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HIGH-TEMPERATURE SEGMENTED THERMOELECTRIC OXIDE MODULE USING *p*-TYPE $Ca_3Co_4O_9$ AND *n*-TYPE ZnAlO/$CaMn_{0.95}Nb_{0.05}O_3$ Legs

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ABSTRACT

Thermoelectric (TE) power generator using TE materials which directly convert heat into electricity offers a viable environmental friendly technology for waste heat recovery. Recently, TE oxide modules have gained much attraction since they are composed of cheap materials and are stable at high temperatures up to 1200 K, where most the conventional TE materials based on alloys are often degraded over the time. In this report, oxide TE materials of p-type $Ca_3Co_4O_9$, n-types ZnAlO, and $CaMn_{0.95}Nb_{0.05}O_3$ were used to fabricate high temperature TE segmented modules. These oxide materials were prepared by solid-state reaction, followed by a spark plasma sintering technique, and their thermoelectric properties were characterized from 300 to 1200 K. The module performance was first investigated by numerical modeling using the experimental thermoelectric properties data as input parameters. In these calculations, the power generation characteristics were investigated in terms of various n-leg selections (ZnAlO, $CaMn_{0.95}Nb_{0.05}O_3$, and segmented ZnAlO/$CaMn_{0.95}Nb_{0.05}O_3$), while the p-leg $Ca_3Co_4O_9$ was fixed. Based on the model predication, several modules were fabricated, tested, and compared again with the theoretical calculations. The obtained results are discussed in details and also compared with other reported oxide modules.