

Fabrication of Microelectrode Arrays for Oxygen Generation to Support Cellular Growth in Implantable Devices

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Primary CNF Tools Used: AJA Sputterers, Oxford 81/82, ABM Contact Aligner, Odd-Even hour evaporators

Abstract:

This project aims to develop a microelectrode array for wireless generation of oxygen to support cell culture in implantable, therapeutic devices. To achieve this goal, we have fabricated Platinum (Pt) and Gold (Au) microelectrodes using tools available at Cornell Nanofabrication Facility (CNF). The electrodes are fabricated directly into flexible substrates (e.g., polyimide (PI) and PET thin films) and Iridium oxide (IrOx) films are electrochemically deposited. IrOx catalyzes watersplitting, leading to oxygen evolution at a lower potential (~ 1.2 V) compared to bare Pt (~ 1.7 V). Based on the oxygen generation performance of the Pt/IrOx electrodes, the microelectrode design have been revised to optimize oxygen generation for cell growth. In future, the Pt/IrOx electrodes will be integrated with NFC chips to allow for wireless operation of the devices.

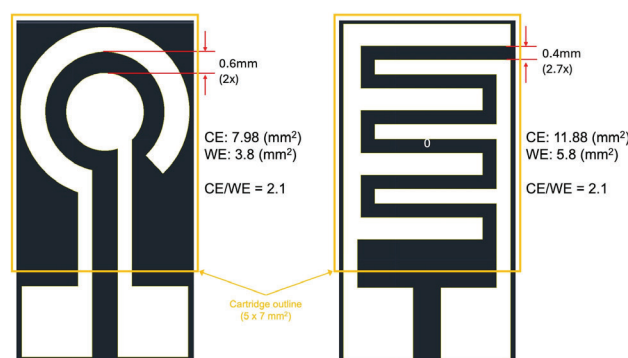


Figure 1: Updated design of microelectrode to enhance counter electrode area.

of the microelectrode array has been optimized to account for the potential drop in 2-electrode setup for seamless integration with the final implantable device. In 2-electrode system, the onset potential for oxygen generation is shifted to higher values due to the unavoidable potential drop arising from the current-driven polarization on the surface of the counter electrode continuously altering the reference [1]. To balance this, we have updated the design of our microelectrodes for a higher counter/working electrode surface area and decreasing the distance between them to enhance conductivity (Figure 1). We have successfully redesigned the mask and fabricated Pt and Au microelectrodes with higher counter electrode area on commercially available PI as previously (Figure 2).

Summary of Research:

The Ti/Pt and Cr/Au microelectrode array is fabricated using much simpler approach compared to previous iterations. Commercially available PI and PET thin films are treated with oxygen plasma and primed with HDMS followed by photolithography for patterning microelectrode arrays. Pt microelectrodes are fabricated using lift-off process while Au microelectrodes are fabricated using wet etching. This year, the design

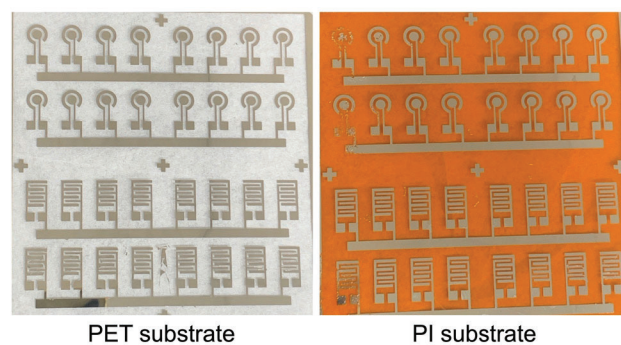


Figure 2: Pt microelectrodes fabricated on polyimide (PI) and PET films.

Conclusions and Future Steps:

Based on our preliminary experiments using the microfabricated devices, the designs have been updated to enhance performance. We are currently exploring and investigating micro-coil antenna designs to integrate the microelectrodes into a wireless oxygen generation system.

References:

- [1] Robert K. Franklin, Steven M. Martin, Timothy D. Strong, Richard B. Brown, 2.12 - Chemical Sensors, Editor(s): Yogesh B. Gianchandani, Osamu Tabata, Hans Zappe, Comprehensive Microsystems, Elsevier, 2008, Pages 433-461, <https://doi.org/10.1016/B978-044452190-3.00044-6>.