Wearable sweat sensing device for monitoring sweat rate from single glands in sedentary state

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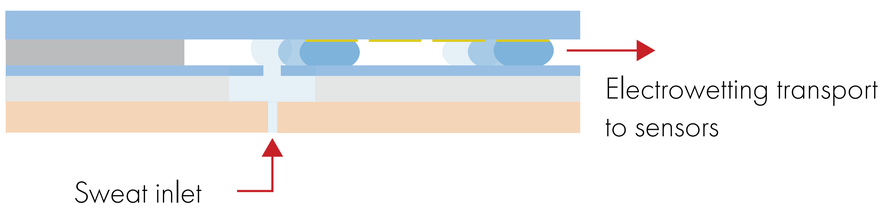
Introduction

The current research of wearable sweat sensing is dominated by devices for monitoring of heat stressed individuals, like atheletes. Development of sweat sensing devices for individuals in sedentary state, like hospitalized patients, is hampered by the low volumes of produced sweat. While stimulation via Pilocarpine iontophoresis can increase the sweat rate temporarily, this is not desired for patients who are critically ill, and it is not a suitable solution for prolonged monitoring. When a typical microfluidic channel would be placed on top of the skin, it would take hours or days to fill, eliminating the possibility to obtain any clinically relevant information in a timely manner. In this work we present an innovative solution for this problem based on sweat collection from single glands and discretized transport using electrowetting-on-dielectrics (EWOD).



Conclusions

- Sampling sweat from single glands.
- Sweat rate measurement of individuals in sedentary state.
- Fast transport of 0.3 nL droplets to the sweat rate sensor proven with functional demonstrators.
- COMSOL models describing the EWOD and filling of the channel.
- Different biosensor integrations possible.

actual size

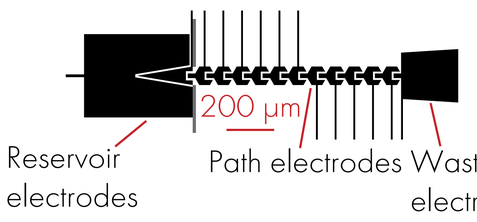
17X30 mm

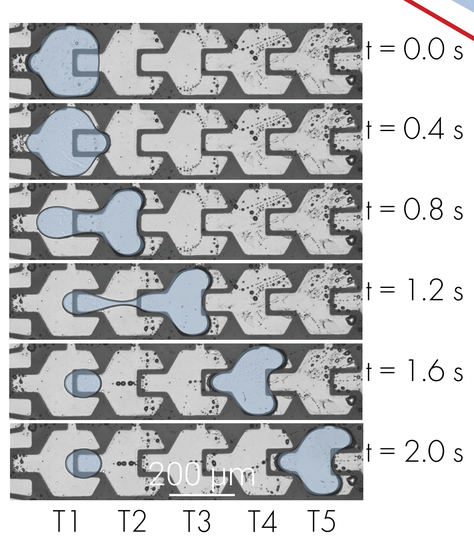
Biosensor module

- Electrochemical glucose sensor.
- Waste reservoir.

Electrowetting transport

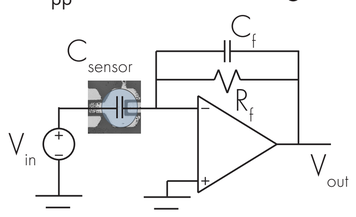
- Contact angle variation by application of an electric field.
- Dielectric stack: 250 nm Silicon nitride, 500 nm Parylene C, and 50 nm PTFE AF1600.
- Oil impregnation on surface to improve sweat transport and reduce biofouling.



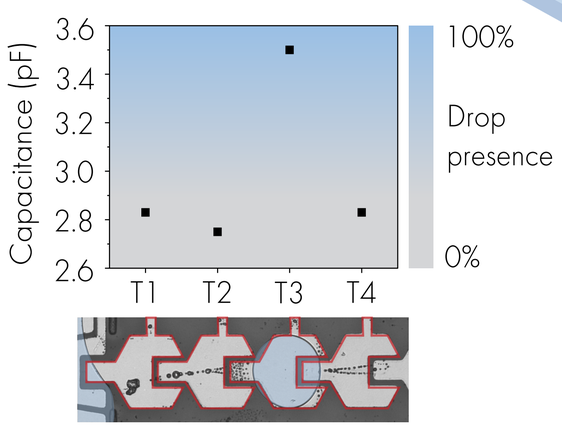


Sweat rate sensor

- Capactive sweat rate sensor by droplet counting.
- 0 V_{pp} measurement signal



$$|V_{out}| = |V_{in}| \frac{C_{sensor}}{C_f}$$



Collection plate

- 400 µm fused silica glass.
- Machined using femtosecond laser and KOH wet etching.
- 20 µm spacer for channel height definition.
- Conductive coating 3/30 nm Cr/Au.
- 50 nm hydrophobic coating PTFE AF1600.

Medical tape

- Sealed discrete sampling chambers.
- Statistically a low (0.1%) chance of sampling more than two glands in the same chamber.
- Covering a total surface area with ~10 glands.

	P_0	P_1	$P_{>1}$
50 active glands/cm^2	96.5%	3.4%	0.1%
Collection area ø 300 µm			

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