Centre for
Data Analytics

WEARABLE CHEMICAL SENSING – OPTIMIZING PLATFORMS AND SENSITIVITY FOR REAL-TIME SWEAT ANAYLSIS

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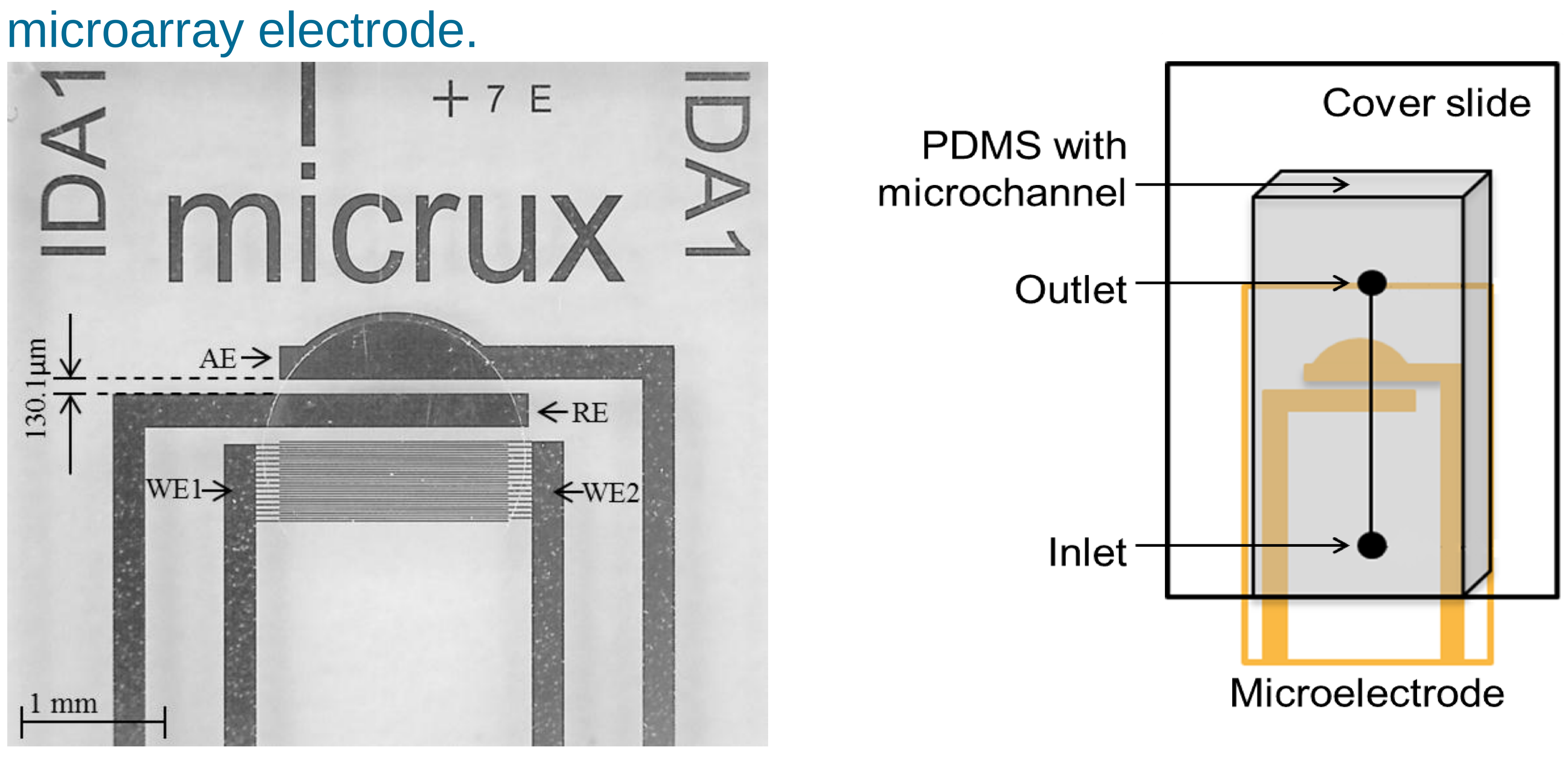
Introduction

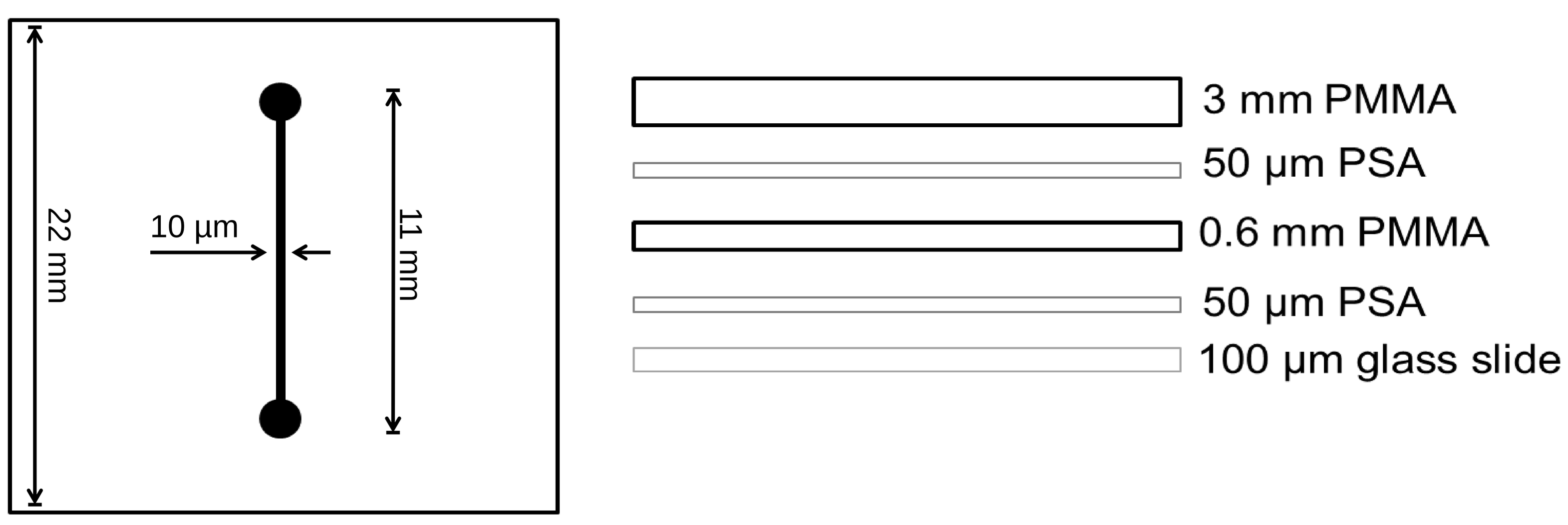
This work presents the optimization of electrical parameters and sampling platforms to maximize the sensitivity of conductivity measurements for applications in wearable sweat sensing. Capacitively coupled contactless conductivity detection (C4D) was used to test microelectrodes in preparation for the creation and development of an on-body detection system for sweat analysis. In addition, various polydimethylsiloxane (PDMS) and poly(methyl methacrylate) (PMMA) microchannels of various configurations were tested for their compatibility with the system and their enhancement effect on signal sensitivity.

Background

A TraceDec C4D system was used to determine the conductivity of a range of NaCl solutions using a Micrux thin-film interdigitated microarray electrode.

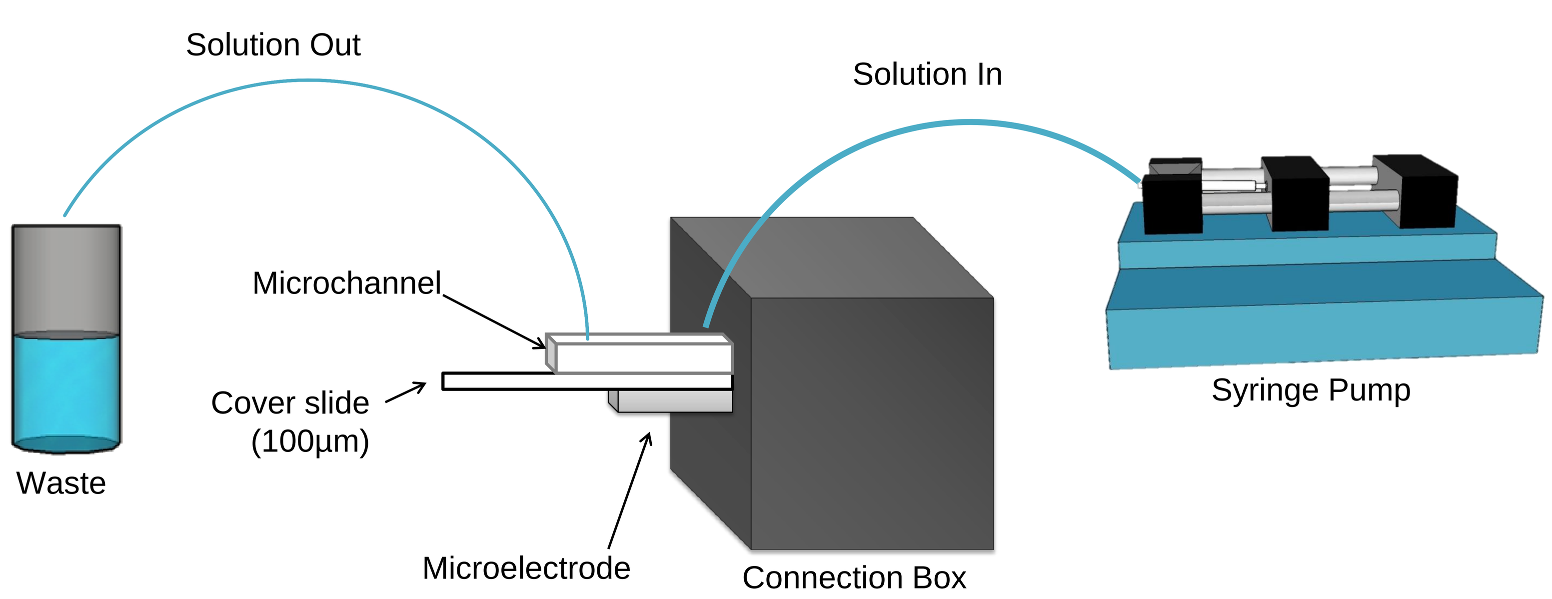


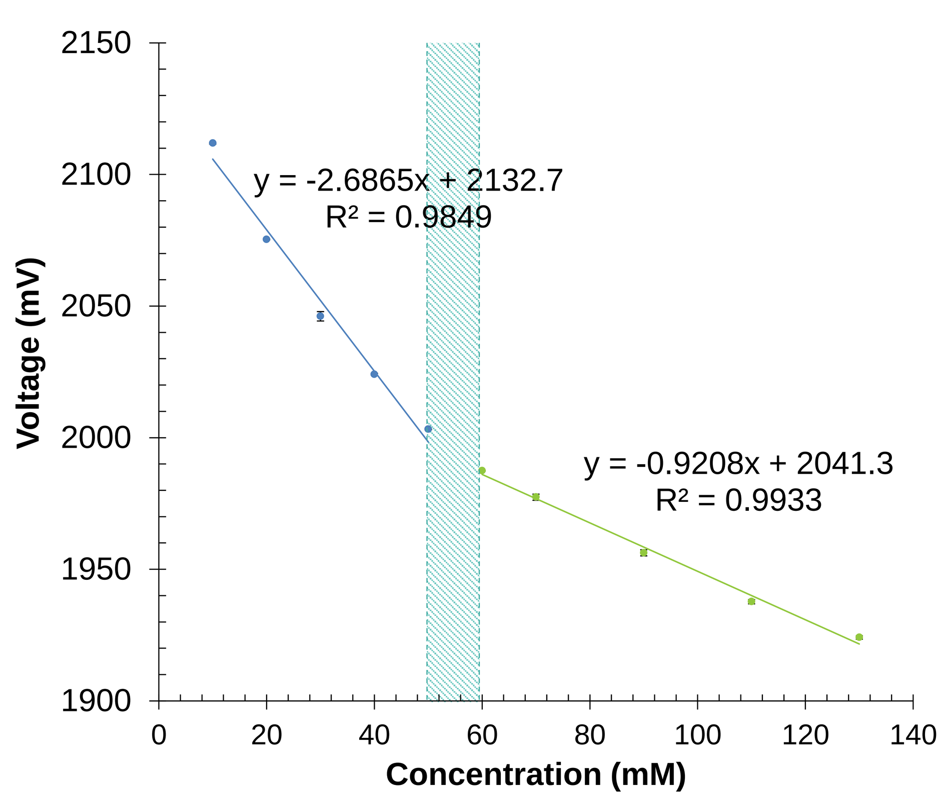
Multiple channel configurations were created in PDMS to optimize the design with respect to direction of flow and practical integration into a wearable device.



Channel designs were also created in PMMA for increased durability in wearable applications and increased surface area of the channel with respect to the sensor.

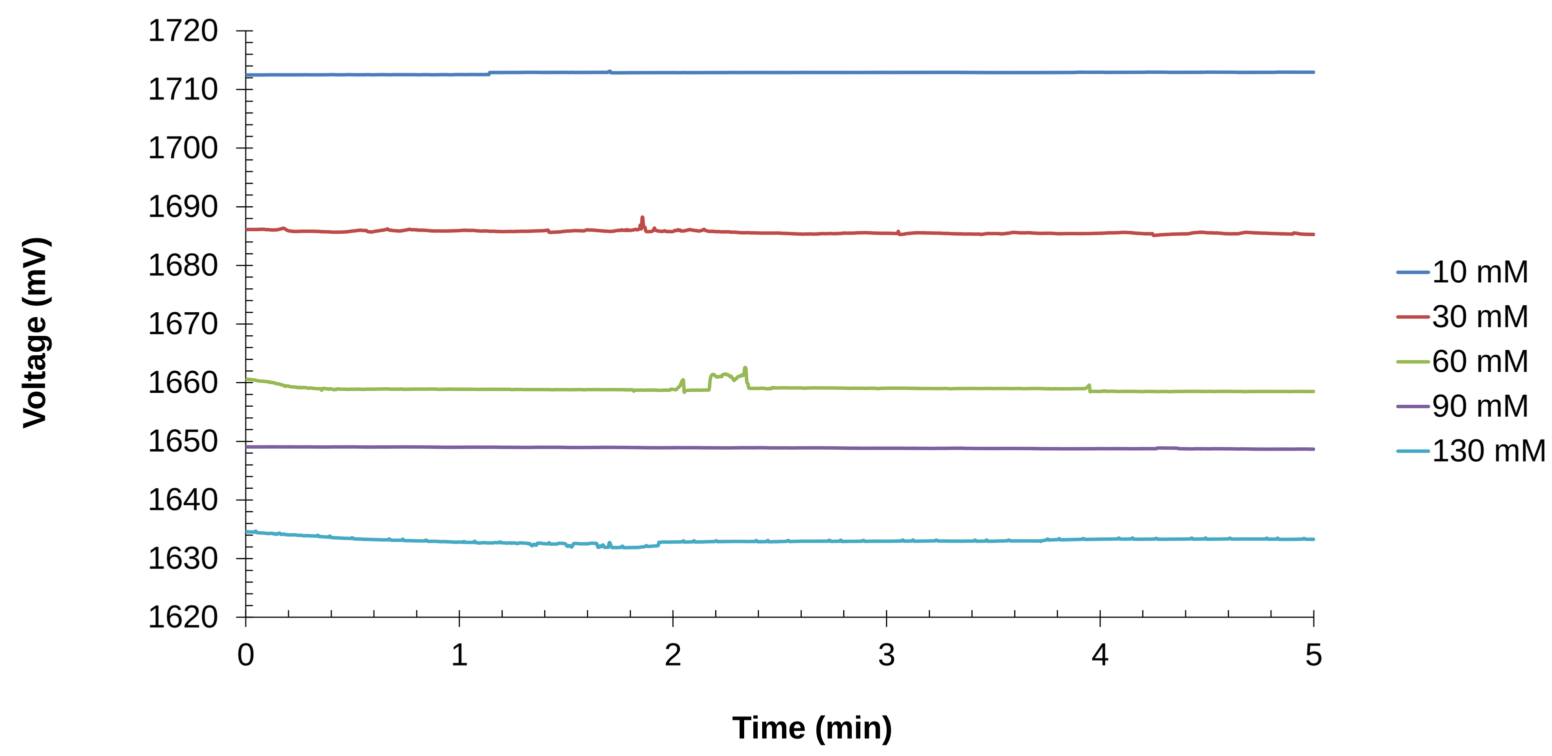
C4D Calibration





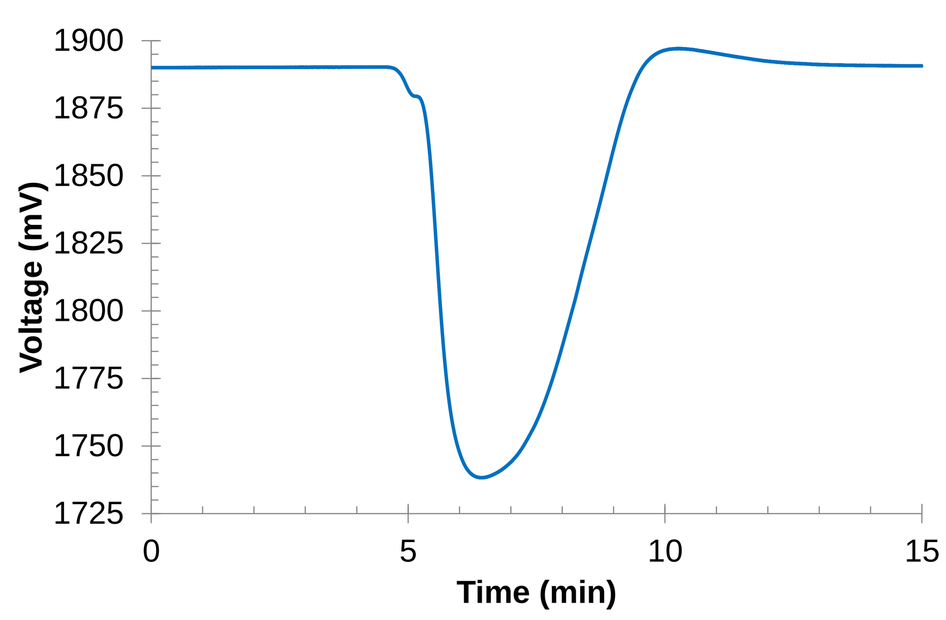
A gold Micrux chip was calibrated with 10-130 mM solutions of NaCl with a flow rate of 20 µL/min. Two distinct linear ranges are sustained; 10-50 mM and 60-130 mM. NaCl concentration variations over the normal range (<60 mM) and elevated values associated with cystic fibrosis (>60 mM) can be clearly distinguished.

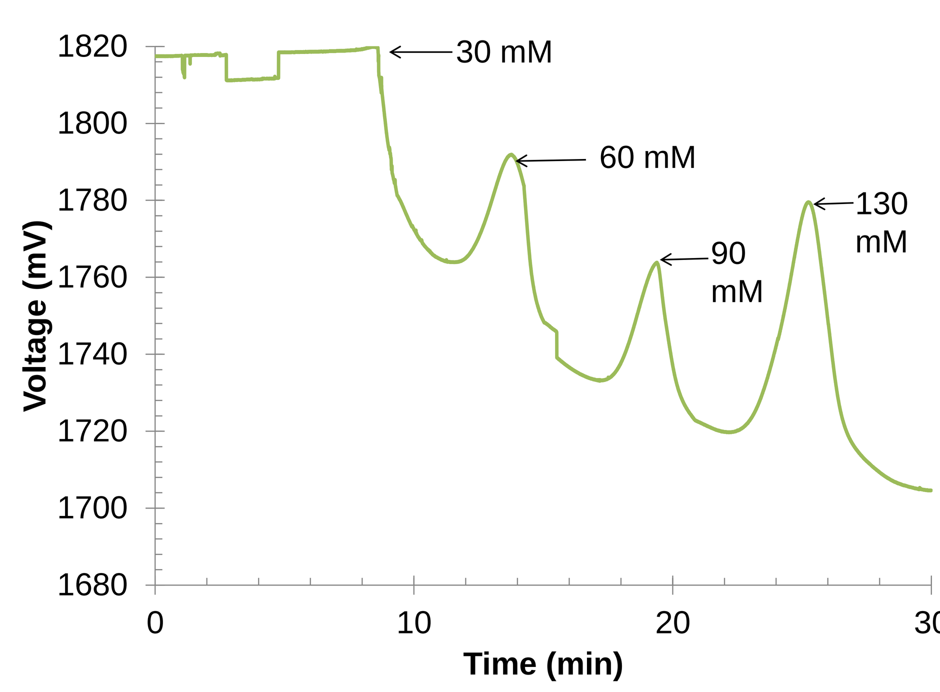
Measurement Stability



Measurements also showed high repeatability over the calibration range (relative standard deviation between 0.0087%-0.0726% for n=3) and high stability over 5 minute measurements (relative standard deviation between 0.0017%-0.0860% for n=5940). These measurements may be used to determine the efficacy of therapeutic interventions to regulate the ion composition towards normal levels, which is detectable in sweat.

Platform Optimization





Multiple channel configurations were created to optimize the direction of flow and surface area of the channel with respect to the sensor. The larger channel surface areas with respect to the electrode used in the PMMA microchannels dramatically increased the voltage difference between [NaCl] compared to the PDMS microchanels. In addition, the durability of the PMMA channels makes them desirable for wearable applications.

Conclusions

The results of this work will be implemented in a real-time, wearable device for monitoring the sweat conductivity. Such a device may be used to monitor hydration levels and test the effect of cystic fibrosis medications. Additionally, optimization of such a platform could allow replacement or integration of other detection methods for sodium, or integration of detection methods for other physiological features.

Acknowledgments

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