

Improving Sensitivity of the Lab on a Chip Device by Using Optical Detection

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Significance of this Research

- ❖ There is a lack of access to healthcare facilities, which causes difficulty when trying to obtain blood tests.
- ❖ Lab-on-a-chip makes it accessible at low cost.
- ❖ Optical detection is advantageous because light is ubiquitous, and easier to use.



Abstract

- ❖ Pathogen detection is limited in applications due to lack of portability and disposability of sensitive and selective equipment.
- ❖ Large and complicated equipment and need for trained personnel restricts detection to a laboratory.
- ❖ ReS2 is used to explore optical detection methods to improve sensitivity and usability.
- ❖ Optical methods using ReS2 are less prone to deviations based on ionic concentration than electrical methods.

Background

- ❖ Nanoporous substance increases mixing and reduces the effect of the parasitic double layer.
- ❖ Electrical methods using interdigitated electrodes packed with CNT have shown to be highly sensitive and selective and precise.

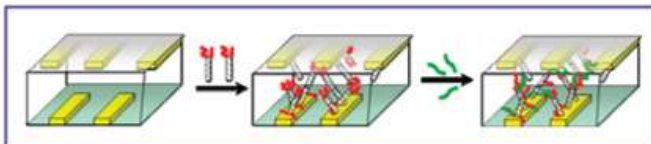


Figure 2***. Treated nanotubes capture biomarkers from the sample, while also decreasing laminar flow.

Objective

To implement optical detection methods of pathogen detection in the lab on a chip using ReS2 to increase usability.

Chip Design

The smaller device allows for easy transportation and accessibility. Remote areas will have access to quick blood testing, even without trained personnel.

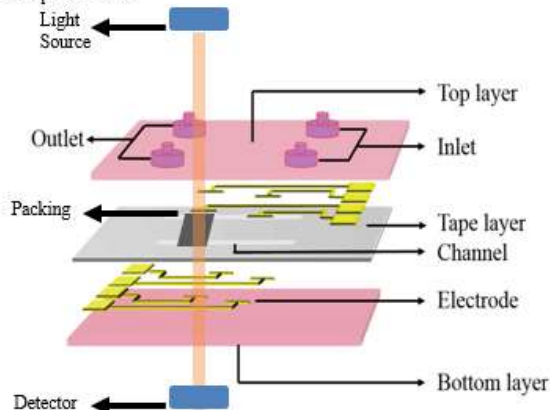


Figure 1. Schematic of chip design

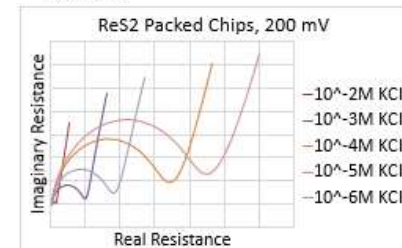
Experimental Protocol

Gather optical and electrical data of the ReS2, TiO2, and CNT chips by using multiple concentrations of KCl. The Electrochemical Impedance Spectroscopy machine and the optical detection unit were used.



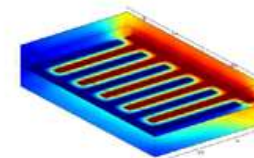
Results

- ❖ ReS2 is highly sensitive to changes in ionic concentration
- ❖ While optical results have not been finalized, it is expected that ReS2 will be less sensitive to ionic changes when optical detection is utilized.



Future Work

- ❖ Hybridize single stranded DNA to connect it to ReS2
- ❖ Quantifying measurements.
- ❖ Explore the effectiveness of other light reactive nanowires with different light responses



References

- ❖ Pires NM, Dong T, Hanke U, Hoivik N. Recent developments in optical detection technologies in lab-on-a-chip devices for biosensing applications. *Sensors (Basel)*. 2014;14(8):15458-15479. Published 2014 Aug 21. doi:10.3390/s140815458
- ❖ Sagnik Basuray, Satyajyoti Senapati, Andrew Aijian, Andrew R. Mahon, and Hsueh-Chia Chang. Shear and AC Field Enhanced Carbon Nanotube Impedance Assay for Rapid, Sensitive, and Mismatch-Discriminating DNA Hybridization. *ACS Nano* 2009 3 (7), 1823-1830 DOI: 10.1021/nn9004632***

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Improving Sensitivity of the Lab on a Chip Device by Using Rhenium Disulfide

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Problem Statement

- Blood testing is expensive and inaccessible
- Lab on a chip will:
 - More accessible: cheaper and more portable than transporting blood samples
 - Early detection: biomarkers are present before symptoms arise

Significance

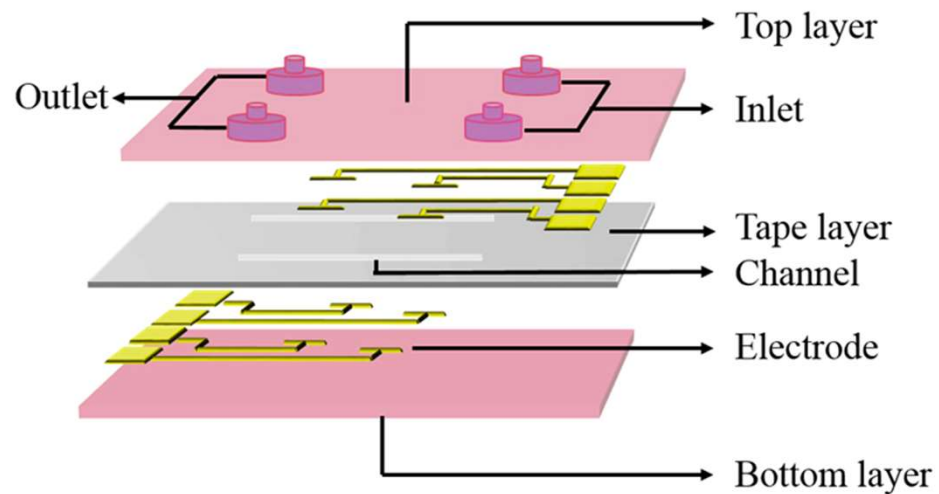
- More accessible: cheaper and more portable than transporting blood samples
- Early detection: biomarkers are present before symptoms arise

Specific Objectives

- To increase sensitivity by using both optical and electrical detection methods

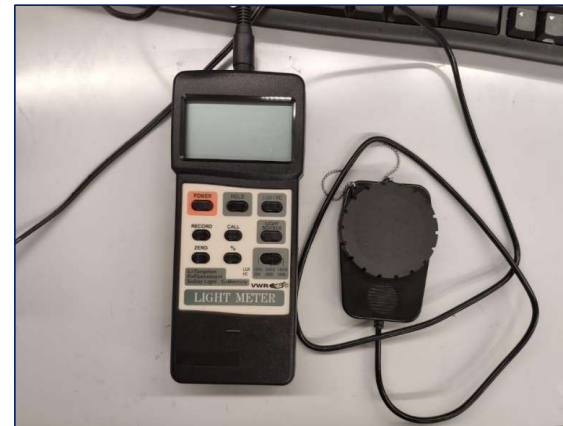
Background and Approach

- Biomarkers: a pathogen, protein or strand of DNA whose presence in a blood sample indicates a disease.
- ELISA test: enzyme linked immunosorbent assay

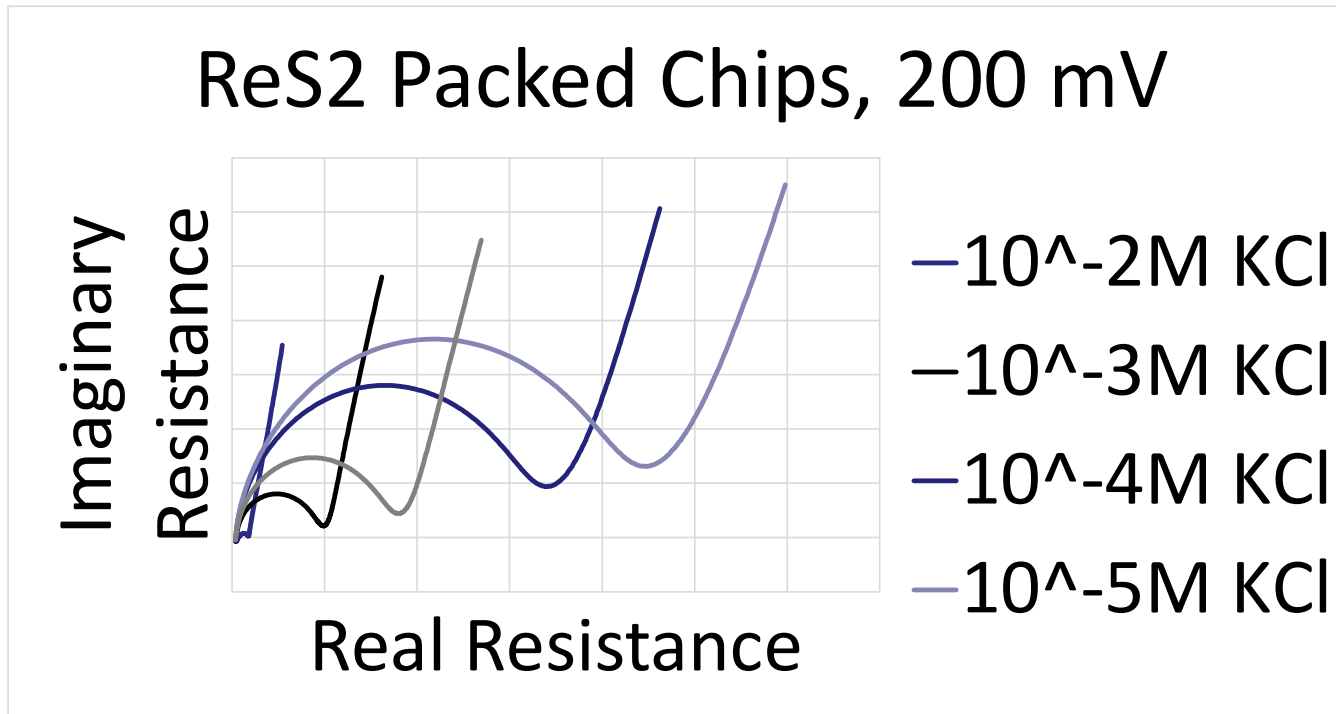


Experimental Design and Methods

- Vary concentration, configurations, and voltage to observe change in impedance



Results



Conclusion and Future Work

- Optical and electrical detection will increase sensitivity
- In the future we will use DNA
- Repeat the experiment without light

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 - REU students for unwavering support

References

- Pires NM, Dong T, Hanke U, Hoivik N. Recent developments in optical detection technologies in lab-on-a-chip devices for biosensing applications. *Sensors (Basel)*. 2014;14(8):15458–15479. Published 2014 Aug 21. doi:10.3390/s140815458
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