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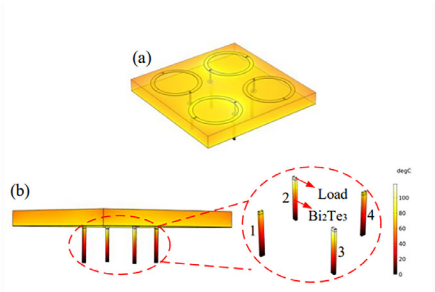
By converting electromagnetic radiation into thermal energy first, this harvester circumvents the inefficiencies of other wireless energy converters.



Rectifying antennas, or rectennas, are used in wireless power transmission systems to convert electromagnetic energy into electricity. However, the rectifier circuits are inefficient, and they reflect almost half of the microwave energy.

Xiong et al. proposed an alternative wireless energy harvester that leverages the power of electromagnetic metamaterials to convert microwave radiation energy into thermal energy first, then uses thermoelectric conversion materials to produce electricity. Their four-ring resonator design ensures the device can power electrical devices while in motion and independently of the electromagnetic radiation incident angle or polarization.

“When electromagnetic waves penetrate metal metamaterials or metasurfaces, they induce eddy currents in the metal substrate,” said author Han Xiong. “Through judicious design, these currents can be guided to flow along the metal surface and be dissipated, thus manifesting the material’s ability to absorb electromagnetic waves. The objective of this study is to direct the electromagnetic energy towards a resistive element located at the rear end, thereby generating heat.”

The team achieved 99.5% energy harvesting efficiency at 5.8GHz, a commonly used frequency for wireless energy transmission. According to numerical simulations, at an incident wave power of 7 W, the device can generate 171.8 mV and 9.71 mW.

Applications for this design include everything from wireless sensors to drones, but the technology still has some refining before it hits the market.

“The efficiency of thermoelectric conversion materials is currently low,” Xiong said. “In the future, if there is a breakthrough in thermoelectric conversion materials, it is believed that this technology will be more efficient, reliable, and cost-effective compared to the current rectification method.”

Source: “Research on electromagnetic energy absorption and conversion device with four-ring multi-resistance structure,” by Han Xiong, Xiaodong Ma, Haisheng Liu, Dongping Xiao, and Huaiqing Zhang, *Applied Physics Letters* (2023). The article can be accessed at https://doi.org/10.1063/5.0170827.