Controlled crystallization of amorphous ZnSb film for thermoelectric properties applications

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Abstract

Thermoelectric materials show great promise for applications in many fields, including direct conversion of waste heat to generate electricity and application as solid state Peltier coolers [1]. Zinc antimonide (ZnSb) binary system is one of the promising P-type thermoelectric materials [2-3]. Generally, ZnSb based films prepared at room temperature are amorphous with poor electrical performance and appropriate heat-treatment is essential to improve its performance. In this work, Zn-Sb thin film was deposited by ion beam sputtering deposition method through a multiple target which combined by periodic the Zn and Sb strips. The experimental results show that the as-deposited zinc antimonide thin film has very high resistivity with amorphous structure. It has been found that the electrical resistivity of the film shows three distinguished steps during the heating process, which can be attributed to the crystallization fraction of the amorphous thin film at different temperatures. The amorphous film has an electrical resistivity of 4750 Wm, which dramatically decreases to 2.3'10-4 Wm at 500 K thanks to generation of ZnSb crystals. Although the amorphous film has a larger Seebeck coefficient value of 1500 mVK-1, which decreases to 250 mVK-1 after heating to 500 K, the power factor of the amorphous film is very low and it is greatly enhanced to 0.3 mWm-1K-2 after crystallization.

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