

Conducting Polymer Hybrid Hydrogels For Energy Generation and Storage Applications

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ABSTRACT: Here we shall discuss four different systems of conducting polymer hybrid hydrogels. They are (i) Dihybrid (GP) and trihybrid (GPPS) hydrogels constructed by 5,50-(1,3,5,7-tetraoxopyrrolo[3,4-f]isoindole-2,6-diyl)diisophthalic acid (P), graphene oxide (GO) and P, GO, and PEDOT:PSS, (ii) Folic Acid-Polyaniline-AgNP hybrid hydrogel (iii) Folic acid (F)-Polyaniline (PANI) hybrid hydrogel (F-PANI) and (iv) MoS₂ QDs embedded polyaniline (PANI)-N,N-dibenzoyl-L-cystine (DBC) hydrogel. In all cases the gelation occurs through H-bonding and π - π stacking interactions. The current-voltage (I-V) characteristic curves of the GP and GPPS gels exhibit rectification properties with the highest rectification ratio of 61; but, the xerogels exhibit only the semiconducting nature. Dye-sensitized solar cells (DSSCs) are fabricated taking the GPPS gels as active materials and the power conversion efficiency (PCE) increases with the increase of PEDOT:PSS concentration showing a maximum PCE of 4.5%.¹ Folic Acid-polyaniline(FP) xerogel exhibits specific capacitance of 295 F/g while FP-AgNP hybrid xerogel exhibit maximum specific capacitances of 646 F/g at a current density of 1A/g, and FP xerogel shows photocurrent of ~2 mA but FP-AgNP hybrid xerogel exhibits photocurrent of 56 mA under

white-light illumination.² The aerogel synthesized from MoS₂ QDs embedded polyaniline (PANI)-N,N'-dibenzoyl-L-cystine (DBC) hydrogel act as an efficient electrocatalyst showing lower HER overpotential in comparison to MoS₂ QDs.³ It exhibits an optimum overpotential value of 196 mV at 10 mA cm⁻², a favorable Tafel slope of 58 mV/dec, and an excellent cyclic stability. The remarkable (153%) enhancement of photocurrent in the DBC-MoS₂-PANI2 aerogel (3.95 mA) at 2 V bias compared to that of DBC-PANI2 is mainly attributed to the electronic coupling between MoS₂ QDs and PANI nanofibers. The interaction between the PANI and MoS₂ QDs produces a synergistic effect resulting in decent energy storage performance. The hybrid DMP gel exhibits a high specific capacitance value 791 F/g at 1.0 A/g in a three-electrode system. For practical applications an all-solid-state flexible supercapacitor device is fabricated. The supercapacitor exhibits a specific capacitance value of 331 F/g at 1 A/g for hybrid DMP xerogel, an energy density 29.4 Wh/kg, and a power density 398 W kg⁻¹. The DMP xerogel demonstrates 84.2% capacitance retention after 10 000 galvanostatic, charge-discharge cycles. Four charged solid-statesupercapacitors connected in series forming a tandem SC which can power red yellow, and white colored light emitting diode bulbs for long time, representing its capability as a good storage device.⁴

KEY WORDS: Dye-sensitized solar cells, specific capacitances, supercapacitor

References

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