Thermoelectric Properties of Nanostructured TiO_2/SnO_2 Composites

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Nanotechnology has provided a new interest in thermoelectric technology. Reduction in lattice thermal conduction by nanostructures has led to significant improvements in conversion efficiency. A simple thermodynamically driven process is one approach in synthesizing stable high temperature nanostructures in bulk materials. The TiO_2/SnO_2 system exhibits a large spinodal region ranging from 15 to 85 mole % TiO_2. The phase separated microstructures are stable up to 1400 ^oC. In-situ nanostructure formation and semiconducting behavior in TiO_2/SnO_2 system has potential for thermoelectric applications.

Sintered TiO_2/SnO_2 nanocomposites exhibit n-type semiconducting behavior. Doping with Ta^{+5} or Nb^{+5} was used to control the electrical properties of TiO_2 rich composition of 75 mole %. Higher electrical conductivity was achieved by +5 cation doping, achieving 700-900 S/m. Seebeck coefficient is dependent upon the dopant level, it ranged from -1000 μV/K to -300 μV/K. Oxygen deficiency ($Ti_xSn_{1-x}O_{2-y}$) was investigated to further enhance electrical conductivity. A combination of Ta^{+5} doping with oxygen deficiency achieved 1200 S/m, the Seebeck coefficient was reduced -100 μV/K range. Transmission Electron Microscopy revealed formation of nano-precipitates upon annealing. The nanocomposites exhibit low thermal conductance of 2-6 W/mK, far below the thermal conductance of the parent phases. Seebeck coeffcient, thermal conductivity, electrical conductance and microstructure will be discussed in relation to composition and doping.