

Electrochemical route to Bi-Bi₂Te₃ superlattice

A. Bakavets¹, Y. Aniskevich^{1,2}, G. Ragoisha¹, N. Tsyntsar^{3,4},
H.Cesiulis^{3,5}, E. Streltsov²

¹Research Institute for Physical Chemical Problems, Belarusian State University,
Minsk, Belarus,

²Faculty of Chemistry, Belarusian State University, Minsk, Belarus,

³Vilnius University, Faculty of Chemistry and Geosciences, Vilnius, Lithuania,

⁴Institute of Applied Physics, Chisinau, Moldova

⁵JSC Elektronikos Perdirbimo Technologijos, Vilnius, Lithuania,

e-mail: alexeibokovets@gmail.com

Synthesis of Bi-Bi₂Te₃ superlattice is a promising way to break the trade-off between thermal and electrical conductivities, which limits the thermoelectric efficiency of individual bismuth telluride [1,2]. We present the electrochemical route for fabrication of such superlattice, which is based on concurrent electrochemical deposition of bismuth telluride and bismuth adlayers [1,3]. The process was controlled by periodical switching of the electrode potential between the regions of a predominant electrodeposition of bismuth telluride below $E_{\text{Bi}^{3+}/\text{Bi}}$ equilibrium potential and a predominant Bi adlayer electrodeposition above $E_{\text{Bi}^{3+}/\text{Bi}}$. The superlattice is formed via the stacking of the elementary building blocks of the layered Bi₂Te₃ crystal structure: Te-Bi-Te-Bi-Te quintuples with Bi adlayers on the both sides of the quintuples, so that each pair of Bi adlayers gives a biatomic interlayer in the resulting (Bi₂)_m(Bi₂Te₃)_n superlattice structure. The obtained films were examined by SEM in order to optimize electrodeposition conditions for the preparation of compact uniform (Bi₂)_m(Bi₂Te₃)_n films. Cyclic voltammetry coupled with quartz crystal microbalance techniques allowed to monitor Bi adlayer and bilayer transformations during the electrodeposition and anodic decomposition of the superlattice. Bismuth bilayers in a superlattice are electrochemically labile and can be removed via selective anodic oxidation, preserving the expanded superlattice structure that was proved by refinement of XRD data.

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References

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