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# Combined Capacitive and Electrochemical Charge Storage Mechanism in High Performance Graphene-Based Lithium-Ion Batteries

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Chemically produced graphene has already been used to increase specific capacity of batteries and maximum rate of charge and discharge; thanks to its affinity with graphite, batteries with graphene-based anodes can be assembled easily by partially exploiting the already established lithium-ion battery (LIB) technology. Moreover, graphene is also a good candidate in composite materials, in conjunction with high capacity lithium-ion cathodes or anodes, as a conductive matrix.

Graphene was synthesized by thermal exfoliation of graphite oxide (TEGO), while hydrogenated TEGO (H-TEGO) was obtained by heating TEGO under hydrogen flux. Lithium half-cells were assembled either to characterize TEGO and H-TEGO or to achieve preformation of the SEI on the graphene-based electrodes before assembling full cells. Preformed graphene-based electrodes were tested in full cells in combination with different cathodes.

Hydrogenated graphene boasts an impressive reversible specific capacity with fast charge/discharge capabilities, exceeding 370 mA h g<sup>-1</sup> even at 25 C-rate. Diffusion mechanisms of lithium is characterized at different states of intercalation by means of electrochemical impedance spectroscopy. In addition, a novel combined electrostatic and electrochemical charge storage mechanism of lithium ions in graphene-based electrodes is proposed, based on three-electrode cyclic voltammetry investigation. Furthermore, graphene and hydrogenated graphene anodes are paired with commercial cathode materials, to study the feasibility of their application to full-cells.

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