

ABSTRACT

This study focuses on the fabrication and optimization of heterojunction photovoltaic cells using PbS (p-type) and indium-doped ZnS (n-type) thin films deposited on glass substrates. ZnS:In was deposited via chemical bath deposition (CBD) in alkaline conditions at 82°C, while PbS was applied using spray pyrolysis at 375°C. The electrical resistivity was measured using the four-point probe method, and optical properties such as absorbance, transmittance, refractive index, and band gap were obtained using a UV-VIS-NIR spectrophotometer. Results analyzed with Scout Software revealed how deposition conditions influence the optoelectronic behavior of the films. The inclusion of indium in ZnS significantly reduced recombination currents at the junction, enhancing overall photovoltaic cell performance. The deposited ZnS:In films had its band gap varying from 2.99eV to 3.62eV with indium concentration from 0.00 to 0.06M. The band gap widened as the concentration of indium increased up to 0.06M where it recorded the highest with an optimum transmittance of 77% in the visible region. The deposited ZnS:In samples recorded very low extinction coefficients showing that very little radiation was absorbed forming a good window layer material. The electrical resistivity values increased as Indium concentration increased. The resistivity range of 1.54×10^4 to $64 \Omega\text{-cm}$ was obtained as recorded by the four-point probe. The Keithley 2400 source meter and the Four-point probe were combined. These photovoltaic cell applications require such properties to form the suitable window layers. The p-type (PbS) thin films had a transmittance of below 52 % and recorded a band gap of 1.68 eV which was fitting for formation of photovoltaic cell's absorber layers. A range of $12.29 \times 10^3 \Omega\text{-cm}$ to $8.18 \times 10^3 \Omega\text{-cm}$ of resistivity was obtained at a concentration of between 0.3M to 0.6M. The properties of the fabricated photovoltaic cell obtained were as follows; $V_{oc} = 0.37\text{V}$ (Open Voltage), $I_{sc} = 0.032 \text{ A}$ as (short circuit current), $FF=0.67$ the Fill Factor and $\eta = 1.31\%$ as the cell's efficiency. This suggests that the two materials under investigation formed a good pair suitable for photovoltaic applications in the visible up to Infra-red regions of the spectrum.