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Laser Irradiation of Graphene Oxide for Electrochemical Capacitors

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ABSTRACT

Graphene Oxide (GO) was fabricated via Modified Hummers' Method [1], prior to laser irradiation inside a Laser Scribe enabled DVD. Laser irradiation reduces the GO to Laser Scribe Graphene (LSG) [2]. It was observed that multiple laser irradiations reduce it from a very high ohmic material to that with approximately 4 kΩ/cm2 resistance. This is due to the removal of the oxygen functional groups of the non-conducting GO following the reestablishment of the sp2 carbon bonding. This reduction is confirmed using Raman Spectroscopy characterization, through a redshift on the G band peak from 1604 cm-1 to 1586.294 cm-1 after laser irradiation. This shift signifies the reduction of the graphitic sheets from GO and also indicates the removal of oxygen functional groups on GO and the recovery of the sp2 hybridization in the carbon backbone. The appearance of the 2D band at 2696.324 cm-1 on the LSG spectra implies the appearance of graphene sheets signifying the mechanical exfoliation of GO. The appearance of the sheets agrees with Scanning Electron Microscopy measurements.

We tested the capacity of our LSG as the electrodes for an all-solid-state electrochemical capacitor (EC) with a 1 cm x 1 cm dimension. The electrolyte used was a mixture of Polyvinyl Acetate (PVA) and 85% Phosphoric Acid (H3PO4) with a ratio of 2.5 gPVA: 0.5 gH3PO4. Based on electrochemical impedance spectroscopy measurements, we were able to produce a double layer capacitor. On the other hand, IV curves show that EC acts more resistive than capacitive. We believe that the resistive behavior is somewhat related to the physical defects of our LSG electrodes. We still need to optimize our samples, and hopefully the electrochemical capacitive properties improve.

KEYWORDS: Graphene; Laser-Scribed Graphene; Electrochemical Capacitor