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Optical properties of pulsed laser-deposited Cu_2SnS_3 films for photovoltaics

Andrea Crovetto[(1)], Rebecca B. Ettlinger[(2)], Jørgen Schou[(2)] and Ole Hansen[(1,3)]

[(1)] DTU Nanotech, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark

[(2)] DTU Fotonik, Technical University of Denmark, DK-4000 Roskilde, Denmark

[(3)] CINF, Center for Individual Nanoparticle Functionality, Technical University of Denmark, DK-2800 Kgs. Lyngby, Denmark

The ternary chalcogenide compound Cu_2SnS_3 (CTS) is of interest for thin film photovoltaic applications. The tetragonal phase of CTS typically exhibits a direct band gap of around 1.35 eV and a high absorption coefficient. Hence it can be potentially employed as a photovoltaic absorber using the same device structure as in $Cu(In,Ga)Se_2$ solar cells. On the other hand, the cubic phase of CTS has a typical bandgap of 0.9 eV and good lattice matching to Cu_2ZnSnS_4 (CZTS). Therefore it may find an application as a top absorber in a CTS/CZTS tandem cell.

In this work, CTS films are grown by pulsed laser deposition (PLD) on fused silica glass and Mo-coated soda lime glass substrates. Cubic and tetragonal phases are obtained by changing deposition parameters (temperature and laser fluence) and post-annealing conditions (annealing temperature and time). Dielectric functions and other optical properties of the resulting CTS films are extracted by spectroscopic ellipsometry. The differences in band gap, absorption coefficient and critical points in the dielectric functions are related to structural, compositional and morphological differences in the CTS films. The validity of the optical models used to derive dielectric functions from ellipsometry is discussed in relation to results from direct measurement methods such as optical transmission, Scanning Electron Microscopy (SEM) stylus profiling and atomic force microscopy (AFM).