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Laser direct writing of high-performance micro-supercapacitors on graphene oxide and polymer films

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Abstract

The rapid development of portable miniaturized electronics has improved the research demand for compact energy storage components with high energy and power densities. In recent several years, a new type on-chip energy storage unit, which is called micro-superapacitor (MSC) with two interdigitated electrodes in the same plane, has attracted much research attention, because MSCs possess not only the advantages of the supercapacitors, such as high power densities, robust cycle performance, pollution-free operation, and maintenance-free features, but also the small size, light weight, and flexibility, as well as the simplified packaging processes and compatibility to the integrated circuits. However, the materials and fabrication methods should be cost-effective, scalable, and compatible with current electronic industries. Carbon materials, especially graphene, which possess high specific surface areas, electrochemical stability, high conductivity, and high mechanical tolerance, can meet the requirement for energy storage unit in flexible wearable devices. Laser induced carbonization from polymers and laser induced reduction of graphene oxide have been reported for the preparation of MSCs due to the high power at the focused area. Compared to the commonly used printing and lithographic techniques, laser direct writing is a non-contact fast single-step fabrication technique with no need for masks, post-processing, and complex clean environments. Moreover, the laser direct writing method has the potential to be integrated to current product lines for commercial use. Therefore, it is necessary and important to study the preparation of high-performance micro-supercapacitors on graphene oxide or polymer films by laser direct writing technique.

In this paper, we will introduce our recent studies on the laser direct writing of high-performance micro-supercapacitors on polyimide and graphene oxide films, which consists of the following several parts: the preparation of carbon MSCs by laser direct writing on polyimide films in air using a continuous-wave blue-violet semiconductor laser (Figure 1) [1]; the improvement of the carbon MSCs by laser direct writing in Ar [2]; the carbon/Au MSC with high-rate charge-discharge capacitive performance [3]; and electrolyte-free high-performance reduced graphene oxide (RGO)-GO-RGO MSCs prepared by laser direct writing on graphene oxide films (Figure 2) [4].

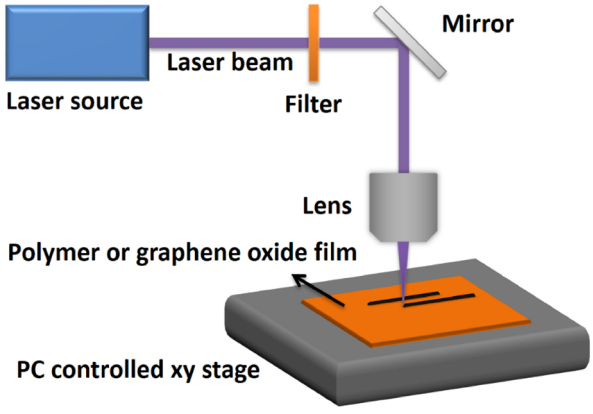

***Figure 1**. Schematic illustration of the laser direct writing system.*

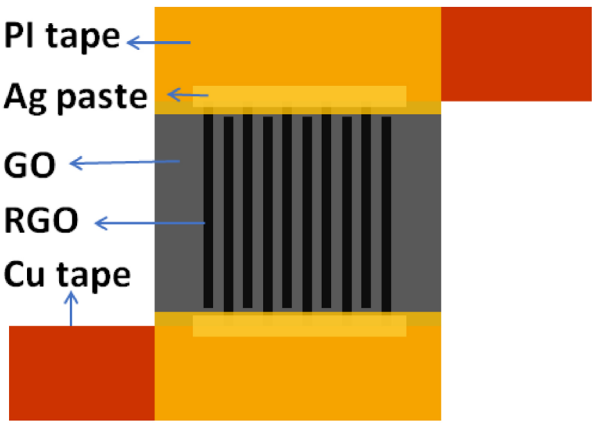

***Figure 2.** Schematic illustrating of a MSC device obtained by laser direct writing. Ag paste was used to make good connection between Cu tape electrodes and RGO lines.*

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