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Thermoelectric characterization of nickel-nanowires and nanoparticles embedded in silica aerogels

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ABSTRACT

Embedded nickel nanowires (NiNWs) and nickel nanoparticles (NiNPs) in silica aerogels at three different concentrations are characterized by scanning thermal microscopy, a Hot disk method and four probe measurements to consider them as potential thermoelectric materials. NiNW samples exhibit 9 orders of magnitude improvement in thermoelectric figure of merit while the embedded NiNPs samples show a 6 orders of magnitude improvement when the concentrations are increased from 0 to 700 ppm. The electrical resistivity is highly sensitive to the concentration of NiNWs and NiNPs in the silica aerogels, while the thermal conductivity remains largely unchanged over temperature range 300 to 420 K. The electrical conductivity σ follows a percolation scaling law of the form $\sigma \propto (W - W_c)^t$ with critical weight fraction (W_c) to form a conductive network at range 0.04-0.06 Wt% and 0.08-0.1 Wt% for embedded NiNWs and NiNPs, respectively. The investigation suggest that further optimization of the concentration of nanomaterials in aerogels could yield promising thermoelectric properties.

Key words

Silica aerogel, Thermoelectric materials, thermal conductivity