WALKING TOWARDS A TRANSPARENT PHOTO-SUPER-CAPACITOR

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Store a large amount of energy in a device and can deliver it in a short time, high-power devices, low weight and size is a strong challenge for nanotechnology with important applications in defense, both in integrated wearable personal protective systems and offensive weapons; if, in addition, these devices could be transparent, flexible and solar rechargeable, because its autonomy its applications in defense will be very important.

In this paper we present the latest results from our laboratory, Nanotech UNIT of UMA, in the development of transparent super-capacitors based in nano-structures as a previous step to an integrated photo-supercapacitor.

The photocapacitor can be considered as a simple sandwich-type electro-chemical cell consisting of a light-absorbing electrode (photoelectrode), a redox-free electrolyte, and a counter-electrode. The photoelectrode bears a heterojunction of dye (dye sensitized solar cells, DSSCs) or quantum dots (quantum dots sensitized solar cells, QDSSCs) and a porous layer, a counter-electrode also bears a porous layer. The first step in making a transparent photo-supercapacitor; really, we have prepared a pseudo-capacitor, that is, a pseudo-capacitors or redox supercapacitors using fast and reversible surface or near-surface reactions for charge storage, mainly by transition metal oxides as well as electrically conducting polymers.

We have combined various nano-structures as nanorods, QDs, thin films of semiconductor materials using deposition techniques following the criterion of low-cost, easily up-scaling and friendly to ambient. For a start, we have use a mixture of PVP and LiClO4 as solid ionic conductive energy storage in transparent systems; so, the films were used in a symmetrical supercapacitor (PEDOT/PVP/PEDOT). The goal of this work was to study, by first time, the availability of the PVP/LiClO4 as solid polymer electrolyte in transparent SC [1].

In a second step, we have obtained ZnO nanorods by electrochemical methods and we have combined with QDs of CdS obtained by Spin-Coating Assisted Successive-Ionic-Layer-Adsorption and Reaction Method to study the interaction of n-ZnO and the QDs of CdS with a mean diameter about 5 nm. The interaction between ZnO and CdS QDs/ZnO NRs was evaluated in a photoelectrochemical solar cell configuration with a polysulfide electrolyte under white illumination. The decoration of ZnO NRs with CdS QDs leads to a cell performance of J_{SC} = 2.67 mA/cm2, V_{OC} = 0.74 V, FF = 0.30 and η = 1.48%.

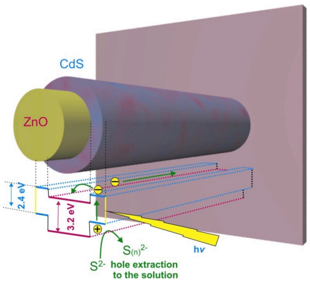

Fig. 1. Schematic diagram of the operation of the ZnO/CdS core/shell nanorod array PEC solar cell: electron–hole pair generation by incident photons, electron injection from the excited CdS nanocrystal shell into the ZnO nanorod core and scavenging of holes by the S^{2-}/S^{2-} redox couple in solution. The normal to the substrate nanorod architecture provides a direct pathway for electron transport from ZnO to the FTO substrate and then via the external circuit to the working load [2].

The next step was to design and to do a pseudo-capacitor by combining the above elements and some innovations. A hybrid nano-architecture with high electrochemical performance for supercapacitors have been obtained by growing hierarchical ZnO NRs@CuS@PEDOT@MnO2 core@shell heterostructured nanorod arrays on ITO/glass substrates, this structure is shaping as a semi- transparent supercapacitor electrode showing some novelties with respect to other similar supercapacitors that have been reported. For instance, it is the first time that it has been employed covellite by spray pyrolysis as a good electrical conductor to improve the electron transfer to the nanorod and to facilitate the PEDOT electrodeposition onto the nanorod. The balance between transparency and capacitance is good comparatively to other reported results in the bibliography. Adding MnO_2 to the PEDOT layer improves the performance and the transparency of the device [3]

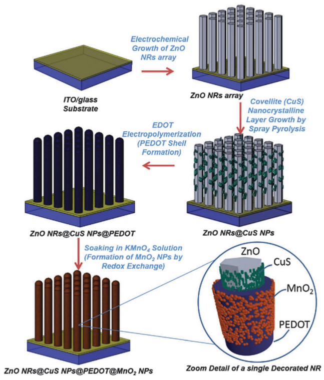

Fig. 2. Schematic illustration of the synthesis process for the designed ZnO NRs@CuS@PEDOT@MnO_2 hybrid nanostructured electrode.

The major impediment, which hampers many practical applications of existing supercapacitors, is their limited performance, stability, operating electrochemical windows and short lifetimes, which are strongly determined by the properties of the electrolytes being used. Now, we have introduction a new polymer electrolyte with ionic liquid. The synthesis feasibility of two different gel polymer electrolytes based each one on methyl methacrylate (MMA) and 1-Vinyl-2-pyrrolidone (VP) monomers, respectively, by using a common ion liquid i.e. 1-(2-hydroxyethyl)-3- methyl imidazolium tetrafluoroborate ([HEMIm][BF_4]) as the conductive plasticizer, has been done. PVP/[HEMIm][BF_4] solid-state ion gel electrolyte has then been synthesized and we can prepare supercapacitors with a more effective electrolyte. We have prepared a glass/ITO subtrate of PVP, Poly (3,4 ethylenedioxythiophene) PEDOT, HEMIm[BF4], and ZnO hybrid nano- architectures with good electrochemical performance. These hybrid nano- structured electrode exhibits excellent electrochemical performance, with high specific areal capacitance, good rate capability, cyclic stability and diffused colure transparency [4]

The next step will be to design an to prepare a complete device supercapacitor and the last step to do a photo-supercapacitor, better it is a transparent and flexible device

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