Biomass Derived Li-S Batteries and Upcycling of Spent Li-Ion Battery Anodes

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Naturally abundant biomass with hierarchically porous architecture is a green, alternative carbon source with many desired properties for advanced energy storage devices sch as supercapacitors and lithium-based batteries. Recently, we converted cotton, banana peel, and recycled paper into highly porous, conductive activated carbon scaffolds for high performance supercapacitors and lithium-sulfur (Li−S) batteries via a low-cost and high throughput manufacturing process. The biomass-derived activated carbon materials are effective in blocking the dissolution of reaction intermediates in Li−S batteries. Especially, the biomass-derived carbons provide scaffolds for hosting sulfur in Li−S batteries to manipulate the "shuttle effects" of polysulfides and improve the utilization of sulfur. Using biomasses is definitely the right track towards making renewable carbon materials for future energy storage devices.

In the past two decades, lithium-ion batteries have transformed the appearance of the world. Along with the ever-increasing production and usage are the tremendous amount of retired batteries, which have induced social and environmental issues, making battery recycling an urgent task. On the other hand, graphene has exhibited outstanding electronic and mechanical properties but it is still difficult to fabricate high-quality graphene with feasible procedures at low cost. Here, a strategy of smartly converting retired lithium-ion battery anodes to graphene and graphene oxide is proposed. The graphite powders collected from end-of-life Li-ion batteries exhibited irregular expansion because of the Li-ion intercalation and deintercalation in the anode graphite during battery charge/discharge. Such pre-fabrication process facilitated both chemical and physical exfoliations of the graphite. Comparing with the graphene oxide derived from pristine, untreated graphite, the graphene oxide from anode graphite exhibited superlative homogeneity and electrochemical properties. The lithiation aided pre-expansion enabled four times enhancement of graphene productivity by shear mixing. Furthermore, the graphene fabrication was seamlessly inserted into the currently used battery recycling streamline in which the acid treatment was found to further swell the graphite lattice, pushing up the graphene productivity to 83.7 % (ten times higher than that of pristine graphite powders). The findings create new opportunities for capitalizing on waste batteries to produce high-quality graphene and its derivatives.