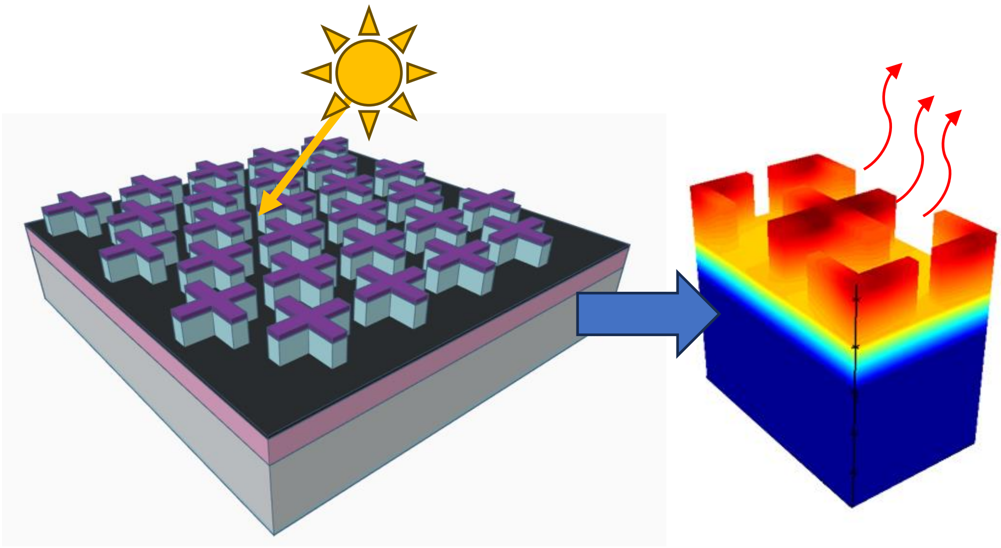
→ DISCOVERY



Thermal energy generation in space: Improved thermoelectric performance via metamaterial technology

Final report
Study

Open Idea

Affiliation(s): Istituto Italiano di Tecnologia/Italian Institute of Technology

Activity summary:
Energy generation in Space poses a severe challenge, the answer to which may be the use of novel metamaterials for thermoelectric generators. Metamaterials can address this question by employing conventional materials and well-established fabrication technologies while leaving room for other approaches to increase the efficiency of thermoelectric generation. In the current study, we investigated possible configurations of metamaterials that could increase the efficiency of thermoelectric generators in Space.

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Thermal energy generation in Space: Improved thermoelectric performance via metamaterial technology

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This two-year theoretical project explored the prospects of using metamaterial technology to increase the efficiency of thermoelectric generators in space. The project implemented the idea IDEA: I-2020-06634.

Agreement/PO number: 4000136842.

EXECUTIVE SUMMARY

This project mostly focused on a theoretical and numerical activity for the identification of potential avenues capable of enhancing the current generation from thermoelectric generators (TEGs). The basic idea was based on the exploitation of metamaterials to augment temperature gradients, ultimately leveraging them for electricity generation.
We focused on the phenomenon of light-induced temperature gradient, by utilizing metamaterial structures responsive to the UV-NIR spectrum. We assessed two types of structures as potential candidates, eventually selecting one for further analysis and experimentation.
Through our numerical simulations, we determined that the selected structure could achieve an impressive light absorbance of approximately 95%, hence suggesting the possibility of generating substantial thermal differentials. Our calculations revealed that within the thickness of the TEG (approximately 500 nm), we could establish temperature gradients exceeding 100 K, with the actual value depending on the number of pulses impinging on the structure.
Finally, we conducted a preliminary fabrication trial to realize a structure closely resembling our simulations. The outcome was highly successful, indicating the feasibility of the proposed device as a crucial component in energy production.