Conformal 3-Dimensional Energy Storage through Inkjet and Water-Transfer Printing

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The rapid growth of Internet-of-Things (IoT) has stimulated the development of embedded electronics into physical components and daily objects which triggered a tremendous and rapidly grown interest for electronic devices and energy storage systems with advanced and diverse form factors (i.e. flexible, wearable and conformal). Typical fabrication methods, such as photolithography and electrode winding/stacking, that are commonly used in conventional electronics and energy storage systems respectively, are difficult to be applied as fabrication strategies towards devices with advanced form factors (e.g. three-dimensional (3D), stretchable, conformal). In this study, we demonstrate the fabrication of supercapacitors on 3D objects through inkjet and water-transfer printing (Figure 1). The devices are printed on a water-soluble substrate, which is then placed on the surface of water, and once the substrate is dissolved, the devices are transferred on the 3D object by controlling the level of water. Planar supercapacitors constituted of a silver nanoparticle-based current collector, a nickel (II) oxide (NiO) nanoparticle-based active electrode material and an ultraviolet-cured triacrylate polymer-based solid-state electrolyte, were used as model materials to explore the feasibility of the proposed concept. The conformed supercapacitors showed maximum areal capacitance of 87.2 mF·cm⁻² at a voltage window of 0 – 1.5 V. This new class of water transferable, inkjet-printed, all-solid-state supercapacitors with advanced conformality, offer new alternative approach towards monolithically-integrated/object-tailored power sources that are needed for complex-shaped devices for IoT and flexible/wearable electronic applications.

Acknowledgement
This research is supported by the European Regional Development Fund, Interreg France (Channel) England under the project SURFAS.

Figure 1. Fabrication process of inkjet and water transferred supercapacitors.