Effect of concentration of electrolyte on thermoelectric properties of electrodeposited Bi_2Te_3 thin films

Published: 05 July 2024

Volume 35, article number 1344, (2024) Cite this article

Journal of Materials Science: Materials in Electronics

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Selected Papers from Third International Conference on Advanced Materials Synthesis, Characterization, and Applications (AMSCA 2023)

Abstract

The current thread of study focuses on tuning the properties of nanostructured Bi_2Te_3 films for thermoelectric applications, by optimizing electrodeposition conditions, such as the deposition potential, pH of the electrolyte, temperature, and concentration of the precursors in the solvent. In this paper, small coagulated masses of Bi_2Te_3 dendritic nanostructures were electrodeposited on a stainless-steel substrate for six different concentrations of Bi^{3+} ions in the electrolyte (varied from 2.5 to 15 mM) at previously optimized deposition potential and pH conditions. Systematic testing of electrodeposited films has been carried out to analyze the effect of variation of Bi^{3+} ions. Cyclic voltammetry studies revealed irreversible electrodeposition of Bi_2Te_3 films. A series of scanning electron micrographs revealed the evolution of small coagulated masses of dendritic nanostructures. Thermoelectric properties such as a Seebeck coefficient up to −45.81 μV/K and power factor up to 311 μW/cmK^2 have been achieved for the deposited films. The results reveal significant variation in the thermoelectric properties as a function of the concentration of Bi^{3+} in the electrolyte through changes in the surface morphology and stoichiometry of the films. The analysis also revealed ideal concentrations of precursor ions to obtain Bi_2Te_3 as the dominant phase.