Optical Parameters of Both As_2S_3 and As_2Se_3 Thin Films from Ultraviolet to the Near-Infrared via Variable-Angle Spectroscopic Ellipsometer

© F. Abdel-Wahab [1], I.M. Ashraf [2,1], F.B.M. Ahmed [1,¶]

[1] Department of Physics, Faculty of Science, Aswan University, Aswan, Egypt
[2] Advanced Functional Materials & Optoelectronics Laboratory (AFMOL), Department of Physics, College of Science, King Khalid University, Abha 61413, Saudi Arabia

¶ E-mail: fatmaowny@sci.aswu.edu.eg

Received May 25, 2020
Revised June 22, 2020
Accepted for publication July 1, 2020

In the UV-visible–near infrared regions from 245 to 1000 nm, variable-angle spectroscopic ellipsometer (VASE) was used to investigate optical functions of As_2S_3 and As_2Se_3 thin films. In the entire measured spectral range, data were analyzed by assembly from several dispersion models. These assemblies comprise individual Tauc–Lorentz supplemented by several Lorentz (TL-group) or single Cody–Lorentz with several Lorentz (CL-group) models. For As_2S_3 and As_2Se_3 thin films, the optical parameters were quantified. The model parameters, such as the Lorentz amplitude, resonance frequency, oscillator width, extinction coefficients, refractive indices, and Urbach and optical band energy of both films were obtained. The band gap energy E_g was experimentally determined using the obtained data of CL-group from $(\alpha h\upsilon)^{1/2}$ vs $h\upsilon$ plots. It is found that the band gap energies of As_2Se_3 and As_2S_3 were 1.796 and 2.349 eV, respectively. The E_g values for the films were theoretically investigated by the bond statistics of the random covalent network model (CRNM) with the aid of Manca's relation. Plausible agreement between the experimental and calculated Eg values for both samples was obtained.

Keywords: chalcogenide thin films, variable-angle spectroscopic ellipsometer, Tauc–Lorentz model, Cody–Lorentz model.

Full text of the paper will appear in journal SEMICONDUCTORS.