Contactless Conductivity Sensor for Wearable Sweat Monitoring

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Background: Sweat as a diagnostic tool

- Hydration
- Disease (CF)

https://www.girlsgonestrong.com/blog/nutrition/water-hydration/
https://en.wikipedia.org/wiki/Cystic_fibrosis
Background: Challenges

- Sampling mechanism
- Sample handling
- Analysis

S. M. Shirreffs and R. J. Maughan, Journal of Applied Physiology January 1, 1997 vol. 82 no. 1 336-34

Temporary tattoos

+ Inexpensive
+ Unobtrusive
+ Disposable
- Fully Wearable?
- Real time?


Watches and Wristbands

+ Fully integrated device

- ISEs
- Use time?


Experimental set-up

- Capacitively coupled contactless conductivity (C⁴D)
- No biofouling of sensor
Microchannels

Top

Bottom

Expanded side

- 3 mm PMMA
- 50 µm PSA
- 0.6 mm PMMA
- 50 µm PSA
- 100 µm glass slide
- 50 µm PSA
- 0.6 mm PMMA
CF: 

\[ [\text{NaCl}] > 60 \text{mM} \]

\[ y = -2.6865x + 2132.7 \]
\[ \text{R}^2 = 0.9849 \]

\[ y = -0.9208x + 2041.3 \]
\[ \text{R}^2 = 0.9933 \]
Voltage vs. time using 10, 30, 60, 90 and 130 mM NaCl at a flow rate of 20µL/min. Each measurement was taken in triplicate 5 min tests and averaged. A PDMS microchannel with a surface area over the electrodes of 0.183 mm² was used.
Microchannel design

Maximize surface area of the channel with respect to the electrode

PDMS channel design

PMMA channel design
Injection of varying NaCl concentrations

Au microelectrode voltage vs. time graph using 10 mM NaCl as the eluent and injecting 100µL of (A) 130 mM NaCl and (B) 30, 60, 90 and 130 mM NaCl at a flow rate of 20µL/min. A PMMA microchannel with a surface area over the electrodes of 0.36 mm² was used.
Next steps

• New PMMA channel designs
  – Minimizing fluidic volume
  – Maximizing surface area

• Varying flow rates

• Integration into on-body platform

Glennon, T; O'Quigley, C; McCaul, M; Coyle, S.; Matzeu, G; and Coleman, S; and Ben Azouz, A; Beirne, S; Wallace, G; and White, P; O'Mahoney, N; Diamond, D. (2016) ‘SWEATCH’ - A platform for real-time monitoring of sweat electrolyte composition. In: ACES2016 Symposium, 10-12 Feb. 2016, Deakin University, Melbourne, Australia.
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