A Patch for Estimating Exercise Intensity by Monitoring Lactate in Sweat

D. Migliorelli, T. Parkel, N. Tscharner, S. Generelli

Recent developments in wearable sensor technologies have opened new frontiers in the monitoring of body parameters. Wearables could play a great role in markets such as sports and healthcare by continuously monitoring body parameters in sweat or other secreted body fluids. Wearable sensors can also provide feedback to their users about their lifestyle regarding physical activity and sports and in this way encourage a more active, healthier lifestyle.

The monitoring of sweat electrolyte concentrations can provide a great deal of information on the state of the human body. Typically, low water levels (dehydration) or low sodium concentrations (hyponatremia) should be immediately replenished to avoid detrimental effects to human health and reduced physical and mental performance.

Another important biomarker is lactate, an indicator of tissue oxygenation. During intensive physical activity the stored glycogen is consumed to produce lactate (glycolysis). Consequently, this parameter is of great importance in assessing physical performance in sports and health care applications.

CSEM has been active for many years in developing technologies for accurate, real-time and on-body, measurement of a variety of health indicators like heart rate, heart rate variability and blood oxygenation. These technologies include all aspects of the wearable from the sensor membranes to the electronics and algorithms collecting and analyzing the data. More recently, activities focusing on biocompatible, disposable sensing solutions for monitoring skin pH, conductivity, ion content, sweat rate and lactate levels have been initiated.

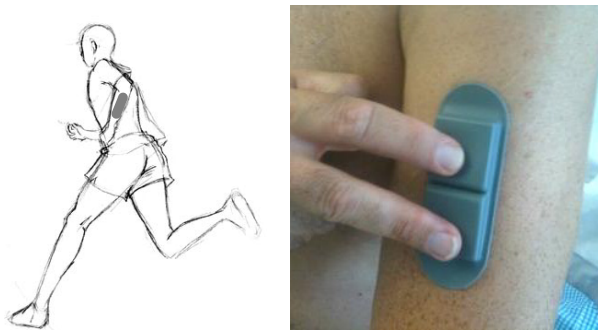

Figure 1: The ECHO patch (Kenzenwear Inc. product, on the arm) is worn during exercise, and has the necessary electronics for the readout of the system. The data are either sent to the athlete's smartphone or stored within the patch for further transfer, after the training session (sketch by studiocyen.net).

In line with these activities, a smart patch able to read and store the information from the lactate sensors has been realised. The lactate sensor is based on screen printing technology, and is in contact with sweat, which gives a real-time readout of the concentration of lactate in sweat. The adhesive patch is placed on the athlete's body as shown in Figure 1.

The patch (Figure 2) will read lactate concentrations in real-time, and either store the data in the device until the end of the training session for further transmission to dedicated data storage and analysis software, or is sent in real-time to a mobile device. The continuous monitoring of lactate will thus alert the athlete of sub-optimal use of resources during physical effort.

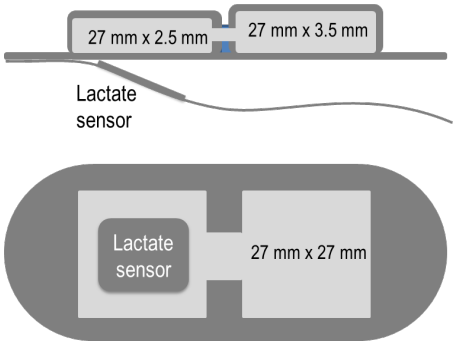

Figure 2: Side and bottom schematic view of the patch. In light grey the non-disposable core of the patch, with its dimensions. In dark grey the disposable part of the patch. Overall dimension 100 mm x 40 mm x 8.5 mm.

A lactate sensor is being developed to address the challenges of acquiring measurements in sweat. The focus of the current development is to obtain a stable and robust device for the detection of lactate in sweat in the concentration range of 1 mM up to 20 mM for a period of one to four hours. A calibration curve in the range of interest has been recorded in buffer solution and is depicted in Figure 3.

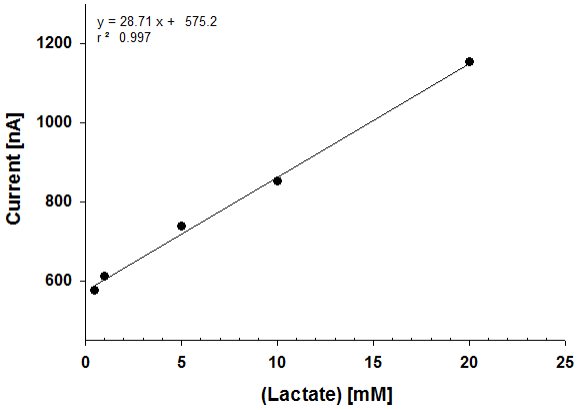

Figure 3: An example lactate calibration curve.