SPS for the fabrication of thermoelectric devices from Bismuth Telluride compounds

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Sparc plasma sintering (SPS) has gained increasing interest for the preparation of thermoelectric composites of doped bismuth telluride and its alloys. This group of compound semiconductors has developed to be one of the most important thermoelectric materials found to date for devices working close to room temperature. In this paper we want to discuss the evolution of the material parameters like thermal and electrical conductivity, Seebeck coefficient and the dimensionless figure of merit (ZT) in dependence on the fabrication and doping of the base material as well as on the treatment during and after manufactoring with SPS. Finally, the influence of these parameters will be looked at with respect to the device performance.

The possibility to sinter materials almost without grain growth makes the SPS-Process a relevant technique for the compaction of nanostructured powders. The SPS-process leads to mechanically rugged material which could even be processed to wafers by standart polishing techniques. By this, we were able to produce 2 inch wafers with a thickness of only 100 µm, valuable for our development of high-performance cooling modules.

A special preparation of the sample is not necessary, because the powder is filled directly in the mould. That makes the method very valuable for production processes with high material throughput. For material produced under these conditions a ZT value of about 1 could already be obtained.

A very important application field focused by us is the energy supply to remote sensing units combined with wireless data transfer. We used this material as the basis for fabrication of modules to be integrated into thermoelectrically power supplies which employ particularly tailored dc-dc-converter topologies and which are configured to cope with extremely low input voltage sources. Hence, small sized thermo generators or small temperature differences can be taken advantage of to power electrical circuits.