Professor Jungil Choi's team from the Department of Mechanical Engineering develops a wearable fiber sensor system to measure health status using sweat

Our school's Department of Mechanical Engineering, led by Professor Jungil Choi, has developed a wearable fiber-based sensor system that analyzes human sweat to measure health status in real-time.

Professor Jungil Choi (photo) from the SOFT Lab in the Department of Mechanical Engineering developed a fiber-based wearable microfluidic sensor system that can

analyze and detect various substances in sweat using electrochemical and color change methods.

This was published in the January issue of the prestigious Chemical Engineering Journal under the title "Wearable, fabric-based microfluidic systems with integrated electrochemical and colorimetric sensing array for multiplex sweat analysis."

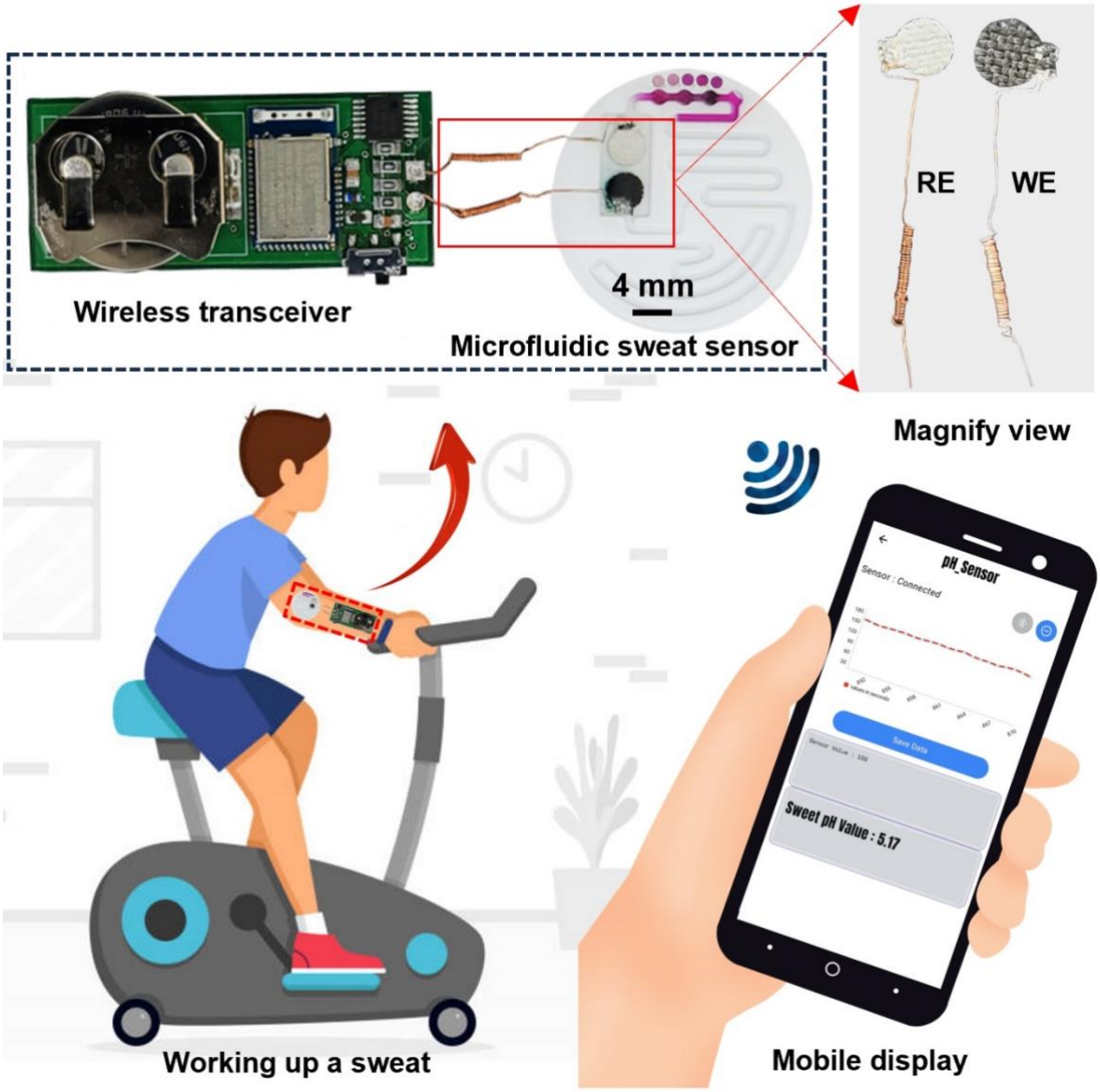
Professor Jungil Choi served as the corresponding author, and Dr. Sekar Madhu, a postdoctoral researcher in the Department of Mechanical Engineering at Ajou University, was the first author. Researcher Md. Sajjad Alam and postdoctoral researcher Sriramprabha Ramasamy also participated.

Sweat is an ideal diagnostic fluid for health monitoring. It contains various biomarkers that can detect changes in the body related to various metabolic processes, as well as drug research for diseases such as diabetes and cystic fibrosis (CF). Recently, sweat analysis through wearable sensors has garnered attention as a non-invasive method for real-time health monitoring.

In particular, detecting the acidity (pH) in sweat can help evaluate metabolism and homeostasis, and accurately measuring it can aid in the early diagnosis of diseases, such as kidney dysfunction, diabetes, and skin disorders. For example, the chloride concentration in sweat is the gold standard for diagnosing CF, a hereditary endocrine disorder. By monitoring changes in chloride concentration, the disease can be diagnosed early, thereby enhancing the effectiveness of treatments.

Moreover, by monitoring sweat loss and secretion rates in real-time, dehydration, heat exhaustion, and heat-related illnesses in athletes, soldiers, and medical personnel can be prevented and promptly detected.

The conventional sweat analysis methods have faced considerable challenges, such as sweat evaporation, uneven sweat distribution on the sensor surface, and the dilution effect of the sample. Therefore, the Ajou University research team attempted improvements by applying a microfluidic system. The microfluidic system is a method of controlling fluid flow at the micro level, allowing sweat from the skin to be directly transmitted to the sensor for sensitive and accurate measurements. Additionally, it enables stable signal measurement even during body movements using flexible fiber-based sensors.



Wearable fiber-based sensor system developed by the Ajou University research team

The top left shows the sweat collection and wireless communication parts of the wearable sensor, and the top right shows the flexible electrode device for body movement.

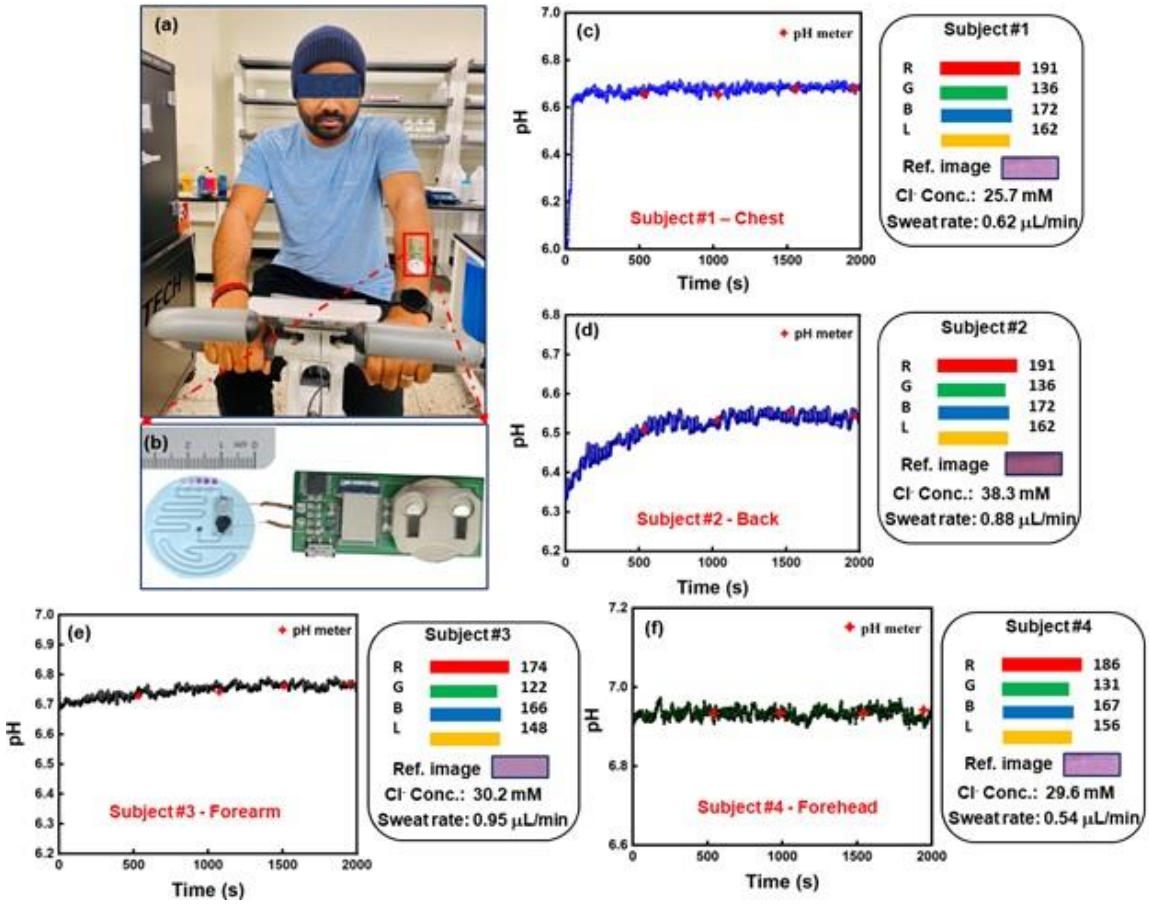
The image below shows the process of attaching the device to the skin to monitor the composition of sweat in real-time on a smartphone.

The Ajou University research team used a microfluidic system to conduct rapid and accurate sampling with just a small amount of sweat. The possibility of evaporation or contamination of sweat was minimized by enabling rapid collection and analysis. The research team confirmed that using polyaniline (PANI) as an electrode could accurately monitor the pH of sweat (pH 2–9, sensitivity: 75.15 mV/pH, the highest sensitivity in the same range). By combining electrochemical and color change detection methods, the analysis of multiple biomarkers from a single sample was enabled. The sensor developed by the research team is made from fiber, allowing it to adhere closely to the skin and be used multiple times reliably. It can also be linked to devices, such as smartphones, for real-time data transmission and monitoring.

Professor Jungil Choi, who led the research, explained, "We developed a method to precisely measure metabolism in real-time, such as acidity, sweat loss, and secretion rate, using a small amount of sweat sample," calling it "an innovation in non-invasive skin-attachable health monitoring technology."

"In the future, we will provide innovative solutions that can practically improve the quality of life for individuals through subsequent research," he added.

This study was conducted with the support of the Brain Pool program (an excellent early-career researcher project), an overseas excellent early-career researcher support project by the National Research Foundation of Korea, and research support from Ajou University.



Actual measurement being conducted using the sensor developed by the research team. It can measure the pH value and chloride ion concentration through sweat.