Storage of Solar energy by Heterostructured Carbon/ Silver-Metal oxides/ Tin Sulphide Photocapacitors

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ABSTRACT

Over the past few decades, there has been increasing interest in the design and construction of energy conversion and storage systems that can simultaneously convert and store various forms of energies from nature. A large number of energy conversion and storage systems have been developed with different energy conversion technologies such as solar cells, mechanical and thermoelectric generators and energy storage devices such as rechargeable batteries and supercapacitors. In this project, we have developed a photocapacitive device based on the heterostructured carbon based Silver-Metal oxide/SnS working electrode system which allows direct conversion and storage of solar energy. Silver-Metal oxide provides the photoactive core of the device, while SnO_x nanoparticles (formed by the controlled oxidation of SnS nanoparticles) deliver a capacitive platform by redox reaction. The synergistic coupling of these two systems leads to high capacitance under solar illumination, which can be subsequently utilized based on our requirements. Initially, the Silver-Metal oxides (Ag_2MoO_4 and Ag_2CrO_4) and SnS materials were synthesized and characterized by XRD, EDX, SEM, Raman, FTIR and diffuse reflectance spectroscopies. Then, photoelectrochemical studies were performed on the fabricated working electrode systems of Carbon sheet/Ag_2MoO_4/SnS, Activated Carbon (AC)/Ag_2MoO_4/SnS and AC/Ag_2CrO_4/SnS. The plausible mechanisms for charging and discharging of such a system are also discussed in this research work. These integrated heterostructured photocapacitor devices exhibited excellent behaviours in terms of solar light harvesting and specific photocapacitance compared to other studies reported in the literature. The specific photocapacitances of 340 F/g, 20 mF/g and 4782 mF/g were observed for Carbon sheet/Ag_2MoO_4/SnS, AC/Ag_2MoO_4/SnS and AC/Ag_2CrO_4/SnS devices respectively and their performance could be attributed to availability of numerous channels for charge transport, decreased path length for charge transfer, porous structure of carbon and good conductivity of carbon and Silver-Metal oxide. Hence, these photocapacitors are found to be one of the most promising research avenues in the development of novel solar energy conversion and storage strategies.

Keywords: Silver-Metal oxide; Photocapacitors; Solar energy; Specific photocapacitance; Activated carbon; Heterostructure; Tin sulphide