordinary capacitance for electrochemical energy storage. Science. 350, 1508-1513 (2015). doi:10.1126/science.aab3798

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