LASER-ANNEALING FOR ANTIMONY SELENIDE (SB_2SE_3) DEFECT PASSIVATION AND IMPROVEMENT OF SB_2SE_3 THIN-FILM SOLAR CELL PARAMETERS

Rokas Kondrotas[1], Miglė Lenkauskaitė[1], Gustas Mickevičius[1], Marius Franckevičius[1], Vidas Pakštas[1]

[1]Center for Physical Sciences and Technology (FTMC)
migle.lenkauskaite@ff.stud.vu.lt

Antimony selenide (Sb_2Se_3) is a promising absorber material for photovoltaic application that has been widely researched for the past ten years. However, the main parameters of Sb_2Se_3 thin-film solar cells (such as efficiency, open-circuit voltage, short-circuit current and fill factor) still remain limited due to the presence of complex defects in the material [1]. In this study, we present an approach for minimizing defects at the interface of Sb_2Se_3 using laser-annealing strategy. The latter allowing the energy induced upon exposure to be precisely localized in time and space enables changes in crystallinity of the material [2]. During our experiments Sb_2Se_3 was deposited on FTO-coated glass substrates using the vapor transport deposition method. Sb_2Se_3 solar cell had Au contacts deposited on areas annealed with a laser as pictured in Figure 1.

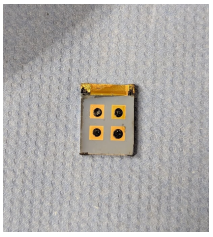

Fig. 1. Sb_2Se_3 solar cell with Au contacts.

We show that laser annealing done with a 532 nm pulsed laser with varying values in power density slightly improved the main parameters characterising the performance of Sb_2Se_3 thin-film solar cells. Open-circuit voltage reached 310 mV compared to 300 mV in a reference cell. The efficiency value increased from 3,06 % to 3,37 %.

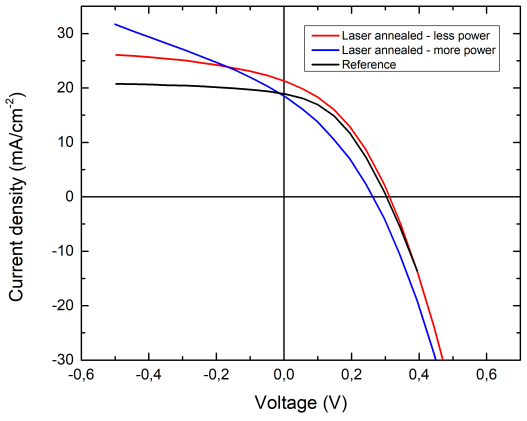

Fig. 2. Current-voltage (J-V) curves measured for a reference cell (black line), for a laser-annealed area with the most improved (red line) and decreased (blue line) parameters.

These results are considered to be related to an improved quality of the pn junction of the cell. Observed enhancement indicates the possibility that further experiments using different wavelength pulsed lasers could provide us with a better insight into correlation between the choice of a laser for the annealing process and the parameters of Sb_2Se_3 thin-film solar cells. In conclusion, this laser-annealing strategy has the potential for passivating various defects in the material and enhancing the performance of Sb_2Se_3 thin-film solar cells.

[1] C. Chen, K. Li, J. Tang, Ten Years of Sb2Se3 Thin-Film Solar Cells, Solar RRL, 2022.
[2] R. Nielsen, T. Hemmingsen, T. Bonczyk, et al., Laser Annealing and Solid-Phase Epitaxy of Selenium Thin-Film Solar Cells, ACS Applied Energy Materials, 2023.