Photocurrents in crystal-amorphous hybrid stannous oxide/alumina binary nanofibers

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ABSTRACT

Suppression of charge recombination by thin amorphous alumina layers on metal oxide semiconductors has demonstrated a vital role in electronic appliances beside its role as an insulator. This study reports effect of amorphous alumina (Al2O3) on the structural, electrical, and optical properties of stannous oxide (SnO2). The samples for the present study are prepared as nanofibers by electrospinning a polymeric solution containing aluminum and stannous precursors and subsequent annealing; six samples with varying concentrations of aluminum and stannous are considered. A crystal-amorphous SnO2/Al2O3 hybrid system was confirmed by both XRD and XPS analysis. Both BET and Mott-Schottky analysis showed increase in the surface area and conduction band minimum of the sample with increase in the Al content, however, at the expense of its electrical conductivity. The electron lifetime of the sample increased with increase in the Al content, but the electron transport time increase with decrease in the electrical conductivity of the sample. Both Urbach energy measurement and Stoke's shift showed generation of deeper trap state with increase in the Al content. Investigation on sample photovoltaic performance showed that the loss in electrical conductivity of the sample can be compensated by the improved surface area to a certain extent. Interestingly, a composite nanofiber containing equal molar fraction of aluminum and stannous showed orders of magnitude higher photocurrent despite its similar resistivity as that of pure alumina fibers, which is shown to originate from a Fermi energy gradient at the Al2O3/SnO2 interface.

KEYWORDS: Al-doped SnO2, band bending, composite nanofibers, crystal-amorphous composite, SnO2/Al2O3composite

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