

Optimization of Electrochemical Sensors to Study *Pseudomonas aeruginosa* in Hospital Environments

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It is well-known that bacteria play major roles in the world that we live in today. These roles vary widely from aiding in digestion in the human intestinal tract to deadly infections.¹ Understanding what regulates bacterial response is therefore of utmost interest to the scientific and medical community. It is not yet fully understood how infection begins at the single-cell level. Beginning with a single bacterial cell, stimuli from the environment and other physiological factors set in motion a series of events that lead to colonization, and in certain cases infection. By elucidating these factors and investigating their processes, significant insight can be made into the prevention of bacterial infections as well as the development of more sophisticated drug treatments. By combining this knowledge with micro- and nano-engineering, a new generation of sensors can be developed to both detect and prevent infection.

Of the various bacteria that plague modern medicine today, *Pseudomonas aeruginosa* is important to study because of its opportunistic nature that allows it to persist in the healthcare setting. Accounting for 10% of hospital acquired infections, *P. aeruginosa* is a widespread gram-negative bacterium responsible for severe infections in people with compromised immune systems such as those with burns, HIV, and cystic fibrosis.² Unique to this bacterium is its production of pyocyanin, a quorum sensing molecule linked to biofilm formation and ultimately infection in humans. Being a redox active molecule, pyocyanin can be measured electrochemically to monitor how *P. aeruginosa* communicates and grows.

The fabricated nanofluidic electrochemical assembly developed by the Goluch Group is currently able to measure low concentration levels of pyocyanin. The device integrates a palladium hydride reference electrode with a working electrode to create a sensor inside of a nanofluidic constriction that is small enough to study individual bacterial cells.³ Although the device can detect early infection and contamination of *P. aeruginosa*, its current design limits its use to the laboratory setting. Made of a rigid silicon substrate that is sensitive to high electrochemical noise, the sensor is not stable enough to function in the medical environment. Several limitations of the device include its non-flexible substrate, limited sample medium, and sensitivity to sound.

The research will aim to develop alternative fabrication techniques and materials to address the previously stated limitations of the device. Because of their mechanical flexibility, light weight, enhanced durability, and cost efficiency, polymer-based materials will be examined. Recent advances in the fabrication of single-walled carbon nanotubes have resulted in the successful transfer of integrated digital circuits onto polyimide, demonstrating the need to further explore alternative methods for fabrication on polymer substrates.⁴ Adapting the current device to a flexible substrate is a necessary step towards creating more effective bacterial detection sensors in the hospital setting.

References:

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