Spark plasma sintering of thermoelectric materials

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Thermoelectric technology that are capable of direct interconversion between heat and electricity have drawn increasing attention both from scientific and industrial interests, so the development of high-performance thermoelectric materials has been one of the frontier fields of functional materials research. In the last decades, great progress has been made in thermoelectricity research, and material processing has made important contributions to thermoelectricity research. Spark plasma sintering (SPS) is increasingly used for processing thermoelectric materials, as a rapid sintering process with advantages of lower sintering temperature and short holding times for synthesizing fine-grained microstructures, which are usually required for developing thermoelectric materials with high dimensionless figure of merit (ZT) benefiting from a reduced thermal conductivity. Also importantly, most thermoelectric materials must be sintered in a reduced atmosphere, which can be easily realized in SPS. Bi_2Te_3 alloys as representative thermoelectric materials are conventionally fabricated by the zone-melting method, but their ZT values remain lower than unity. Substantial increase in ZT values has been achieved in the SPS-processed Bi_2Te_3-based materials. GeTe and $Mg_3(Sb,Bi)_2$ are new thermoelectric materials with high ZT at middle temperatures. It was found that increasing electrical conductivity and reducing thermal conductivity can be achieved simultaneously by suitably increasing SPS temperature, leading to a significant ZT enhancement in both materials. By focusing on three representative examples, this talk will show how SPS is effectively employed for developing high-performance thermoelectric materials.