First health care device powered by body heat made possible by liquid based metals

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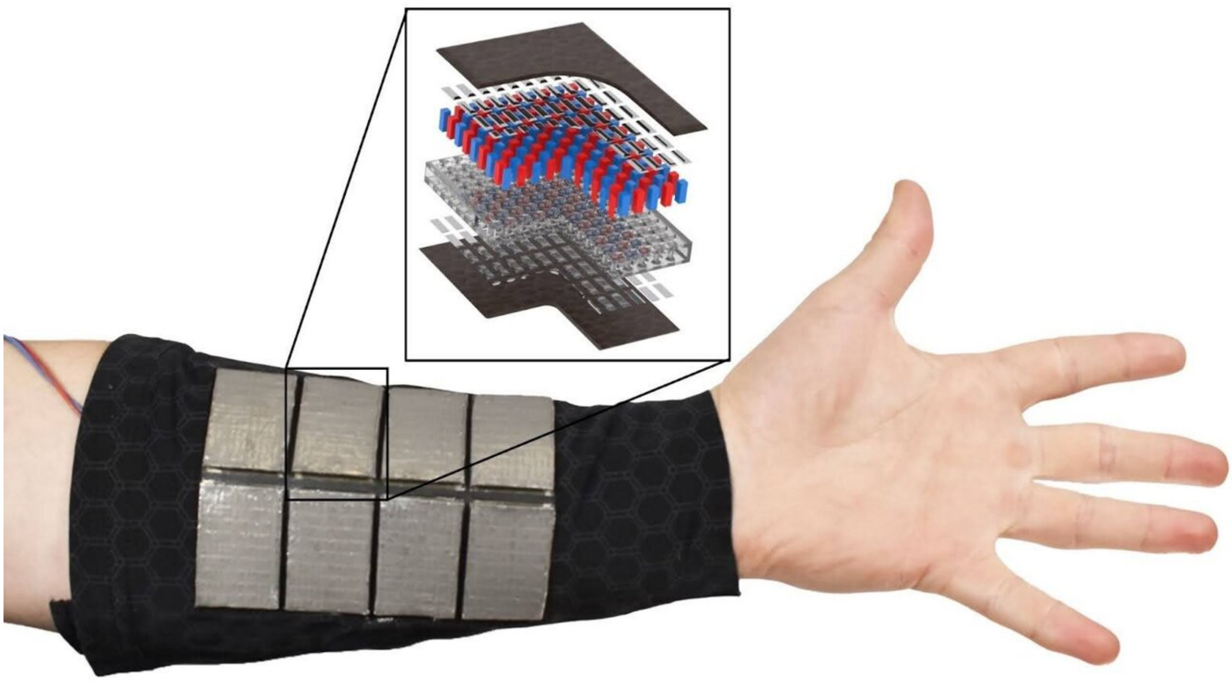

Credit: Carnegie Mellon Unviersity, College of Engineering

In the age of technology everywhere, we are all too familiar with the inconvenience of a dead battery. But for those relying on a wearable health care device to monitor glucose, reduce tremors, or even track heart function, taking time to recharge can pose a big risk.

For the first time, researchers in Carnegie Mellon University's Department of Mechanical Engineering have shown that a health care device can be powered using body heat alone. By combining a pulse oximetry sensor with a flexible, stretchable, wearable thermoelectric energy generator composed of liquid metal, semiconductors, and 3D printed rubber, the team has introduced a promising way to address battery life concerns.

"This is the first step towards battery-free wearable electronics," said Mason Zadan, Ph.D. candidate and first author of the research published in *Advanced Functional Materials*.

The system, designed to achieve high mechanical and thermoelectric performance with seamless materials integration, features advancements in soft-materials, TEG array design, low energy circuit board design, and on-board power management.

"Compared to our past research, this design improves power density by roughly 40 times or 4000%. The liquid metal epoxy composite enhances thermal conductivity between the thermoelectric component and the device's point of contact on the body," explained Carmel Majidi, Professor of Mechanical Engineering and Director of the Soft Machines Laboratory.

To test its voltage output, the device was worn on a participant's chest and wrist at rest and in motion.

"We saw greater output while the device was on the participant's wrist and while they were in motion," Zadan said. "As the participant moves, one side of the device is cooled by the increase in airflow, and the other is heated from the rise in body temperature. Walking and running created an ideal temperature differential."

Moving forward, Dr. Dinesh K. Patel, a research scientist on the team, is eager to work on improving electrical performance and explore how to additively manufacture the device. "We want to move it from a proof of concept into a product people can start using."

This research was done in collaboration with Arieca Inc, The University of Washington, and Seoul National University.

More information: Mason Zadan et al, Stretchable Thermoelectric Generators for Self-Powered Wearable Health Monitoring, *Advanced Functional Materials* (2024). DOI: 10.1002/adfm.202404861

Provided by Carnegie Mellon University Mechanical Engineering

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