Crystalline Antimony Selenide Thin Films for Optoelectronics through Photonic Curing

Thermal annealing is the most used postdeposition technique for antimony selenide (Sb_2Se_3) thin films in laboratory research. However, due to slow processing speeds and a high energy cost, it is incompatible with the upscaling and commercialisation of Sb_2Se_3 for future photovoltaics. We have recently adapted a fast-annealing technique that uses millisecond light pulses to deliver energy to the sample, curing thermally evaporated Sb_2Se_3 films. This study demonstrates how photonic curing conditions affect the outcome of Sb_2Se_3 conversion from amorphous to crystalline by evaluating the films' crystalline, morphological, and optical properties. We show that Sb_2Se_3 is readily converted under a variety of different conditions, but the zone where suitable films for optoelectronic applications are obtained is a small region of the possible parameter space. Sb_2Se_3 annealing with short pulses damage the sample significantly, while using longer pulses produces (211) and (221) oriented crystalline Sb_2Se_3 with minimal to no damage to the sample. Photonic curing is a promising annealing method for large-area, high-throughput annealing of Sb_2Se_3 with various potential applications in Sb_2Se_3 photovoltaics.