Enhancing thermoelectric performance of zinc phosphate glass composites by a likely tunnel percolation mechanism

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Abstract

More than 70% of the world's energy consumption is lost as waste heat during energy conversion processes. Recovering this waste heat is crucial for improving overall energy conversion efficiency. One promising solution is to use the thermoelectric effect (TE), which allows for the direct conversion of heat into electricity using thermoelectric materials. In this study, we investigate zinc phosphate glasses (ZPG) characterized by a high Seebeck coefficient (5mV.K-1) but low electrical conductivity. The aim of this investigation is to enhance the thermoelectric properties of ZPG by incorporating external guest graphitic particles. Transport parameters, including the Seebeck coefficient, thermal conductivity, and electrical conductivity of zinc phosphate glass composites, were measured as a function of graphite concentration. Subsequently, the thermoelectric figure of merit (ZT) was calculated. The results indicate that the thermoelectric properties of the ZPG/graphite composites outperform those of the pristine ZPG matrix and are significantly influenced by the volume concentration of the graphite filler. Among the ZPG/graphite composites, the one with a graphite content of 5 vol. % exhibited the best thermoelectric performance, with a power factor of PF≈0.98 $\mu W.m^{-1}.K^{-2}$ and $ZT \approx 2.6\times10^{-4}$.