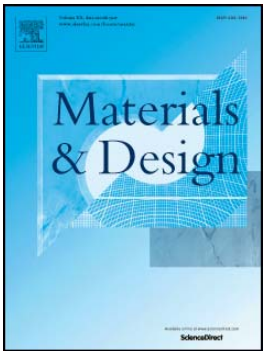

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Mechanical properties and microstructure of spark plasma sintered nanostructured p-type SiGe thermoelectric alloys

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Abstract

SiGe based thermoelectric (TE) materials have been employed for the past four decades for power generation in Radio-isotope thermoelectric generators (RTG). Recently "nanostructuring" has resulted in significantly increasing the figure-of-merit (ZT) of both n and p-type of SiGe and thus nanostructured $Si_{80}Ge_{20}$ alloys are evolving as a potential replacement for their conventional bulk counterparts in designing efficient RTGs. However, apart from ZT, their mechanical properties are equally important for the long term reliability of their TE modules. Thus, we report the mechanical properties of p-type nanostructured $Si_{80}Ge_{20}$ alloys, which were synthesized employing spark plasma sintering of mechanically alloyed nanopowders of its constituent elements with 1.2% boron doping. Nanostructured p-type $Si_{80}Ge_{20}$ alloys exhibited a hardness of ~9 ± 0.1 GPa, an elastic modulus of ~135 ± 1.9 GPa, a compressive strength of 108 ± 0.2 MPa, fracture toughness of ~1.66 ± 0.04 MPa√m with a thermal shock resistance value of 391 ± 21 Wm^{-1}. This combination of good mechanical properties coupled with higher reported ZT of nanostructured p-type $Si_{80}Ge_{20}$ alloys are render it to be a potential material for power generation applications, compared to its bulk counterpart.

Keywords: Nanostructured p-type $Si_{80}Ge_{20}$ alloy, Thermal Shock Resistance, Fracture Toughness, Spark Plasma Sintering, Compressive Strength, Hardness, Elastic Modulus.

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