MXene-based smart fabric shows potential for energy harvesting and health monitoring

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University of Waterloo Ph.D. student Jun Peng wearing a mask made from smart material that can detect lung cancer and viruses from the breath. Credit: University of Waterloo

Imagine a coat that captures solar energy to keep you cozy on a chilly winter walk, or a shirt that can monitor your heart rate and temperature.

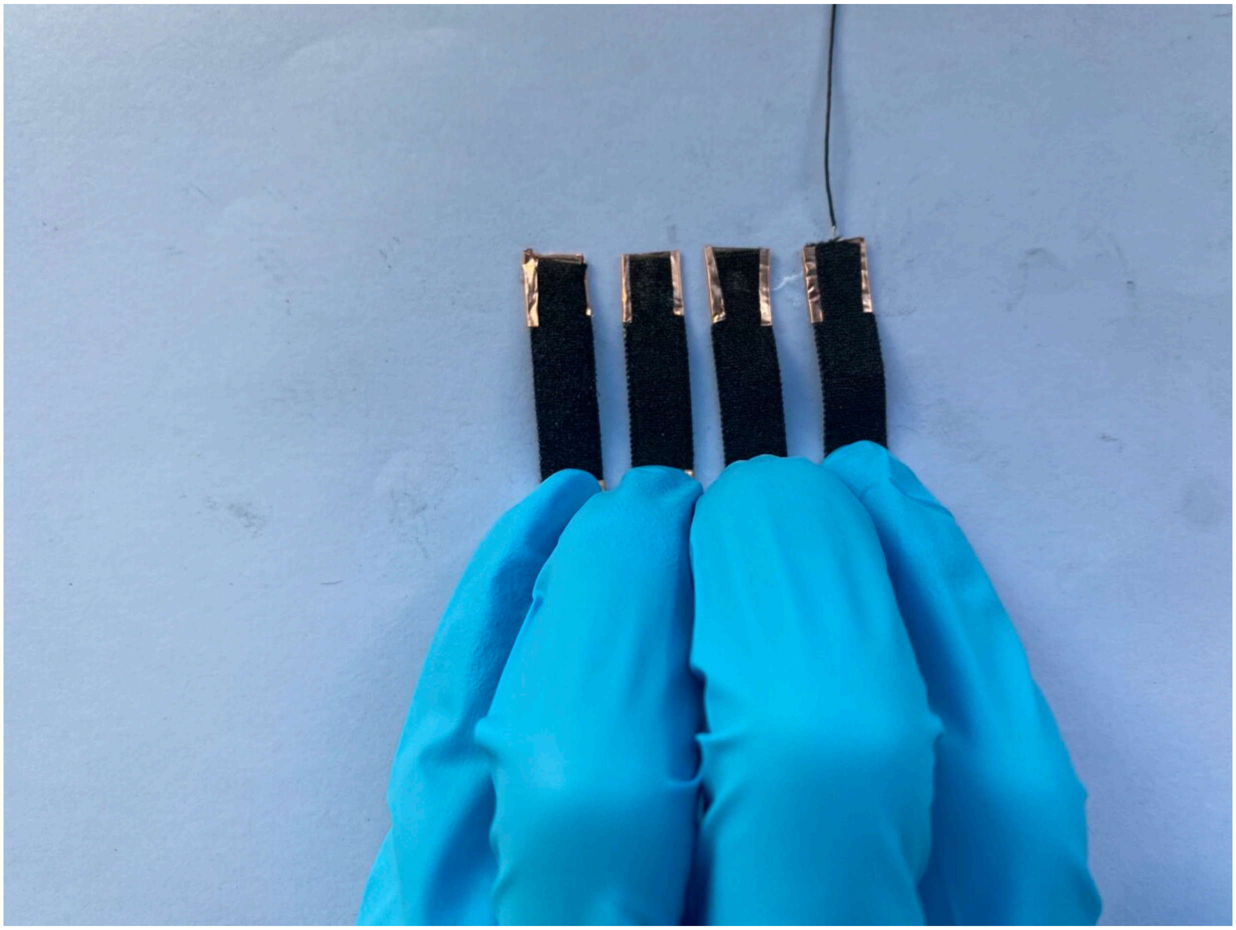
Picture clothing athletes can wear to track their performance without the need for bulky battery packs.

University of Waterloo researchers have developed a smart fabric with these remarkable capabilities. The fabric has the potential for energy harvesting, health monitoring, and movement tracking applications. The study is published in the *Journal of Materials Science & Technology*.

The new fabric developed by a Waterloo research team can convert body heat and solar energy into electricity, potentially enabling continuous operation with no need for an external power source. Different sensors monitoring temperature, stress, and more can be integrated into the material.

It can detect temperature changes and a range of other sensors to monitor pressure, chemical composition, and more. One promising application is smart face masks that can track breath temperature and rate and detect chemicals in the breath to help identify viruses, lung cancer, and other conditions.

"We have developed a fabric material with multifunctional sensing capabilities and self-powering potential," said Yuning Li, a professor in the Department of Chemical Engineering. "This innovation brings us closer to practical applications for smart fabrics."



Black strip of fiber is coated with MXene that allows the fabric to absorb sunlight and body heat and convert it to energy. Credit: University of Waterloo

Unlike current wearable devices that often depend on external power sources or frequent recharging, this breakthrough research has created a novel fabric which is more stable, durable, and cost-effective than other fabrics on the market.

This research, conducted in collaboration with Professor Chaoxia Wang and Ph.D. student Jun Peng from the College of Textile Science and Engineering at Jiangnan University, showcases the potential of integrating advanced materials such as MXene and conductive polymers with cutting-edge textile technologies to advance smart fabrics for wearable technology.

Li, director of Waterloo's Printable Electronic Materials Lab, highlighted the significance of this advancement, which is the latest in the university's suite of technologies disrupting health boundaries.

"AI technology is evolving rapidly, offering sophisticated signal analysis for health monitoring, food and pharmaceutical storage, environmental monitoring, and more. However, this progress relies on extensive data collection, which conventional sensors, often bulky, heavy, and costly, cannot meet," Li said.

"Printed sensors, including those embedded in smart fabrics, are ideal for continuous data collection and monitoring. This new smart fabric is a step forward in making these applications practical."

Someone stretching the smart fabric to demonstrate its mechanical robustness, demonstrating that it's a durable material that can be stretched and washed. Credit: University of Waterloo

The next phase of research will focus on further enhancing the fabric's performance and integrating it with electronic components in collaboration with electrical and computer engineers.

Future developments may include a smartphone app to track and transmit data from the fabric to health care professionals, enabling real-time, non-invasive health monitoring and everyday use.

More information: Jun Peng et al, MXene-based thermoelectric fabric integrated with temperature and strain sensing for health monitoring, *Journal of Materials Science & Technology* (2024). DOI: 10.1016/j.jmst.2024.06.011

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