HIGH THERMOELECTRIC PERFORMANCE OF p-BiSbTe COMPOUNDS PREPARED BY ULTRA-FAST THERMALLY INDUCED REACTION

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DOI: 10.24411/9999-0014A-2019-10169

The traditional zone melting (ZM) method for the fabrication of state of the art Bi₂Te₃-based thermoelectric materials has long been considered a time and energy intensive process. Herein, a combustion synthesis known as the thermally induced flash synthesis (TIFS) is employed to synthesize high performance p-type BiSbTe alloys within 20 min compared to tens of hours for the ZM samples. The thermodynamic parameters and phase transformation mechanism during the TIFS process were systematically studied for the first time. TIFS combined with plasma activated sintering (PAS) results in a single-phase homogeneous material with excellent repeatability, high thermoelectric performance (maximum $ZT \sim 1.2$ at 373 K) and robust mechanical properties in a very short time of less than 20 min. The technologically relevant average ZT value of TIFS-PAS fabricated Bi_{0.5}Sb_{1.5}Te₃ from 298 K to 523 K is 0.86, about a 46% improvement over the ZM sample. The compressive and bending strength of TIFS-PAS Bi_{0.5}Sb_{1.5}Te₃ are also improved by about 5 fold compared with those of the ZM samples. Thermoelectric power generation modules assembled using the TIFS-based high performance n and p type materials show the largest thermoelectric conversion efficiency of 5.2% when subjected to a temperature gradient of 250 K, representing about 42% enhancement compared with the commercial ZM-based module. Because of the simplicity and scalability of the process and short synthesis time, the TIFS-PAS technology provides a new and efficient way for large-scale, economical fabrication of Bi₂Te₃-based thermoelectrics.