**High-Performance Graphene-based Supercapacitors: From Materials Design to Devices Fabrication**

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Graphene holds great promise to spark revolutions in future supercapacitor electrodes benefiting from its excellent electrical conductivity and chemical stability. Current protocols for graphene mass-production heavily rely on the exfoliation of expanded graphite and the reduction of graphite oxide. However, the former method usually produces stacked graphite flakes with low specific surface area, while the latter generally introduces numerous oxygen groups and defects, leading to low electrical conductivity. Therefore, it is urgently desired to develop a straightforward and green technique for production of high-quality graphene. To solve this problem, we turned to a competing alternative technique called self-propagating high-temperature synthesis (SHS), which utilized a controlled exothermic reaction between CO2 and Mg. The SHS protocol for graphene production is time-efficient, environment-friendly, low-cost and readily scalable in industrial occasions, and the graphene products show excellent physiochemical properties. The specific surface area of graphene by SHS can reach 709 m2 g-1, and its electrical conductivity is as high as 13000 S m-1. Encouraged by these achievements, our next target is to construct a pilot test base to commercialize the scalable synthesis of graphene powders by SHS.

Lithium-ion capacitor (LIC) emerges as a promising candidate to bridge the performance gap between lithium ion batteries and supercapacitors. Our group has been continuing to study the electrode materials of high-performance LICs and key technologies of LIC devices. We investigated the fabrication of porous carbon cathode with high surface area and transitional metal oxide/graphene anode with high rate behavior, and developed high-performance pouch-type LIC devices with large capacity of 2400F, energy density of 30 Wh/kg, power density of 5 kW/kg. A 7.5 Ah LIC module is assembled, which was employed to develop the trolley car utilizing LIC as the sole power source. This car can sustain a distance of 4-5 km after charging for 2 min, which lay a solid foundation toward practical application of LICs.

**References**

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