

Wearable Sensors for Ion Monitoring

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Fitness trackers, and more in general wearable wellness monitoring devices have become in the last years a common tool, sold in millions of pieces. The integration of additional markers for the evaluation of the metabolic status of the body is the natural evolution of them, and would open the way for the application of wearables in healthcare and at-home patient tracking.

The last years have seen the rapid and widespread adoption of fitness trackers going to nearly zero in 2010 to several million users in 2016 [1]. The latest developments in the wearable world are going mostly in the direction of combining the vital signs sensors as heart rate, temperature, etc. with sensors for metabolic markers. In order to provide an affordable solution for the professional and non-professional athletes market, CSEM is developing solutions for disposable, flexible sensors for potassium ion, sodium ion, glucose, lactate, pH, sweat rate and impedance that can be eventually integrated in wearable solutions.

The first sweat monitoring device developed at CSEM focusses on pH, potassium ion and sodium ion, parameters related to the hydration state of the body. The pH sensors cover a range of pH 3-9, potassium and sodium ion sensors with a linear range of 0.1 mM to 100 mM, and 0.1 mM to 200 mM, respectively (characterization in artificial sweat). All these disposable sensors can be used with minimal preconditioning and are stable for 2 hours, the time of a typical workout session.

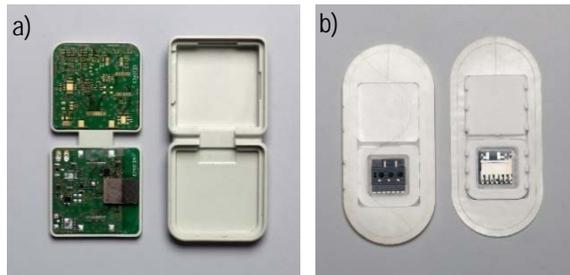


Figure 1: The wearable sweat monitoring device comprises of two parts: a) Flexible data acquisition and transmission electronics; b) Disposable sweat monitoring patch.



Figure 2: The sweat monitoring device is placed on the back of a test subject.

The wearable device comprises a re-usable part, including data collection and transmission electronics, connected by Bluetooth to a portable device and sending data in real-time. The sweat monitoring sensors are printed on a disposable patch, which is used to fix the system on the athlete's body (Figures 1 and 2).

The device was used for on-body measurements during a session of ergometer cycling. The parameters measured after 15 minutes warm up from the ergometer, as well as an example of the real-time data for temperature, heart rate, pH, K⁺ and Na⁺ are shown in Figure 3.

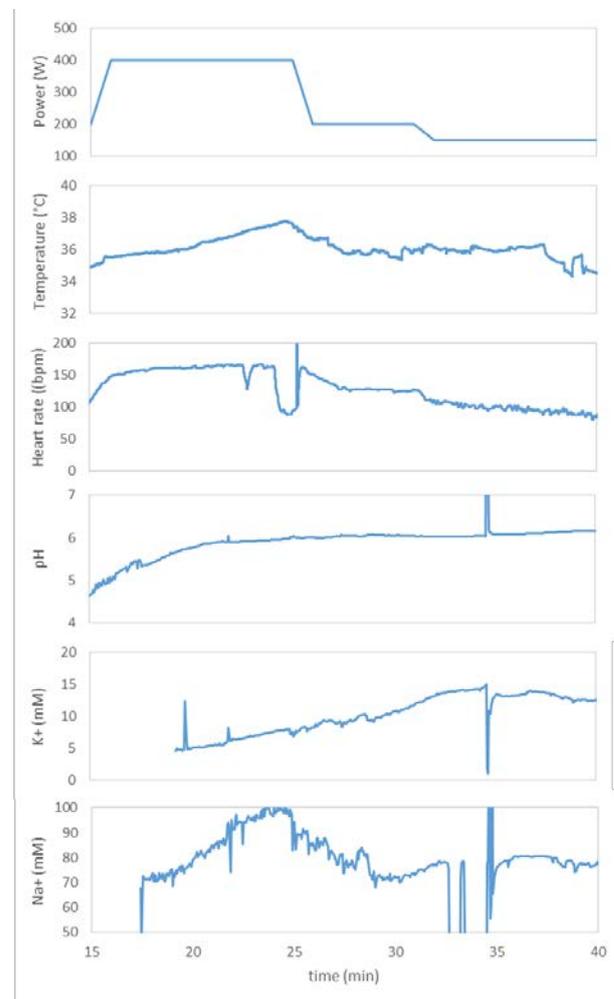


Figure 3: Real-time data collected during an ergometer session. From top to bottom: power set on the ergometer, temperature measured at the forearm and heart rate monitored at the fingertip, both measured with a BioRadio wireless physiology monitor, pH, K⁺ concentration and Na⁺ concentration, measured with the wearable sweat monitoring device, placed on the back of the test subject.

[1] www.statista.com