Fast Direct Synthesis and Compaction of Homogenous Phase-Pure Thermoelectric Zn₄Sb₃

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Zn₄Sb₃ is among the cheapest high performance thermoelectric materials, and it is made of relatively nontoxic elements. Strong activities are aimed at developing commercial power generation modules based on Zn₄Sb₃ making it vital to develop fast reliable synthesis processes for high-quality material. Here direct synthesis and compaction of homogeneous phase-pure thermoelectric Zn₄Sb₃ by spark plasma sintering (SPS) has been developed. Compared with the traditional quench and press method, the complexity and process time of the new method is very significantly reduced (order of magnitude), making large-scale production feasible. A composition gradient is observed in the pellet along the axis of applied pressure and current. The homogeneity of the pressed pellets is studied as a function of the SPS parameters: sintering time, applied current, sintering temperature and applied pressure, and the mechanism behind the formation of the gradient is discussed. The key finding is that pure and homogeneous Zn₄Sb₃ pellets can be produced by adding an extra layer of elemental Zn foil to compensate the Zn migration.