NAPLES, ITALY 30 JUNE - 4 JULY
ACEX2025 NAPLES
18th International Conference on Advanced Computational Engineering and Experimenting

ABSTRACT

Numerical Design of a Thin-Film Thermoelectric Cooler using Two-Dimensional Materials for Microsatellite Thermal Control

C. –H. Cheng[1], S. -Y. Lin[2], T. -S. Ko[3], Y. -S. Chang[4], S. Wu[5]

[1]National Cheng Kung University, Taiwan
[2]National Cheng Kung University, Taiwan
[3]National Changhua University of Education, Taiwan
[4]National Formosa University, Taiwan
[5]Lunghwa University of Science and Technology, Taiwan

The rising use of microsatellites in space exploration has made heat dissipation from high-density electronic devices a critical issue. Traditional thermal control systems using heat pipe networks face challenges like increased thermal resistance, temperature gradients, and spatial constraints [1]. Thermoelectric devices (TEDs) offer a promising alternative with solid-state operation, silent performance, durability, and dual cooling-heating functions adjustable by current direction. This study utilizes numerical simulations to examine thin-film TEDs' temperature distribution across various geometric designs, providing insights for optimizing thermoelectric components in microsatellites. Additionally, it explores the potential of two-dimensional (2D) materials, MoS2 and SnSe, used in thermoelectric applications due to their high carrier transport efficiency and reduced thermal conductivity with stable temperature gradient [2]. Existing studies have shown that the 2D materials exhibit high Seebeck coefficients and low thermal conductivity, benefiting micro-scale cooling and energy harvesting [3]. Combining optimized TED structures with high-performance 2D materials, this study aims to develop an efficient thin-film TED to ensure stable operation in microsatellites while minimizing the amount of materials used. Simulation results will guide designers in achieving significant temperature gradients and improving thermal efficiency.

[1] V.K. Singh, S.S. Sisodia, A. Patel, T. Shah, P. Das, R.N. Patel and R.R. Bhavsar, Appl. Therm. Eng. 224, 120101 (2023).
[2] P. Kumbhakar, J. S. Jayan, A. S. Madhavikutty, P. R. Sreeram, A. Saritha, T. Ito and C. S. Tiwary, IScience, 26, 106671 (2023).
[3] P. -Z. Jia, J. -P. Xie, X. -K. Chen, Y. Zhang, X. Yu, Y. -J. Zeng, Z. -X. Xie, Y. -X. Deng and W. -X. Zhou, J. Phys. Condens. Matter, 35, 073001 (2022).