SCALE-UP OF $Si/Si_{0.8}Ge_{0.2}$ AND B_4C/B_9C SUPERLATTICES FOR HARVESTING OF WASTE HEAT IN DIESEL ENGINES

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ABSTRACT

Thermoelectric devices show significant promise for harvesting and recovery of waste heat from diesel engines, exhaust sys-tems, and industrial heat sources. Con-version efficiencies of bulk thermoelectric systems, however, are still too low for eco-nomical power conversion in diesel-powered vehicles and heavy vehicles.

Thermoelectric superlattice devices have demonstrated the potential for increased efficiencies and utilization of waste heat. Although reported efficiencies are well above 15 percent, fabrication costs are still too high for use in diesel engine systems. To realize this efficiency goal of ~20% and power generation in the kW-MW range, large quantities of superlattice materials are required. Additionally, if the figure of merit (ZT) of these superlattices can be increased to > 2, even less superlattice material will be required to generate electric power from heat in diesel engines.

We report on development of and recent progress in scale-up of $Si/Si_{0.8}Ge_{0.2}$ and B_4C/B_9C superlattices for thermoelectric ap-plications, and particularly for fabrication of large quantities of these materials. We have scaled up the magnetron sputtering process to produce large quantities of $Si/Si_{0.8}Ge_{0.2}$ and B_4C/B_9C superlattices with high ZT at low cost. Superlattices with up to 1,000 layers were deposited onto substrate areas as large as 0.5 m^2 by magnetron sputtering.

Initial studies showed that the power factor of these superlattices was high enough to produce a ZT significantly greater than 1. Both p- and n-type superlattices were fab-ricated to form a complete thermoelectric power-generating device.

ZT measurements will be reported, and based on measured power factor of these materials, should be significantly greater than 1. These results are encouraging for the use of superlattice materials in thermo-electric power generation.