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Performance of dye sensitized solar cells (DSSCs) based on Cu-doped TiO_2 nanostructures photoanodes

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In this research study, Cu-doped TiO_2 nanostructures with different doping contents from 0 to 10.0% (mole fraction) were synthesized through hydrolysis at low temperature. The prepared Cu doped TiO_2 nanostructures was characterized with several techniques, X-ray diffraction (XRD) and Raman spectroscopy were used to study the morphology and structure of the nanoparticles, which confirmed the crystalline anatase tetragonal structure. The UV-Visible Spectroscopy Analysis was found that incorporation of Cu^{2+} into titanium affects the band gap of TiO_2 and extending his activity towards visible sunlight region. Scanning Electron Microscopic (SEM) analysis confirming the Cu content is incorporated into TiO_2 lattice affecting efficiency of doped samples. Further, the active specific surface area of the system was investigated employing Brunauer-Emmett-Teller (BET) measurement. Then the dye-sensitized solar cells (DSSCs) based on Cu-doped TiO_2 photoanodes were fabricated and investigated with chemically absorbed Ruthenium N3 dye electrode under light illumination with standard solar simulator (AM 1.5G, 100 mW/cm^2). Results demonstrated that the 1.0% Cu-doped TiO_2 sample annealed at 773 K for 60 minutes exhibited the best photovoltaic performance of open circuit voltage (Voc = 957.5 mV), short circuit current density (Jsc = 0.795 $mAcm^{-2}$), and the cell efficiency was reached (η = 4.524 %), which consists 50% higher than the un-doped cell. The BET analysis was supported the founding results, indicating that the 1.0% Cu-doped TiO_2 nanoparticle presented the higher active specific surface area of 143.2 m^2g^{-1}. A highest active surface area is a key parameter for solar cells effectiveness, allowing more organic dye and electrolyte to be absorbed and stored into the semiconductor that give photon from solar light energy more probability to be adsorbed which obviously led to improve global cell efficiency. This study may open up more investigated works applying Cu doped TiO_2 in photovoltaic fields.

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