Negative Energy Consumption of Thermostats at Ambient Temperature: Electricity Generation with Zero Energy Maintenance

Jun Wang, Jin Shang, and Jiping Huang*
Department of Physics, State Key Laboratory of Surface Physics,
and Key Laboratory of Micro and Nano Photonic Structures (MOE),
Fudan University, 200433 Shanghai, China

I. Introduction

Thermal maintenance costs 15% of global energy. The concept of an "energy-free thermostat" was accordingly proposed based on the temperature-trapping theory [1]. Here we develop this theory by introducing thermoelectric effects and establish a "negative-energy thermostat" that generates electricity associated with energy-free maintenance of a constant ambient temperature [2].

II. Method

Combining the equation of continuity of heat flow and the equation governing thermoelectric effects, we have theoretically shown a kind of negative energy consumption of thermostats in Fig. 1(a). To show the feasibility and applicability of our theory, we apply the theory and further design a homothermal thermoelectric cloak, see Fig. 1(b). An experimental scheme is given in Fig. 2.

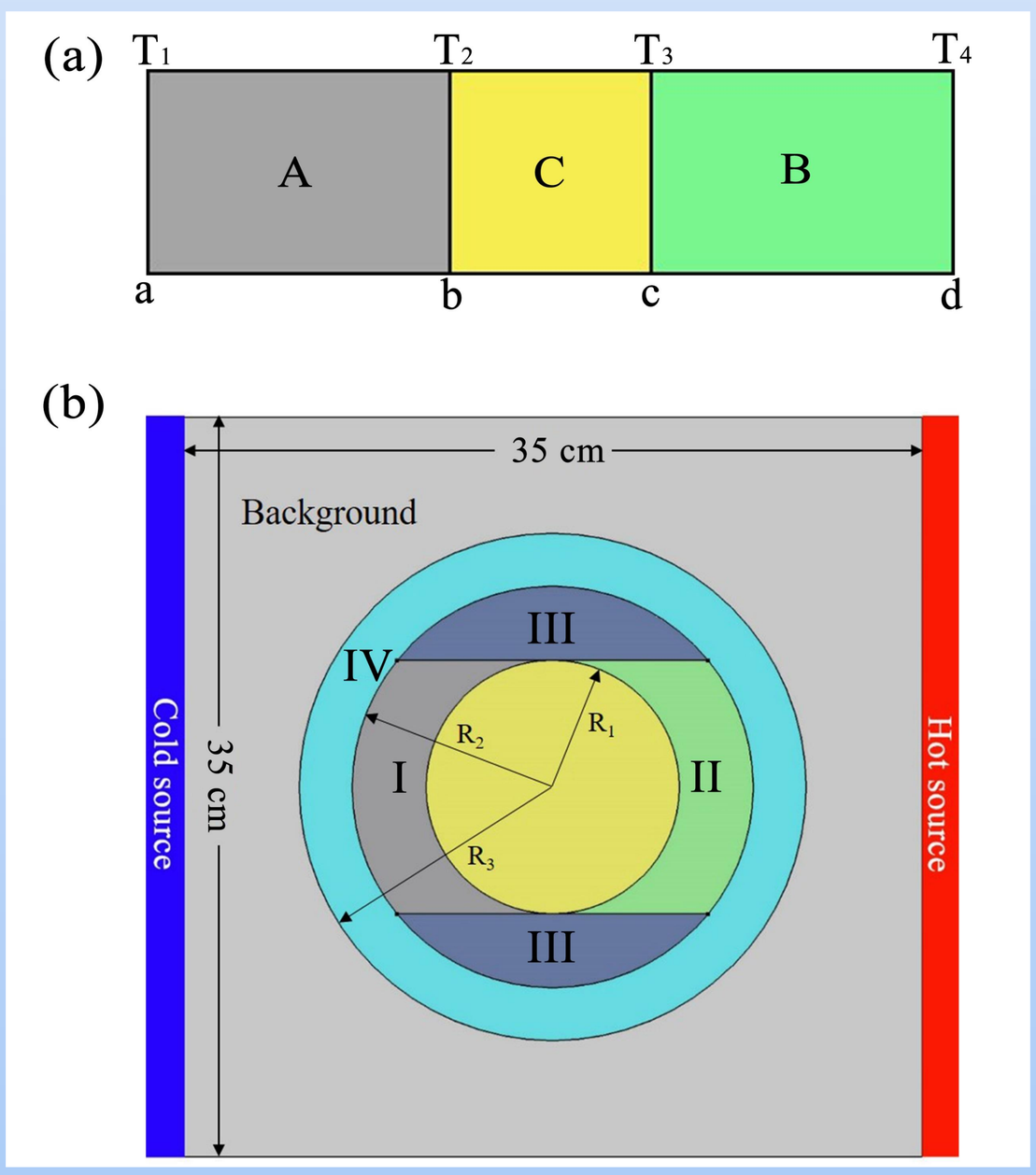

Fig. 1 Schematic graphs of negative-energy thermostat and homothermal thermoelectric cloak.

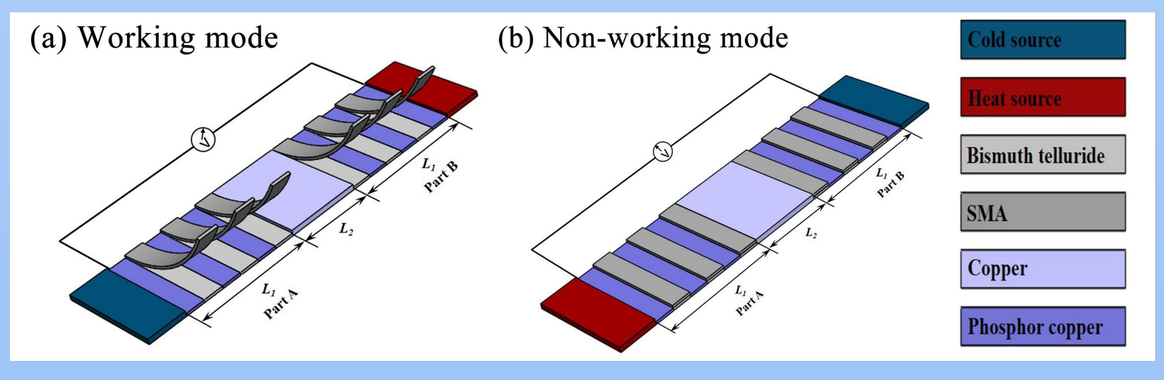

Fig. 2 Schematic drawing for experimental demonstration

III. Finite-element Simulations

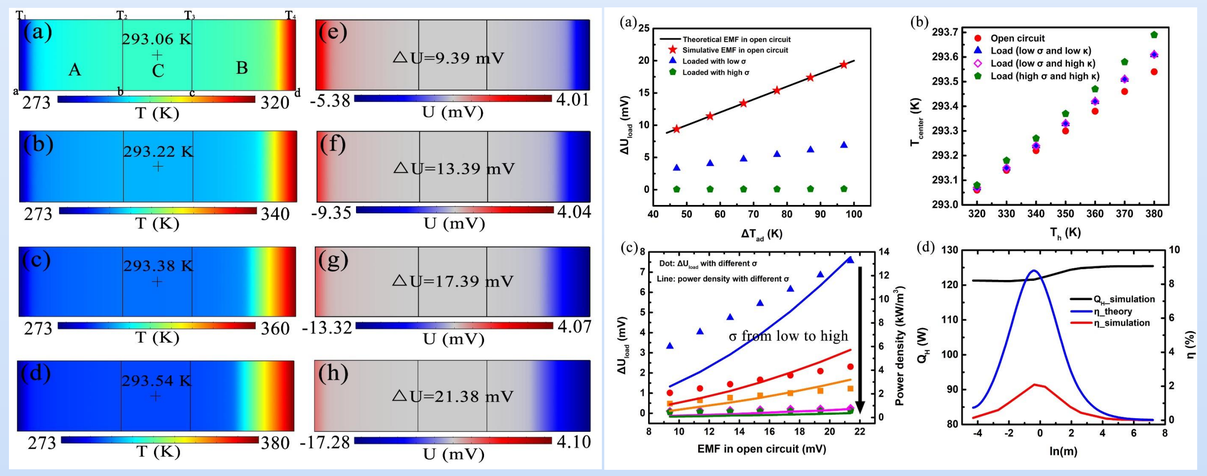

Fig. 3 Simulations on open and closed circuits.

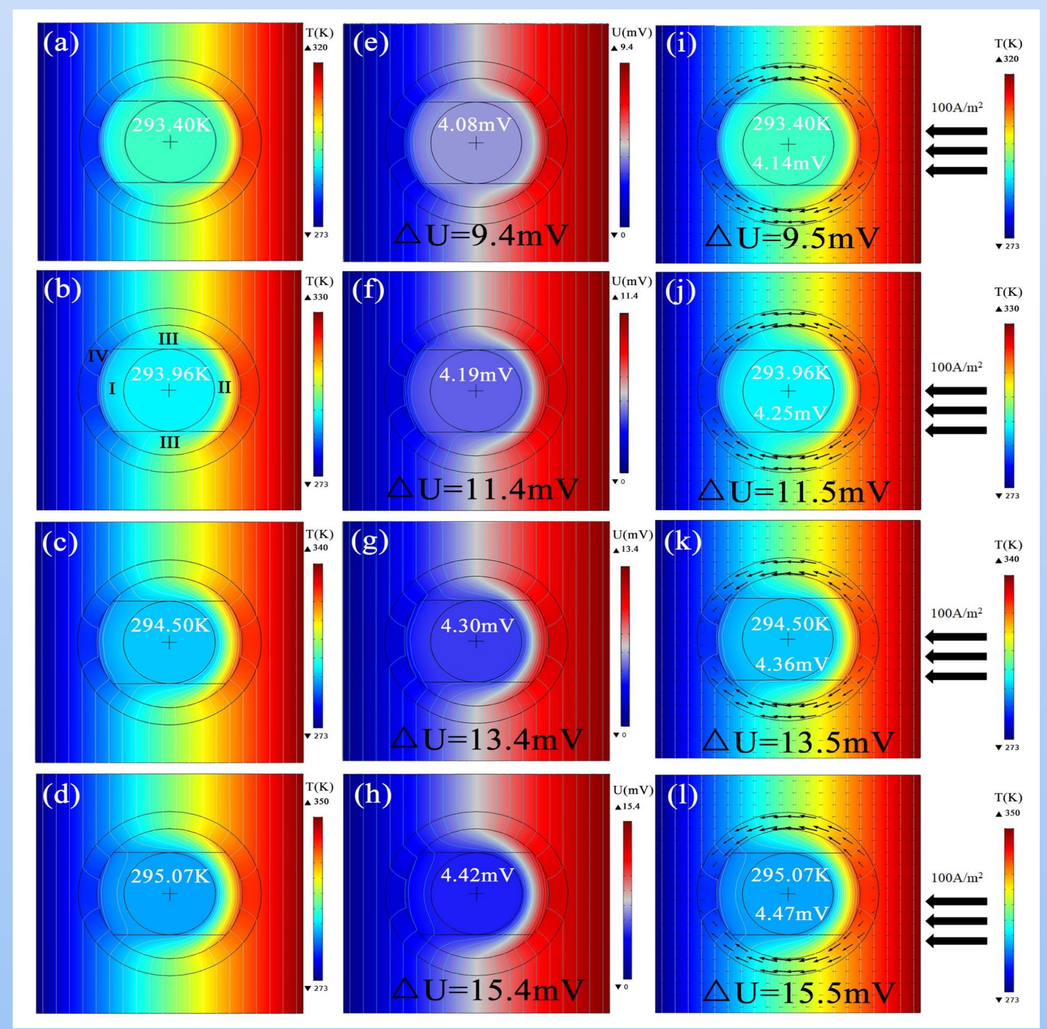

Fig. 4 Simulations of homothermal thermoelectric cloak.

IV. Finite-element Simulations

In summary, this work not only has relevance for expanding the temperature-trapping theory by achieving thermoelectric conversion synergistically, but also offers a different method to manipulate coupled physical fields.

Reference

[1] X. Y. Shen, Y. Li, C. R. Jiang, and J. P. Huang, Phys. Rev. Lett., 117, 05550 (2016).
[2] J. Wang, J. Shang, and J. P. Huang, Phys. Rev. Appl., 11, 024053 (2019).