Study of thermal and post- deposition treatments in $Sb_2(S, Se)_3$ thin film grown by hydrothermal processes

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Thin film technology has stood out by trying to overcome limitations related to Si technology, including the high energy payback times, low industrial production rates, and significant initial investment values associated with production facilities. It provides advantages such as monolithic integration, lower energy processes, and reduced material requirements. The antimony chalcogenides $Sb_2(S_{1-x}, Se_x)_3$ exhibit high absorption coefficients, a tunable bandgap, and long-term stability. In addition, the advantages of their optoelectronic characteristics make them an emerging technology in PV applications.

The aim of this study is to optimize the fabrication process of $Sb_2(S, Se)_3$ absorber layers using hydrothermal techniques for use in thin-film photovoltaic solar cells [2]. We examined how the duration of the hydrothermal deposition process of the precursors (Figure 1) and the duration of the annealing process affects the fundamental properties of the samples. Several properties were analyzed in order to gain a comprehensive understanding of the transformations observed, including the chemical composition, the morphology, and the optical properties of the layers. Characterization techniques such as scanning electron microscopy (SEM), energy-dispersive spectroscopy (EDS), X-ray diffraction (XRD), and spectrophotometry were used.

Based on the results, it can be suggested that the Sb/Se percentage ratio is altered throughout the entire fabrication process, which can be considered, together with no less than 3 hours of hydrothermal cycle time, key factors in obtaining uniform layers of $Sb_2(S, Se)_3$.

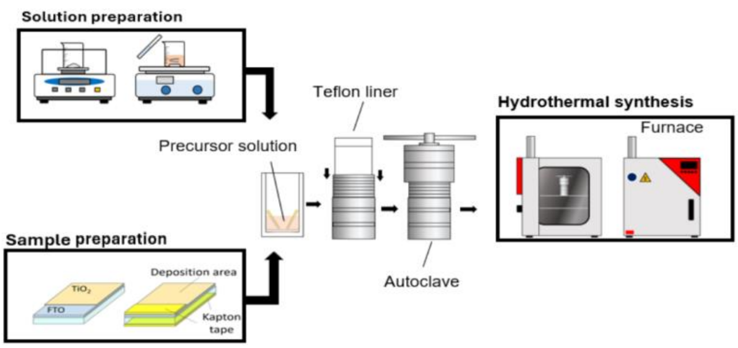

Figure 1: Process flow of the hydrothermal synthesis for the preparation of $Sb_2(S, Se)_3$ thin films.

[1] Mavlonov et al. (2020) "A review of Sb_2Se_3 photovoltaic absorber materials and thin-film solar cells." In Solar Energy (Vol. 201, pp. 227–246).
[2] Liu, D. et al. (2021) "Direct Hydrothermal Deposition of Antimony Triselenide Films for Efficient Planar Heterojunction Solar Cells." ACS Applied Materials and Interfaces, 13(16), 18856–18864.

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