Nanostructured bismuth telluride electrochemically grown inside flexible templates

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In this work, we present different nano-structures of bismuth telluride based on scalable and low cost fabrication techniques. The objective is to improve the thermoelectric performance of this material grown by electrochemical deposition, and then use these nanostructures to develop efficient flexible thermoelectric generators (TEGs) which will allow the conversion of wasted heat around room temperature into usable electrical energy.

The main advantage of nanostructures over thin films or bulk is that they should increase the thermoelectric performance of the bismuth telluride (which is the most used thermoelectric material for room temperature appilcations) by lowering its thermal conductivity. This has been already proved for 3D interconnected nanowire networks of bismuth telluride [1]. In that work, we showed that both the increasing of the surface to volume ratio and the influence of the nanostructure in the the phonon scattering phenomena are the main responsibles of the improvement, but the templates used in that case were made of non-flexible alumina. Here, we will use two different flexible commercial templates to obtain nanostructured thermoelectric materials by template-assisted electrochemical deposition of bismuth telluride: polyester membranes (obtaining an intrincate 3D nanostructure) and cellulose membranes (obtaining a highly porous structure). As it was previously done with the growth of bismuth telluride inside alumina templates [2], the nanostructured bismuth telluride grown inside the flexible templates will be then characterized to optimize the fabricartion parameters to obtain highly oriented, stoichiometric material in such nanostructures.

References

[1] A. Ruiz-Clavijo., O. Caballero-Calero, C. V. Manzano, X. Maeder, A. Beardo, X. Cartoixà, X. Álvarez, M. Martín-González, ACS Applied Energy Materials, 4 (2021). 13556-13566.

[2] A. Ruiz-Clavijo., O. Caballero-Calero, M. Martín-González, Nanomaterials, 8 (2018) 345