

VACUUM BASED SYNTHESIS OF AgBiS₂ THIN FILMS BY MAGNETRON SPUTTERING AND SULFURIZATION

J. Dubikaltis², R. Giraitis¹, M. Frankevičius¹, A. Sekskienė¹, V. Pakštas¹

¹Center for Physical Sciences and Technology (FTMC), Vilnius, Lithuania

²Vilnius University, Faculty of Physics, Vilnius, Lithuania

dubikaltis.juozas@gmail.com

Silver bismuth sulfide (AgBiS₂) is a promising lead-free ternary chalcogenide semiconductor for optoelectronic and photovoltaic applications due to its suitable bandgap (1.0–1.1 eV), strong optical absorption, and environmentally benign composition. In this work, AgBiS₂ thin films were synthesized on fluorine-doped tin oxide (FTO)-coated glass substrates using a vacuum-based approach combining magnetron sputtering and post-deposition sulfurization. Metallic precursor layers were sequentially deposited by magnetron sputtering using two different stacking orders: Ag (40 nm) / Bi (80 nm) and Bi (80 nm) / Ag (40 nm), followed by sulfurization in sulfur vapor at temperatures of 250, 350, and 450 °C for approximately 30 min. The structural properties and phase composition of the films were investigated by X-ray diffraction (XRD), while the surface and cross-sectional morphologies were examined using scanning electron microscopy (SEM). The results show that both sulfurization temperature and metal stacking order strongly influence AgBiS₂ formation and film quality. Films prepared using the Ag/Bi configuration exhibit more efficient sulfur incorporation, improved Ag–Bi interdiffusion, and a significantly more compact and uniform morphology compared to the inverse Bi/Ag configuration. Increasing the sulfurization temperature promotes the transformation of intermediate binary sulfides into the ternary AgBiS₂ phase, with optimal film quality obtained at intermediate sulfurization temperatures. The demonstrated synthesis route provides good control over film structure and highlights the importance of precursor design for scalable vacuum-based fabrication of AgBiS₂ thin films for sustainable optoelectronic and photovoltaic applications.

Acknowledgements

This research was supported by the Research Council of Lithuania (LMTLT) through Grant No. S-MIP-25-76.

Keywords: Green optoelectronic materials, Thin films, Magnetron sputtering