

## **Growth and Characterization of Epitaxial Metal/Semiconductor Hetero-structures for Thermionic Refrigeration**

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Metal/semiconductor multilayer structures are promising candidates for small-scale refrigeration and power-generation applications. In order to maximize the efficiency of such devices near room temperature, the semiconductor barrier material needs to have a small band gap, low thermal conductivity, and exhibit good epitaxy with respect to the metal layer. Two new metal/semiconductor hetero-junctions and multilayers, namely,  $\text{-Sn/PbTe(111)/-Sn}$  and  $\text{Bi/PbTe(111)/Bi}$ , have been investigated in this study. Both structures were grown in a molecular beam epitaxy system equipped with Low Energy Electron Diffraction and Auger Electron Spectroscopy. Epitaxial multilayers were grown successfully in both cases. Ex-situ Atomic Force Microscopy results show that the morphology of the PbTe(111) layer is especially smooth for the Bi/PbTe/Bi system; the  $\text{-Sn/PbTe/-Sn}$  system has a greater rms roughness. Furthermore, for the first time, a long-range PbTe(111)  $(3 \times 3)R30^\circ$  surface reconstruction has been observed which indicates that the semiconductor film on the metal substrate is of good epitaxial quality.

Research sponsored by the Office of Naval Research and by the Division of Materials Science, U.S. Dept. of Energy under contract No. DE-AC05-00OR22725 with UT-Battelle, LLC.

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