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Photovoltaic Performance and Impedance Spectroscopy Analysis of $CuInS_2$ Thin Film Solar Cells Deposited on Polyimide Foil via Spray Pyrolysis

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In this study, we have demonstrated that facile, cost-effective and non-vacuum spray pyrolysis technique which is available for fabricating copper indium sulfide ($CuInS_2$) based flexible thin film solar cells for the first time in the literature. First, we have optimized the molybdenum thin films on polyimide foil to obtain proper back contacts via corona surface treatment. The sheet resistivity of the non-treated molybdenum contacts is about 3.7 Ω/□. On the other hand, the sheet resistivity has decreased to 0.8 Ω/□ after corona treatment. The change in the electrical resistivity values of the molybdenum films on polyimide foil has become more effective after post annealing once the samples have been annealed at 300 °C under atmospheric conditions. Therefore, the sheet resistivity of the films after annealing are 2.1 and 258 Ω/□ for corona treated and non-treated samples, respectively. After back contact optimization copper indium sulfide-indium sulfide heterojunctions has been spray pyrolyzed and a novel device structure of polyimide/Mo/CIS/Ag-In_2S_3/ZnO/AZO/Ag/AZO/Ni/Al has been fabricated. Impedance spectroscopy of the solar cell studies revealed that the post annealing of the absorber layer has a pronounced effect on series resistance, parallel resistance, and constant capacitance although it does not cause a significant change in the electron life time. The conversion efficiency of the 1.43% (J_{sc}=10.0 mA/cm^2, V_{oc}=0.52 V, FF=0.37) has been obtained in this work which proved that the facile spray pyrolysis technique is highly beneficial to fabricate flexible solar cells on polyimide substrates. Besides very low chemical precursor consumption, low equipment cost of spray technology and the device structure proposed in this work are some of the key factors while developing the large area flexible solar cells with short energy-payback time.

Keywords: Spray pyrolysis; copper indium sulfide; polyimide; molybdenum; flexible thin film solar cells.

FULL TEXT