COLORADO STATE UNIVERSITY

bliss

Multi-Sensor Device for Measuring Metabolism for Cell Culture and Live Tissues

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Problem Statement

Problem: Currently, there is no available product to enable researchers to directly measure metabolistic processes for cell and tissue research in terms of glucose, oxygen, pH, lactate, and glutamine levels in real time.

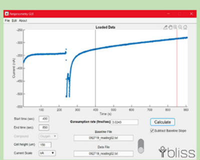
Existing Opportunities: A product with these capabilities would allow researchers to gain a more complete set of data during experimentation to supplement optical observations, to allow for improved understanding of cellular response and testing of novel drug treatments for a variety of applications.

Project Goals

- Ensure biocompatibility for cell and tissue cultures
- Fully calibrate system for glucose, oxygen and pH analysis
- Develop microfluidics system to allow for longer experimentation and future drug testing
- Refine manufacturing process to ensure proper tolerances, improve consistency and increase speed of production
- Minimize cost of production and material usage
- Design smart well-plates systems to be able to integrate up to current 96-well plates

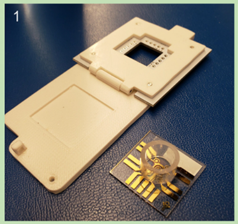
Techniques

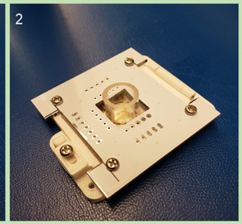
- Photolithography
- Electrochemistry
- Circuit design & soldering
- CNC & 3D printing
- Microfluidics Design
- GUI creation in MATLAB

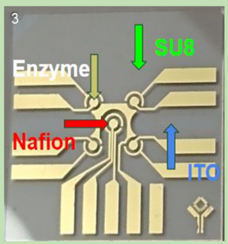


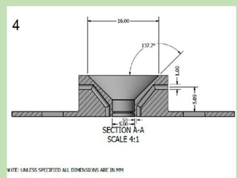
Prototypes and Figures

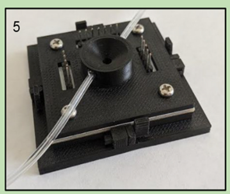
1. Open single-well device
2. Closed single-well device
3. Single chip layout and layer composition
4. Microfluidics cross-section
5. Complete sealed microfluidics device
6. Microfluidics test

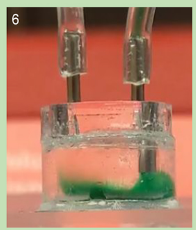






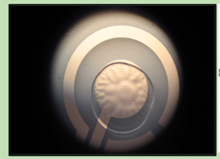


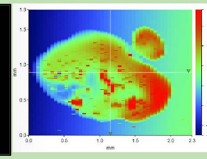




Experiments

- Metabolite Calibration: Glucose, Glutamine, pH
- Gold thickness profiling
- Embryo/Oocyte, Stem cell, Cancer cell experiments.
- Chamber leak test
- Enzyme & Nafion drop-test





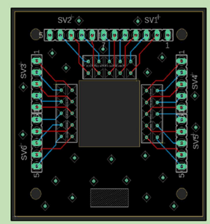
Impact

Ethical Concerns:
- Ethical considerations of selecting “best” embryo based on quantitative data
- Usage of human cells in research

Economic and Environmental Impacts:
- Materials chosen to be biocompatible with cell and tissue cultures
- When possible parts were designed to be reusable (base) and minimize material usage when single use (chips)

Conclusion

- Multiple iterations of device to fix issues discovered during live experiments
- Design for future scalability of a single-well system
- **Future additions**:
  - On-board electronics
  - Illumination for the well
  - Protective encapsulation



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References: Obeidat, Y. M. et al. Design of a multi-sensor platform for integrating extracellular acidification rate with multi-metabolite flux measurement for small biological samples. Biosens. Bioelectron. 133, 39–47 (2019).