SEMI-TRANSPARENT Sb_2S_3 SOLAR CELLS WITH FLUORENE-BASED ENAMINE AS HOLE TRANSPORT MATERIAL

Nimish Juneja[1], Sarune Daskeviciute-Geguziene[2], Ilona Oja Acik[1], Nicolae Spalatu[1], Malle Krunks[1].

[1]*Laboratory for Thin Film Energy Materials, Tallinn University of Technology, 19086, Estonia*
[2]*Department of Organic Chemistry, Kaunas University of Technology, 50254 Kaunas, Lithuania*
e-mail of presenting author: nimish.juneja@taltech.ee

Antimony sulphide (Sb_2S_3) is a promising absorber material for semi-transparent solar cells owing to its suitable optoelectronic properties like a high absorption coefficient of ($\approx 10^5$ cm^{-1} at 450 nm) and relatively wide bandgap of 1.7 – 1.8 eV [1]. Commonly used HTMs such as P3HT and Spiro-oMETAD are expensive [2], P3HT suffer from parasitic absorption in visible light. Here, we present three fluorene-based enamine compounds - V1275, V1235 and V1461 as alternative HTMs to conventionally used ones like P3HT. These novel HTMs are being investigated for the first time in Sb_2S_3 solar cells. The V- series HTMs are significantly cheaper, optically transparent, and do not require additional thermal activation like P3HT. Solar cells are fabricated in glass/FTO/TiO_2/Sb_2S_3/HTM/Au configuration, where TiO_2 and Sb_2S_3 are deposited using ultrasonic spray pyrolysis, the HTMs are deposited using spin coating and the Au contacts are thermally evaporated. The impact of the HTM solution's concentration on the performance of Sb_2S_3 solar cells is studied. The morphological and opto-electronic properties of the fabricated solar cells are studied using SEM, UV-vis spectroscopy, current-voltage (JV) and External Quantum Efficiency (EQE) measurements. Band energy diagram of solar cells is constructed and analysed for a better understanding of the device operation. Novel V-series HTMs demonstrated the band offsets validating their applicability in Sb_2S_3 solar cells. The solar cell with novel HTMs outperform the efficiencies of the cells with P3HT. For example, V1235 yielded a conversion efficiency of 4.3% while the cells with P3HT yielded 3.7%. Furthermore, as compared to P3HT devices, the transparency of the solar cell stack with novel HTMs is enhanced by over 20%. The study demonstrates the successful fabrication of semi-transparent Sb_2S_3 solar cells with novel cost-effective fluorene-based HTMs.

References

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