Design and fabrication of stair-shaped flexible thermoelectric generator using $Ag_{1.97}V_{0.03}S_{0.55}Se_{0.45}$ free-standing film for self-powered wearable electronic applications

Toyota Tech. Inst.[1], ◦Suresh Prasanna C[1], Artoni Kevin R. Ang[1], Masaharu Matsunami[1], Tsunehiro Takeuchi[1]

E-mail: c-s-prasanna-24@toyota-ti.ac.jp

Abstract

Miniaturization of electronic devices has become one of the latest trends of modern technology. Flexible Thermoelectric Generators (f-TEGs), being thin and safe, are the promising replacements for the conventional batteries in mobile applications. Generally, there exists an inverse relation between the thickness of the thermoelectric (TE) material and the thermal gradient (∇T) experienced across it. This raises a limitation against the simultaneous achievement of large flexibility and high output power. The current work, therefore, focuses on a facile approach to fabricate a stair-shaped f-TEG using a high-performance $Ag_{1.97}V_{0.03}S_{0.55}Se_{0.45}$ based compound with superior ductility at room temperature. The ductility of the material allows us to fabricate a 0.2 mm thick flexible free-standing film via simple mechanical rolling on the sintered $Ag_{1.97}V_{0.03}S_{0.55}Se_{0.45}$. The fabricated stair-shaped f-TEG using the free-standing film have demonstrated superior flexibility, coupled with effectively high thermal gradient and high output power. As shown in fig.1 (c), the preliminary results exhibited a ∇T of ~ 4 K and output voltage ~ 0.3 mV with a single TE leg even in the absence of an efficient heat sink. These findings highlight the potential of our design strategy for advanced self-powered wearable electronic applications.

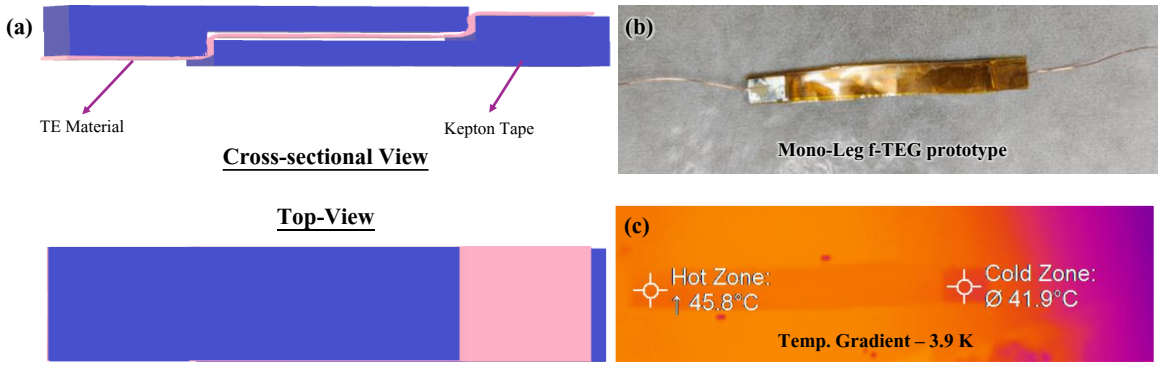

Fig. 1. (a) Schematic representation of stair-shaped f-TEG (b) Photograph of the mono-leg f-TEG prototype (c) Infra-red image of the mono-leg f-TEG on the heat source.