Abstract No: PO-24

Development of tin oxide/copper(I) oxide heterojunction solar cell

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The rapid expansion of the global population together with industrialization intensifies our diurnal energy need. Addressing the present energy demand is a challenging task. Solar energy stands as a pivotal solution to the global energy crisis, offering a sustainable and renewable energy source to meet the escalating demand for electricity. Photovoltaic energy emerges as a favorable substitute due to its widespread availability, free accessibility, eco-friendly nature, and reduced operational and maintenance expenses. However, the markedly available photovoltaics are unaffordable to the public due to their expensiveness. Accordingly, this study focuses on the development of a low-cost eco-friendly tin oxide (SnO_2)-based heterojunction solar cell, aiming to enhance photovoltaic performance through systematic fabrication and optimization processes. The Cu/n-SnO_2/p-Cu_2O/Au heterojunction solar cell was fabricated using the method of electrodeposition. Tin (IV) Oxide (SnO_2) was employed as the n-type material and Copper(I) Oxide (Cu_2O) as the p-type material. The fabrication process involved the electrodeposition of n-type SnO_2 thin film on copper (Cu) substrates, followed by subsequent deposition of p-type copper(I) oxide (Cu_2O) thin film. For making front contacts to the heterojunction, thin Au spots (area $\sim 2 \times 2$ mm^2) were sputtered onto the p-Cu_2O thin film of the bi-layer. The back contact of the solar cell was the Cu substrate. The photoresponses of the Cu/n-SnO_2/p-Cu_2O/Au solar cell structure were monitored by optimizing the bath temperature of the SnO_2 film deposition bath. Electrodeposition of SnO_2 layers was performed on copper substrates in a three-electrode electrochemical cell using a solution containing 30 mM $SnCl_2$ and 150 mM HNO_3 and electrodeposition was conducted at -0.85 V vs. Ag/AgCl for 2 min at temperature values of 70 ˚C, 75 ˚C, 80 ˚C, 85 ˚C, and 90 ˚C. To fabricate the device a p-Cu_2O thin film was electrodeposited on Cu/n-SnO_2 film at -0.45 V vs. Ag/AgCl for 40 min in a three-electrode electrochemical cell containing 0.1 M $CuSO_4$, 3 M $C_3H_6O_3$, and NaOH aqueous solution. The temperature and pH of the bath were maintained at 60 °C and 13 respectively. The results of photoresponse measurements together with current-voltage measurements were used to optimize the solar cell. The highest photoresponses resulted for the SnO_2 thin films deposited at a bath temperature value of 85 ◦C. This research contributes to the advancement of tin oxide-based heterojunction solar cell technology and offers insights for future optimization and development efforts in renewable energy generation.

Keywords: Cu_2O, Electrodeposition, Heterojunction, Photovoltaic, SnO_2

Acknowledgment
This work was supported by the Internal Research Grant, University of Kelaniya under the research grant no: RP/03/02/05/01/2022