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Fast and controllable reduction of graphene oxide by low-cost CO_2 laser for supercapacitor application

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Highlights

- Instantaneous reduction of graphene oxide is achieved by using inexpensive CO_2 laser.
- The extent of reduction is controlled by changing the laser processing parameters.
- Very high carbon to hetero atom ratio is achieved in the synthesized graphene in this method.

Abstract

Direct reduction of graphene oxide has been regarded as the economically viable route for large-scale synthesis of graphene. However, the currently known methods suffer from either poor reduction efficiency or involve multi-step and energy-intensive reduction processes. Here, we demonstrate a remarkably fast, single step as well as highly efficient reduction technique to produce high-quality multilayer graphene film using a compact and low-cost CO_2 laser pyrolysis. Thanks to the intrinsically high absorptivity of graphene oxide in the near- and mid-infrared regions, the irradiation of CO_2 laser generates instantaneous and strong localized heating on it and thus burst apart the oxygen functional groups from the graphene oxide layers. The extent of reduction in the synthesized multilayer graphene films can be fruitfully controlled by variation of laser processing parameters such as laser intensity, scanning speed and shifting pitch. To prove the worth of this method, the graphene films were used as the binder-free and self-standing electrode for symmetric supercapacitor cell. The electrochemical performance data shows that specific capacitance and cyclic stability has a contrasting relation with the reduction efficiency. We believe that this CO_2 laser-based reduction method could guarantee a high outturn of multilayer graphene and its composites for innumerable applications.

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