Electrochemiluminescence & microfluidic combination for imaging permeabilization of giant liposomes

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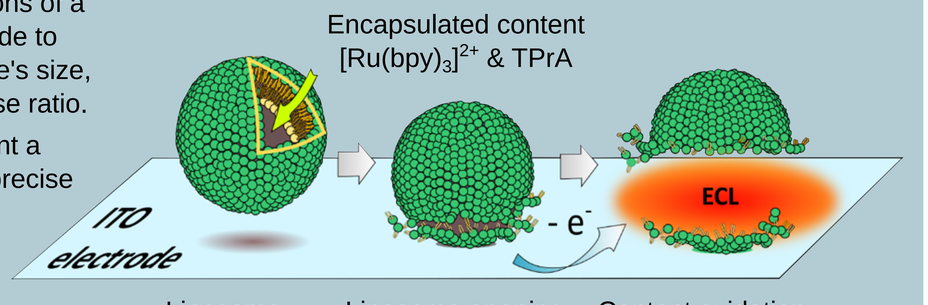
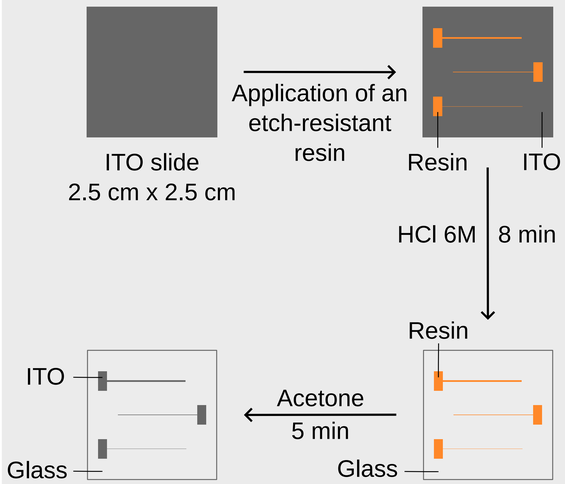
Introduction

In this study, we focus on giant liposomes, which consist of a phospholipid bilayer with a diameter of approximately 100 µm, and offer a versatile model for exploring membrane dynamics and drug delivery strategies. Our primary aim is to investigate the permeabilization of liposomes through imaging techniques. To achieve this, our objectives are as follows:

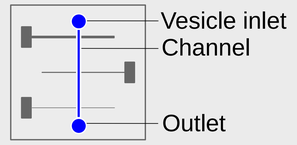
1. Reduce the dimensions of a transparent ITO electrode to match a single liposome's size, improving signal-to-noise ratio.
2. Design and implement a microfluidic device for precise liposome selection.
3. Utilize electrochemi-luminescence (ECL) to observe membrane permeabilization dynamics.



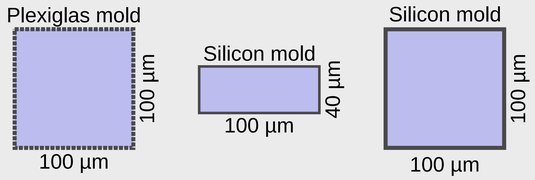
1. Microelectrode design



2. Microfluidic chip



Optimization of the dimensions of the channel:



- Non-adhesive
- Too narrow
- ✓

3. Electrode-chip bonding

Problem: electrode and microfluidic circuit do not adhere.

Hypothesis: etching increases glass roughness, reducing the glass-PDMS contact surface and the effectiveness of bonding.

First trial: reduce the roughness of the ITO slide by reducing [HCl] while increasing etching duration, but bonding was still unsuccessful.

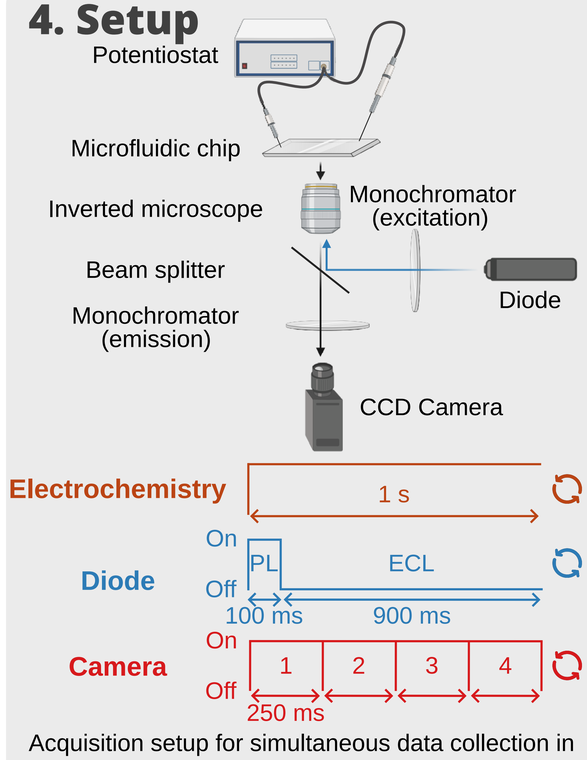
Second trial: reduce the roughness of the microfluidic circuit.

Mold \ Glass	Untreated (ref.)	Treated
Plexiglas	+	-
Silicon	+++	++

Qualitative tests of bonding between the PDMS microfluidic circuit and the etched glass slide.

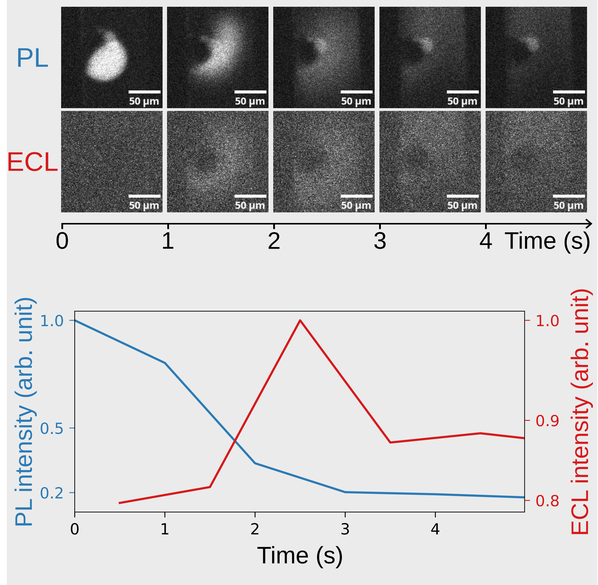
Conclusion: using a Silicon mold, bonding is effective.

4. Setup



Acquisition setup for simultaneous data collection in electrochemistry, ECL, and photoluminescence (PL).

5. Results



Observation of photoluminescence (PL) and electrochemiluminescence (ECL) over time, illustrating liposome permeabilization following electrode polarization.

Conclusion

We developed a method for manufacturing ITO electrodes, determined the optimal dimensions of the microfluidic channel, and conducted experiments on single liposomes.

Further work involves processing current measurements to achieve a triple characterization of liposomal permeabilization.

References

Fatma Ben Trad et al., Electrochemiluminescence Imaging of Liposome Permeabilization by an Antimicrobial Peptide: Melittin. *Chemical & Biomedical Imaging* **2023**, *1* (1), 58–65.

Fatma Ben Trad et al., Dynamic Electrochemiluminescence Imaging of Single Giant Liposome Opening at Polarized Electrodes. *Anal. Chem.* **2022**, *94* (3), 1686–1696.

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