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Reactive magnetron co-sputtering deposition of ZnSnN2 thin films for photovoltaic applications

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Solar cells will become one of the most important energy sources in the future. Searching for a new material for the photovoltaic is part of this challenge. Zinc tin nitride ($ZnSnN_2$) is a new semiconductor material with earth abundant elements and a low-cost production. Due to its direct bandgap, tuneable from 1.0 to 2.1 eV, $ZnSnN_2$ is a good candidate for multijunction photovoltaic cells.
This work presents the development of $ZnSnN_2$ thin films by reactive co-sputtering using zinc and tin metallic targets. The films were deposited at room temperature on glass and silicon substrates. The stoichiometry of the films was controlled by optimizing operating parameters such as the target voltage, the nitrogen partial pressure or the total pressure. The structure of the films was studied by X-ray diffraction. The as-deposited $ZnSnN_2$ thin films crystallise in an orthorhombic structure and the effect of the annealing temperature on the film properties has been studied. No structural change has been evidenced after annealing treatment in nitrogen at temperature as high as 400 °C. Transmission electron microscopy analyses reveal that the films are nanocrystallised. More detailed information about the chemical environment of tin atoms has been obtained using advanced characterization techniques such as Mössbauer spectroscopy. No contribution of metallic tin has been evidenced. Vibration modes were studied with Raman spectrometry and Fourier transform infrared spectroscopy. The optical band gap has been deduced from UV-Visible spectroscopy measurements. Finally, the electrical resistivity at room temperature (approx. $8.3x10^3$ μΩ.cm) has been measured using the four point probe method.

Keywords
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