Semitransparent symmetric and asymmetric supercapacitors

Francisco Martín[1], CJorge Rodríguez-Moreno[1], Elena Navarrete-Astorga[1], Enrique A. Dalchiele[2], José Ramón Ramos-Barrado[1]
[1]Laboratorio de Materiales y Superficies (Unidad asociada al CSIC), Universidad de Málaga, Spain
[2]Instituto de Física & CINQUIFIMA, Facultad de Ingeniería, Montevideo, Uruguay
marjim@uma.es

We have tried to employ common and interchangeable materials to assemble electrochemical capacitors, also known as supercapacitors. Special attention was given for these devices to be transparent or at least translucent with the perspective to achieve in the future a single device having shared materials as well as integrated functions of energy generation (solar cells) and storing of the produced energy (supercapacitor). In order to accomplish those goals, ZnO and PEDOT have been selected as common compounds to be used in the supercapacitors, because they can also form diodes.The used deposition techniques have been selected following the criterion of low-cost, easily up-scaling and friendly to ambient.

We present results about to supercapacitors formed on 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 coloured transparency. ZnO, In_2O_3, and SnO_2 and their doped versions are well-known and widely used in many opto-electronic applications, transparent devices based on the transparent p–n junctions are limited to the scarce existence of p-type TCOs. On the other hand, a p-type conducting polymer as the poly(3,4- ethylenedioxythipohene) (PEDOT) doped with poly (styrenesulfonic acid) (PEDOT:PSS), has attracted considerable interest in recent years because of its low-energy band gap which makes it suitable for electro-optical applications, its excellent electrical characteristics, inherent stability and low oxidation potential. ZnO and PEDOT were selected because its availability to form n-p heterojunction(1).

Electropolymerized PEDOT and polyvinylpyrrolidone (PVP) as a solid polymer electrolyte were used in a semitransparent glass/ITO/PEDOT/PVP-LiClO4/PEDOT/ITO/glass symmetric supercapacitor (2). It was found that the conductivity of PVP depends on the concentration of LiClO4 but also on the residual amount of ethanol from the dip process, and it was shown that that residual amount preserves a good ionic conductivity. Thus, several PVP-LiClO4 layers were exposed to air and characterized by ATR and TGA-DSC. Furthermore, to know the stability of the supercapacitor it was studied the effect of the aging time on the performance of the capacitor. PVP binds exceptionally well to polar molecules, due to its strong withdrawing group, making this polymer behave differently to other such us PEO, PVDF, PVA, PPO, etc. Besides, PVP can be easily obtained and due to its viscosity promptly adhered to the electrode surface, making very simple to control the film thickness by dip-coating. Some addition al experimental work has been done to improve the electrochemical voltage windows as well as to enhance the maximum temperature of operation. It is well known that the energy accumulated by a capacitor depend on the square of the voltage between electrodes, so our aim is not just to enhance the specific capacity but to extend the potential window of the appliance as much as possible. Ionic liquid combined with polymers provide several benefits to previous stated ionic salt polymer electrolyte improving the mechanical and thermal properties and incorporating non-volatility. This means that a completely compatible incorporation of ionic liquid into polymer networks has been achieved. The electrochemical window was determined in conjunction with the ionic liquid conductivity. A thermogravimetric study of the ion gels was done together with measurements of the visual transmittance of the ionic gel corroborates the improved electrochemical potential window of the new assembled symmetric PEDOT/ion gel/PEDOT supercapacitor. Potential window of the supercapacitor is improved half volt in each cycle. The improvement is shows as the energy density of electrochemical capacitor is four times greater than the PEDOT/PVP/PEDOT capacitor.

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 (3), 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.

The techniques used are easy, template-free, low cost and environmentally friendly. Supercapacitors, such as the proposed in this work, that combine good transparency and specific capacitance, are of great interest due to the wide area of applications. The aim of this work was to enhance both parameters, necessary for the development of cutting-edge technologies, i.e. electronics devices, glazing systems, etc.

References

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