Tin sulfide (SnS) is an IV-VI binary semiconductor compound that exists abundantly in nature and has low toxicity. SnS in orthorhombic crystalline structure has direct and indirect bandgaps between 1.3-1.5 eV and 1.0-1.1 eV with p-type conductivity, respectively. Its higher absorption coefficient (~10^5 cm⁻¹, such as GaAs and CdTe) make it an excellent alternative absorber in thin-film solar cell (TFS) applications.

In this study, SnS thin films are grown onto FTO-coated glass substrates using RF-magnetron sputtering at a substrate temperature of 100 °C. As-deposited SnS thin films are then annealed in O₂/Ar gas mixture and pure-Ar atmosphere with different range of temperature from 200 °C to 400 °C for 1 h. The annealing is carried out using a sputtering chamber at a pressure of 10⁻² Torr. It is found that annealing the layers in O₂/Ar at 300 °C changes the stoichiometry of the as-deposited SnS thin films and leads to the formation of a dominant SnS₂ phase. Annealing in a pure-argon atmosphere, however, causes no deviations in the composition of the SnS thin films. The crystalline structure, surface morphology, and optical band gap of the as-deposited SnS thin films are enhanced significantly as the result of annealing in Ar atmosphere, and the thin films are found to exhibit promising properties for fabrication complete solar cells based on low-toxic and earth-abundant SnS absorber layers.

Figure 1: Surface morphology of SnS thin films: (a) O₂/Ar-annealed at 300 °C, and (b) Ar-annealed at 300 °C.