Cold sintering of monolithic multilayer thermoelectric devices using chalcogenide thermoelectric materials.

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With the increased urgency in finding clean alternative energy sources, various technologies and techniques have been investigated and implemented. Generation of electricity from waste heat using thermoelectric (TE) materials has been one of the cleanest approaches. As an improvement to the π-structure of a typical thermoelectric generator (TEG), a monolithic multilayer TEG removes the need for electrode connections and interspaces between the p- and n-type semiconductor legs [1].

In this work, we fabricate monolithic multilayer TEG by co-sintering chalcogenide materials with exceptional TE properties [2-4]. The TE devices were fabricated by co-sintering several pairs of p- and n- legs, with an insulating layer partially inserted between. Various combinations of Cu_2Se, $Ag_2S_xSe_{1-x}$ and $Bi_xSb_{1-x}Te_3$ materials were used as the p-type, insulating spacer, and n-type materials.

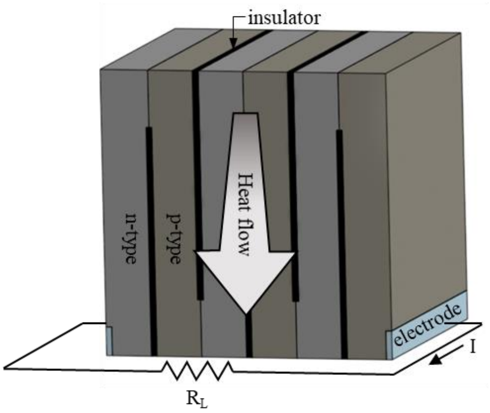

Fig. 1. Schematic illustration of the monolithic multilayer thermoelectric generator.

The TEG structure was designed and optimized using finite element method (FEM) using the COMSOL Multiphysics software. The actual devices were fabricated by assembling the different layers and co-sintering at temperatures below 373K with an applied uniaxial pressure of 100MPa. A typical device module had dimensions of 10×10×15 mm^3.

The structures of the TEG devices were characterized using SEM and EPMA, and the output properties under different temperature gradients were measured using a specially designed device measurement setup [5]. The power output shows that these devices can be used as power sources for many types of wireless sensors used in environmental and building monitoring, security and surveillance, process monitoring and other similar applications.

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