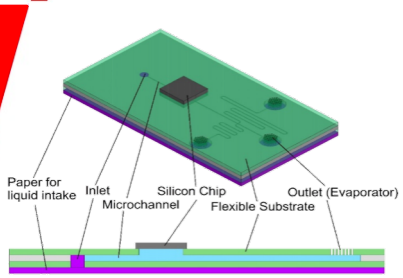
Wearable microfluidic sweat sensor

MSc thesis theme



Introduction

Non-invasive, continuous and prolonged monitoring of biomarkers that indicate health and well-being is in demand for example for monitoring dehydration, stress, sleep, children's health, chronic disease and in perioperative monitoring (Fig. 1). Sweat is a non-obtrusively accessible bio-fluid containing physiologically and metabolically rich information. Therefore, having a wearable device that continuously samples and measures sweat would be ideal. However, the development of reliable sweat sensing has been hampered by several issues: (1) the correlation between blood and sweat values appears to be lacking for various biomarkers; and (2) the focus of sweat sensing has been on sensors, not on reliable and robust collection methods for the minute amounts produced and the enablement of continuous monitoring.

Per gland the secretion is typically 2 nanoliter per minute and there are about 15 active glands per cm^2; constituting in total about 2 microliter per hour. The challenge is to gather sweat in a reproducible manner and transfer the sweat to a sensor in a semi continuous flow.

Figure 1: Opportunities for sweat sensing – applications in which non-obtrusive, continuous, prolonged monitoring of biomarkers is in great demand. It is clear that the developed sweat sensing technology can be leveraged towards many diverse applications.

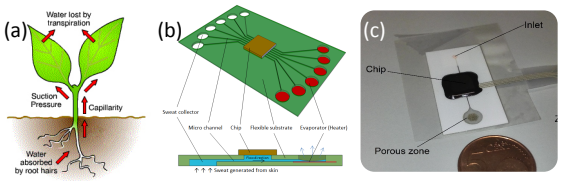


Figure 2: (a) Plants and trees use a combination of fluidic principles to transport liquid from the soil upwards to the leaves. (b) In a previous wearable sweat sensor design, we have mimicked this to achieve continuous absorption of sweat from the skin along a sensor that is integrated in the device. (c) A prototype was fabricated from flexible polymer foils, based on the design in (b), and was proven to work as a continuous liquid pH sensor. [1]

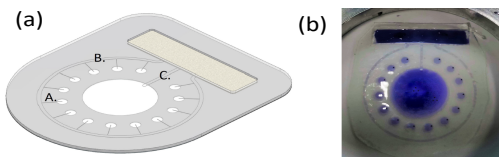


Figure 3: (a) Drawing of sweat collection patch with 14 collection chambers A for sweat rate-per-gland measurement; flow rate sensors are integrated in channels B that lead to a common circular channel that end in a large collection chamber containing an absorber. A larger central chamber collects sweat for concentration measurements for which sensors are integrated in channel C. (b) A prototype filled with a dyed fluid. [2]

Project topics

In our lab, we invent new ways of microfluidic sweat sampling and transfer, suitable for wearable sensing. Fig. 2 shows flexible microfluidic sweat collection device, based on absorption, capillarity, and evaporative pumping, inspired by plants and trees. Fig. 3 shows another approach based on multiple collection chambers, a channel network, and a common sensor channel. However, much work still needs to be done to develop a wearable microfluidic sweat patch with sufficient precision and robustness.

MSc thesis projects can focus on microfluidics design, sweat sampling and transport approaches, microfabrication approaches, integration of sensors, or even panel tests. In this research, our main collaborators are Philips Research, TU/e Electrical Engineering, and Catharina Hospital.

References

[1] C. Nie et al. (2015), Journal of Micromechanics and Microengineering 25, 11.

[2] Ruben Marteijn(2019) MSc thesis TU/e.

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