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A flexible and portable harvesting-storage device by quasi-solid-state supercapacitor and dye-sensitized solar cell integration

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In recent years the utilization of power in off grid conditions is dramatically increasing. For this reason research is putting much effort in obtaining improvements in energy storage devices efficiencies and in discovering alternatives concerning easiness of fabrication that can be industrially implemented. In this framework, integration of energy storage devices with energy harvesting systems is obtaining more and more significance since the amount of energy that can be stored especially in Electrochemical Double Layer Capacitors (EDLCs) is limited. To this purpose, herein we present an innovative flexible integrated device composed by a symmetrical aqueous EDLC and a TiO2 nanotubes-based Dye Sensitized Solar cell (DSSC). A UV photo-polymerized quasi-solid electrolyte was used in both sections. At first a self-standing flexible polymer matrix was fabricated starting from *Bisphenol A ethoxylate dimethacrylate* (BEMA) and *poly (ethylene glycol) methyl ether methacrylate* (PEGMA), adding a 3% by weight of *2-hydroxy-2-methyl-1-phenyl-1-propanone* (Darocur 1173) as photoinitiator. Then, the matrix was soaked in two different liquid electrolytes, a 2 M NaCl aqueous solution for the energy storage section and an Iodine-based liquid electrolyte for the DSSC unit. This is the first work in which this type of polymer electrolyte membrane is used for an EDLC. The electrodes were fabricated onto Stainless-steel and Titanium grids, for EDLC and DSSC respectively. TiO2 nanotubes were grown by means of anodic oxidation as photoanode semiconductor material, while EDLC active material was composed by 85% of graphene nanoplatelets and 15% of Acetylene Black. The harvesting-storage device (HSD) was sealed by a light-cured photo-polymerization method. The measured overall photon-to-electrical conversion and storage efficiency for the HSD was 1.02% under standard test conditions. This value increases for lower illumination conditions reaching 1.46% at 0.3 Sun.

Figure 1