Composites of carbon powders and carbonized polymeric matrix for microsupercapacitors

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Microdevices are currently attracting considerable attention in the fields of biosensors or in energy storage, among others. More interestingly, Carbon microelectromechanical systems (C-MEMS) have the benefits of good mechanical, electrical, electrochemical properties and superior biocompatibility. Their fabrications are generally based on lithographic techniques including UV, electron beam or nanoimprint approaches. The polymeric resins used in these techniques lead after deposition and carbonization at high temperatures to carbon thin films (or microstructures) with good intrinsic electronic conductivities and low surface areas. The latter could be a huge drawback in microsystems for energy storage such as microsupercapacitors, where high surface area is generally required for energy density. At the opposite, the deposition of thin films of carbon materials used in full scale supercapacitors such as activated carbons remains challenging for typical thickness in the micrometer range.

Here we combine the two approaches to obtain composites based on photoresist formulations with carbon-rich acrylate monomers and (nano)carbons in powder form. The aim is to be able to immobilize the carbon (nano)particles in thin films with good mechanical properties given by the polymeric matrix that is turned to conductive carbon by heat treatment. Interdigitated microsupercapacitors have been designed by femtosecond laser microfabrication with carbon nanohorns, and with activated carbons particles, respectively. The assembled microdevices have been electrochemically evaluated with aqueous electrolytes and exhibit high power densities while holding significant volumetric energy densities.