REDUCED GRAPHENE OXIDE HYDROGELS, DEPOSITED IN NICKEL FOAM BY ELECTROPHORETIC DEPOSITION, FOR SUPERCAPACITOR APPLICATIONS: TOWARD HIGH VOLUMETRIC CAPACITANCE

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Key Words: supercapacitors, EPD, graphene oxide

Supercapacitors, a class of electrochemical energy storage devices with superior power densities and long cycling lifetimes, have attracted great attention for the last decade due to their widespread application in backup power supply systems, portable devices, power tools, and hybrid electric vehicles. Graphene is considered as an ideal supercapacitor electrode material due to its large surface area, superior electrical conductivity, good chemical stability, and high mechanical strength. The theoretical specific capacitance of graphene is as high as ~ 550 F/g. The assembly of graphene sheets into three-dimensional interconnected porous microstructures, namely graphene hydrogels, has been considered the most effective approach to utilize these materials in supercapacitors that can achieve high specific capacitances. However, graphene hydrogels typically consist of large amount of water, up to 99 wt. %, resulting in very low graphene packing density. Therefore, the usual volumetric capacitance of graphene hydrogels is very poor, limiting their practical application.

In this study, we report a scalable method to prepare graphene hydrogels with high packing densities through the electrophoretic deposition of graphene oxide onto nickel foam, followed by an electrochemical reduction. The obtained, electrochemically reduced graphene oxide hydrogels (ERGO) on nickel foam were hydraulic compressed (up to 156 MPa) to increase the packing density of ERGO from 0.0098 to 1.32 g/cm3. In a two-electrode symmetric supercapacitor test using 6M KOH electrolyte, the compressed ERGO showed excellent performance with a volumetric specific capacitance up to 176.5 F/cm3 at a current density of 1 A g−1. Further, ERGO exhibited favorable cycling stability with retentions in range of 79 - 90 % after 10,000 cycles, depending on packing density of ERGO.).

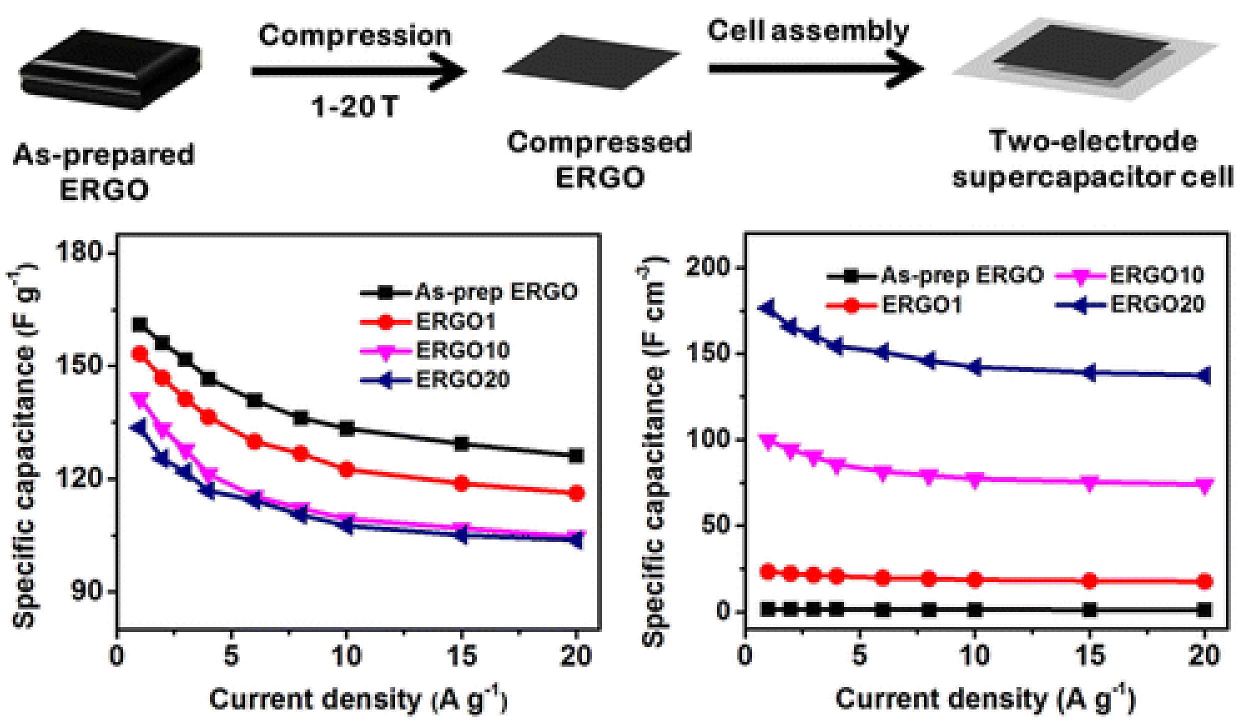

Figure 1: top) Schematic of the fabrication process for the supercapacitors. Bottom) Graphs of the gravimetric and volumetric specific capacitance. Increased reduction of ERGO yields excellent volumetric capacitance