New liquid metal wearable pressure sensor for health monitoring applications

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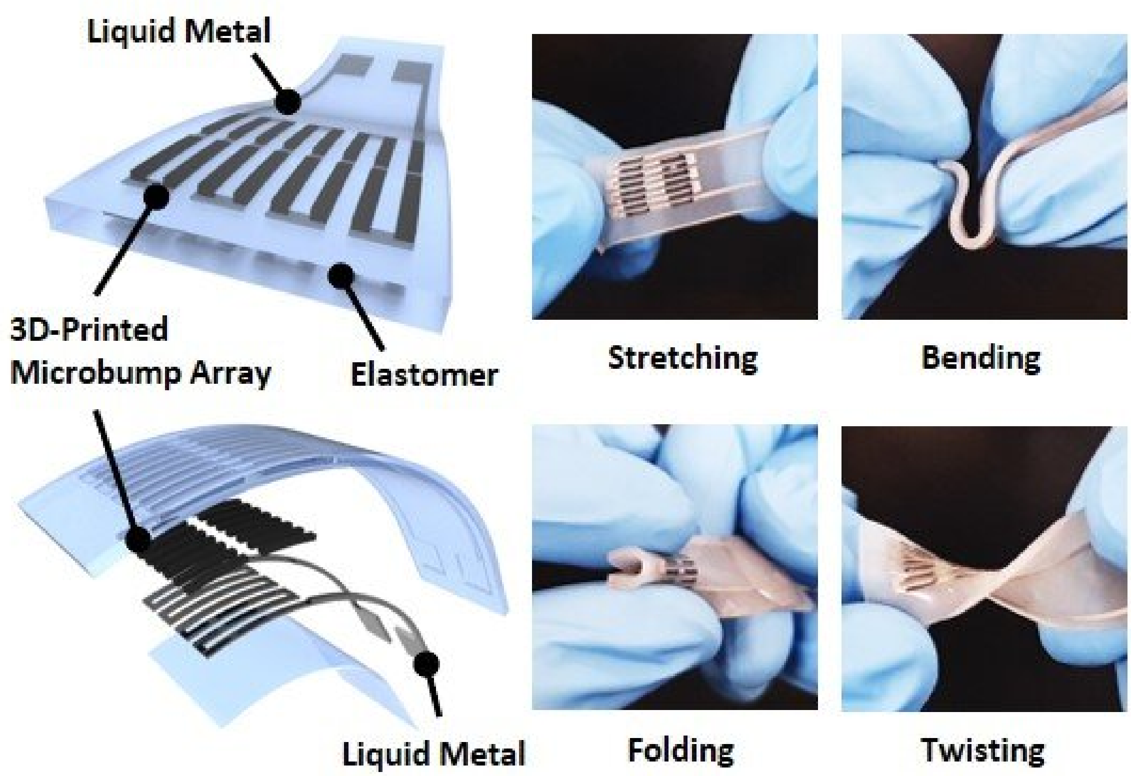


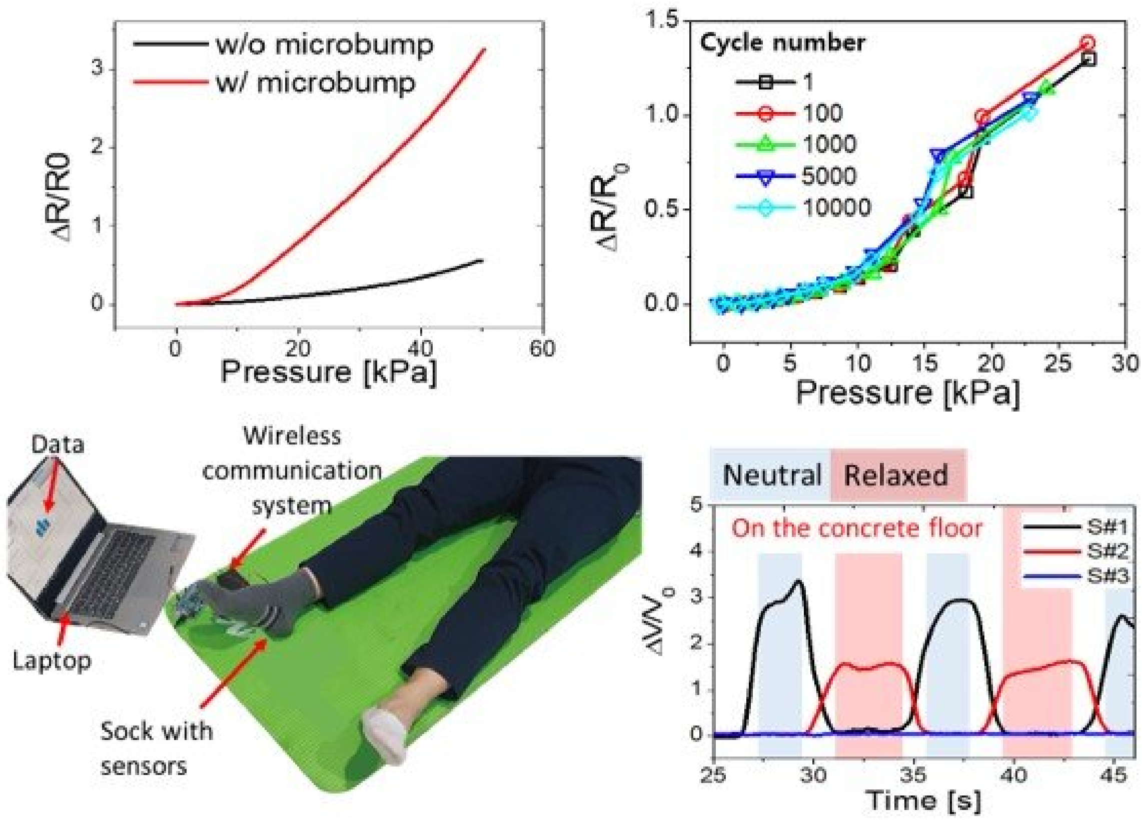
Credit: KAIST

Soft pressure sensors have received significant research attention in a variety of fields, including soft robotics, electronic skin, and wearable electronics. Wearable soft pressure sensors have great potential for real-time health monitoring and for the early diagnosis of diseases.

A KAIST research team led by Professor Inkyu Park from the Department of Mechanical Engineering developed a highly sensitive wearable pressure sensor for health monitoring applications. This work was reported in *Advanced Healthcare Materials* on November 21 as a front cover article.

This technology is capable of sensitive, precise, and continuous measurement of physiological and physical signals and shows great potential for health monitoring applications and the early diagnosis of diseases.

A soft pressure sensor is required to have high compliance, high sensitivity, low cost, long-term performance stability, and environmental stability in order to be employed for continuous health monitoring. Conventional solid-state soft pressure sensors using functional materials including carbon nanotubes and graphene have showed great sensing performance. However, these sensors suffer from limited stretchability, signal drifting, and long-term instability due to the distance between the stretchable substrate and the functional materials.



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To overcome these issues, liquid-state electronics using liquid metal have been introduced for various wearable applications. Of these materials, Galinstan, a eutectic metal alloy of gallium, indium, and tin, has great mechanical and electrical properties that can be employed in wearable applications. But today's liquid metal-based pressure sensors have low-pressure sensitivity, limiting their applicability for health monitoring devices.

The research team developed a 3-D-printed rigid microbump array-integrated, liquid metal-based soft pressure sensor. With the help of 3-D printing, the integration of a rigid microbump array and the master mold for a liquid metal microchannel could be achieved simultaneously, reducing the complexity of the manufacturing process. Through the integration of the rigid microbump and the microchannel, the new pressure sensor has an extremely low detection limit and enhanced pressure sensitivity compared to previously reported liquid metal-based pressure sensors. The proposed sensor also has a negligible signal drift over 10,000 cycles of pressure, bending, and stretching and exhibited excellent stability when subjected to various environmental conditions.

These performance outcomes make it an excellent sensor for various health monitoring devices. First, the research team demonstrated a wearable wristband device that can continuously monitor one's pulse during exercise and be employed in a noninvasive cuffless BP monitoring system based on PTT calculations. Then, they introduced a wireless wearable heel pressure monitoring system that integrates three 3-D-BLiPS with a wireless communication module.

Professor Park said, "It was possible to measure health indicators including pulse and blood pressure continuously as well as pressure of body parts using our proposed soft pressure sensor. We expect it to be used in health care applications, such as the prevention and the monitoring of the pressure-driven diseases such as pressure ulcers in the near future. There will be more opportunities for future research including a whole-body pressure monitoring system related to other physical parameters."

More information: Kyuyoung Kim et al, Wearable Sensors: Highly Sensitive and Wearable Liquid Metal-Based Pressure Sensor for Health Monitoring Applications: Integration of a 3D-Printed Microbump Array with the Microchannel (Adv. Healthcare Mater. 22/2019), *Advanced Healthcare Materials* (2019). DOI: 10.1002/adhm.201970086

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