Pulsed Laser Deposition and Nanostructuring of Thermoelectric BiSbTe Thin Films

Oded Rabin[a] and Jane Cornett[b]

[a] *Department of Materials Science and Engineering and Institute of Research in Electronics and Applied Physics, University of Maryland – College Park, USA, oded@umd.edu,* [b] *Department of Materials Science and Engineering, University of Maryland – College Park, USA.*

$Bi_{(2-x)}Sb_xTe_3$ (p-type) is the leading material for room temperature thermoelectric applications, with a *ZT* value ~1. We report on the fabrication of $Bi_{(2-x)}Sb_xTe_3$ thin films via pulsed laser deposition using a $Bi_{0.5}Sb_{1.5}Te_3$ target. The effect of deposition parameters and annealing conditions on the microstructure, composition and thermoelectric properties of the films is investigated. A strong dependence of film characteristics on background gas pressure and chemistry during deposition and annealing, respectively, was found. The Sb content of the films increases with deposition pressure. Low pressure (1-2 mTorr) depositions yield highly conducting and amorphous films deficient in Te. Annealing under controlled gas chemistry results in the correct stoichiometry of 2:3 (Bi+Sb):Te and thermoelectric power factors. Intermediate pressure (90-180 mTorr) depositions yield crystalline p-type semiconducting films. However, these are found to be compositionally non-uniform.

Nanostructures can be used to reduce the thermal conductivity of thermoelectric materials and increase their *ZT* values. A number of approaches to generate nanostructured thin films of p-type $Bi_{(2-x)}Sb_xTe_3$ will be presented. A comparison of the thermoelectric properties of nanostructured and homogeneous $Bi_{(2-x)}Sb_xTe_3$ films will be shown. The effectiveness of thin film nanostructuring as a means for increasing confinement and improving the thermoelectric power factor will be discussed.