A TEXTILE-BASED PLATFORM FOR REAL-TIME SWEAT COLLECTION AND ANALYSIS

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EXTENDED ABSTRACT

Key Words: sweat analysis, wearable sensors, passive pump, moisture wicking

1. INTRODUCTION

The ability to perform real-time chemical measurements of body fluids is an exciting concept for the healthcare sector and the sports industry. This work is part of the BIOTEX project, an EU FP6 project which involved the development of textile-based sensors to measure the chemical composition of sweat. This is a challenging task involving the collection of sweat samples, delivery to an active surface and the removal of waste products. A textile based platform with a passive pumping mechanism was developed using a combination of moisture wicking fabric and a highly absorbent material. A textile patch with integrated sensors was developed and used to collected sweat on the lower back for real-time measurements of sweat pH, sodium concentration, conductivity and temperature [1].

2. DESIGN AND FABRICATION

A 115 g/m^2 polyester/lycra® blend was chosen as the basis for the pump. A pattern of blue polyurethane is screen-printed onto the fabric as shown in Figure 1A. A clear polyurethane film is attached to the opposite side of the fabric leaving a small inlet (7mmx7mm) at the top of the channel uncovered. The latter side is placed in contact with the skin. In order to collect sweat over the area covered by the textile patch (55mmx40mm) a layer of acquisition material (Coolmax®/polyester) stitched to the inlet(Figure 1B) interfaces between the patch and skin. Once fluid has entered the channel it travels along the length of the fabric channel. A pH sensitive dye is printed onto the fabric channel and a 20-25 µm thick layer of kapton integrating sodium, conductivity and temperature sensors is placed in contact with the fabric channel(Figure 1A). At the end of the channel a superabsorbent material stores the waste products and also ensure a continuous flow through the channel. Absorbtex, Acquitex and Wipex were investigated for this purpose. Of these, Absorbtex was found to be the most suitable. It has a free swell capacity 25.1g/g, basis weight of 172.2 g/m^2, and is thin with a thickness of 0.53mm. A small piece of Absorbtex (10mmx30mm) enclosed in a package of Acquitex using ultrasonic welding is stitched or attached with glue(UHU fabric glue). Assuming a constant flow rate of 17mg/min the pump should operate for 75min, based on based on measurements by Patterson [2] where the sweat rate on the lower back is 0.85 ±0.41mg/cm^2/min and given the collection area of the ADL is 20cm^2. A channel of width 7mm and length 26mm was created to allow integration of pH, sodium, conductivity and temperature sensors. The dimensions of the channel affect the rate of fluid flow and therefore should match the sweat rate of the wearer, for this reason the end of the channel is tapered to

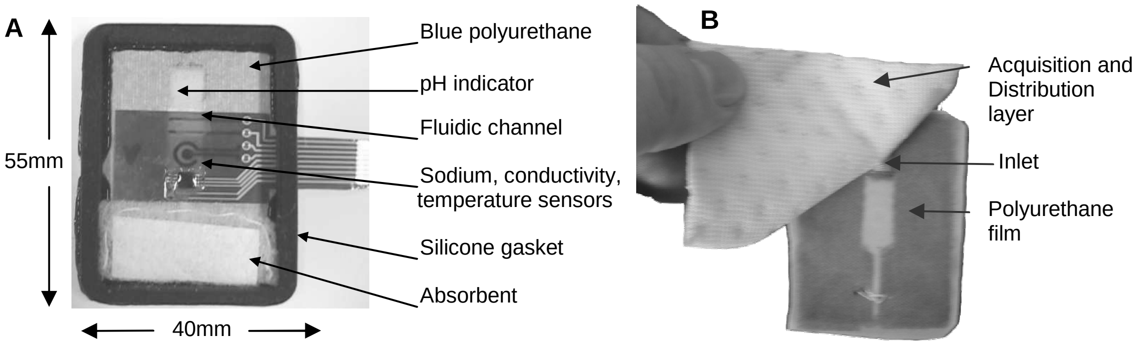

Figure 1 Fabric passive pump design

2mm to reduce the flow rate of the pump. The configuration shown in Figure 1 has an average flow rate of 14mg/min.

3. RESULTS

To demonstrate the ability of the textile based pump to collect and transport sweat during on-body trials the fabric pump was positioned on the lower back of a volunteer performing a cycling exercise in the lab. A green water soluble dye was used to stain the inlet window so that the incoming sweat would carry the dye along the channel into the super absorbent to visually demonstrate the pump operation(Figure 2).

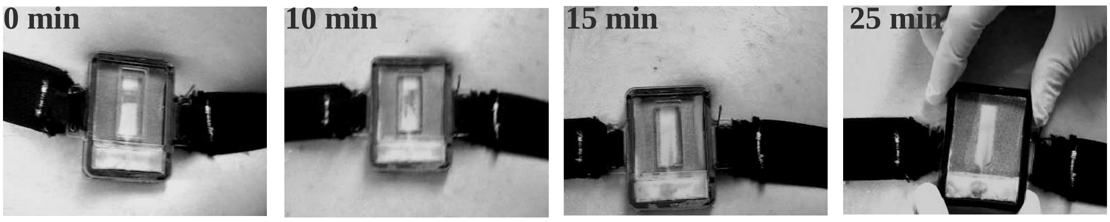

Figure 2 Food dye moved through channel by motion of sweat during exercise

For ten trials, the weight of the absorbent on the fabric patch was recorded before and after exercise in order to obtain an estimate of the rate of flow of sweat through the textile patch. At room temperature (≈20^{o}C) and at low humidity (≈50%) average sweat rates of 3-8.3mg/min were recorded which is significantly lower than the estimated values based on the results by Patterson[2]. This affects the time for sweat to reach the sensors and also affects the contact of sweat with the sensors on the surface of the fabric channel.

4. CONCLUSIONS

The textile pump can successfully collect sweat from human subjects during exercise. Sweat moves along a pre-defined channel where it is analysed by sensors and then stored by an absorbent. This allows a continuous flow of fresh sweat to the sensors using a passive pumping mechanism for wearable on-body sweat analysis.

5. REFERENCES

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