Microfluidics: membrane filters

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Introduction

Soon enough we realized that we would need something to confine the bacteria, so that it doesn't attack the neurons during our experiments, or escape the device in a real prosthesis system. The solution came as a nanoporous membrane, that would also be used as the conductive element in our system to transmit the neuron's impulses to an electrode. The goal here is to coat alumina oxide membranes with different types of conductive polymers.

Figure 1 – *White alumina oxide membranes before coating*

I. PEDOT :PSS coating

An aqueous solution of PEDOT :PSS can be prepared [1]. We decided to dip the membranes in this solution during the polymerization.

I.1. Materials

- EDOT (3,4-Ethylenedioxythiophene, Sigma-Aldrich, 483028-10G)
- PSS (Sodium 4-vinylbenzenesulfonate, Sigma-Aldrich, 94904-100G)
- Deionised water
- Sodium persulfate (Sigma-Aldrich, 216232-500G)
- Iron(III) sulfate hydrate (Sigma-Aldrich, F0638-250G)
- Alumina Oxide Membrane Filters, 0.2 micron pores, 13 mm (Sterlitech)
- Stripette (Corning Costar, 5 mL) + pipette filler

- Analytical balance (Mettler Toledo NewClassic MF ML204 /01)
- Magnetic stirrer with heating plate (yellowline MSH basic)
- Fume hood (Delagrave SA OPTIMUM 1500)
- Gloves (Kimtech purple nitrile)
- Forceps (Bochem art. 1013)
- Glass beaker (600 mL)
- Petri dish

I.2. Procedure

Step 1 : Pour 0.8 g EDOT, 2 g PSS and 208 mL water in the glass beaker.
Step 2 : Put the membranes in the solution.
Step 3 : Stir for 10 minutes.

Figure 2 – *Solution with membranes after 10 minutes of stirring*

Step 4 : Add 2 g of sodium persulfate and 0.015 g of iron(III) sulfate hydrate.
Step 5 : Stir for 24 hours.

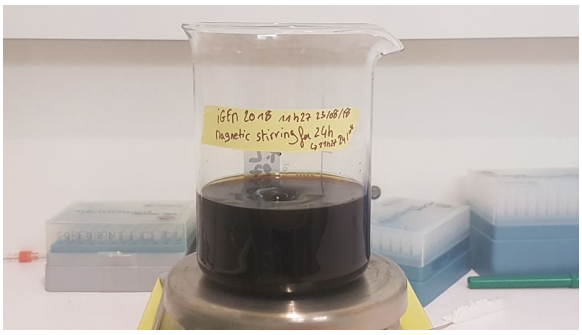

Figure 3 – *Solution after 24 hours of stirring*

Step 6 : Wash membranes with water and let them dry at room temperature in a Petri dish.

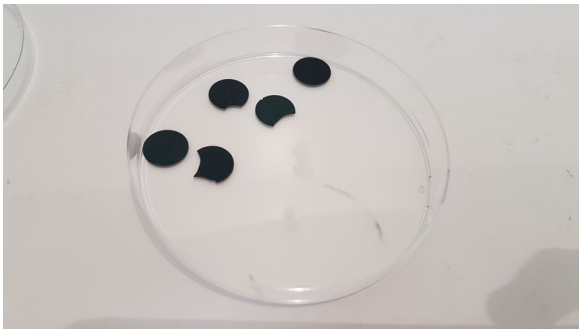

Figure 4 – *PEDOT :PSS coated membranes*

II. PEDOT :TS AND PEDOT :CL COATING

PEDOT :Ts and PEDOT :Cl polymers can be obtained by vapor phase polymerization on alumina oxide membranes [2].

II.1. Materials

- EDOT (3,4-Ethylenedioxythiophene, Sigma-Aldrich, 483028-10G)
- Iron(III) p-toluenesulfonate hexahydrate for PEDOT :Ts (Sigma-Aldrich, 462861-25G) or Iron(III) chloride for PEDOT :Cl (Fischer Scientific, 217091000)
- 1-butanol (Sigma-Aldrich, B7906-500ML)
- Deionised water
- Alumina Oxide Membrane Filters, 0.2 micron pores, 13 mm (Sterlitech)
- Paper masks (see figure 5)

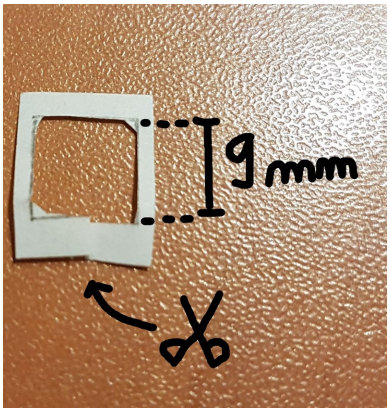

Figure 5 – *Paper mask*

- Stripette (Corning Costar, 5 mL) + pipette filler
- Analytical balance (Mettler Toledo NewClassic MF ML204 /01)
- Magnetic stirrer with heating plate (yellowline MSH basic)

- Fume hood (Delagrave SA OPTIMUM 1500)
- Gloves (Kimtech purple nitrile)
- Forceps (Bochem art. 1013)
- Glass beaker (600 mL and 50 mL)
- Petri dish

II.2. Procedure

Step 1 : Prepare homogenous oxidant solution.
- for PEDOT :Ts : 1.58 g Iron(III) p-toluenesulfonate hexahydrate and 10 mL butanol

Figure 6 – *Oxidant solution for PEDOT :Ts*

- for PEDOT :Cl : 1.35 g Iron(III) chloride and 10 mL butanol

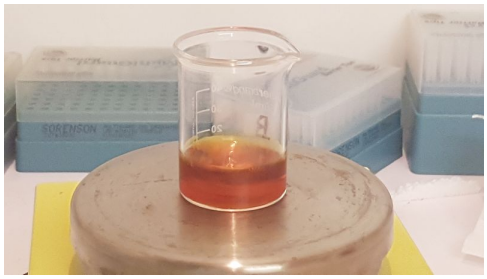

Figure 7 – *Oxidant solution for PEDOT :Cl*

Step 2 : Dip membranes in oxydant solution.
Step 3 : Let membranes dry at 40°C.

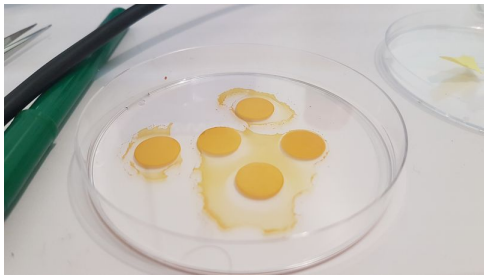

Figure 8 – *Membranes after being dipped in oxidant solution*

Step 4 : Place membranes in paper masks on Petri dish lids.

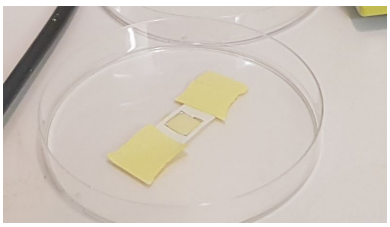

Figure 9 – *Membrane in paper mask*

Step 5 : Pour 200 μL EDOT in 50 mL beakers.
Step 6 : Place Petri dish lids on top of the 50 mL beakers, membranes facing the inside of the beakers.
Step 7 : Heat the beakers at 40°C and stop when membranes darken (takes about 6 minutes).

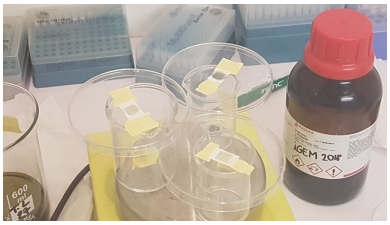

Figure 10 – *Vapor phase polymerization of PEDOT :Ts*

Step 8 : Wash membranes with butanol and water.
Step 9 : Let membranes dry at room temperature.

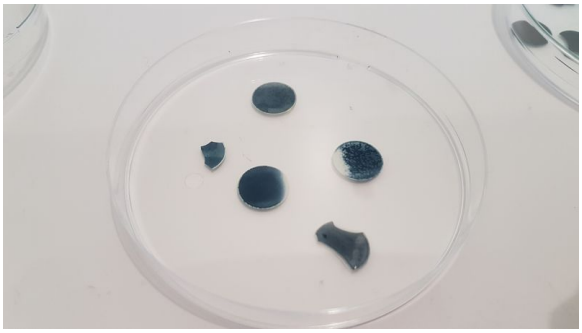

Figure 11 – *PEDOT :Ts coated membranes*

Figure 12 – *PEDOT :Cl coated membranes*

References

[1] Jikui Wang, Guofeng Cai, Xudong Zhu, Xiaping Zhou, *Oxidative Chemical Polymerization of 3,4-Ethylenedioxythiophene and its Applications in Antistatic coatings*, Journal of Applied Polymer Science, 2012, Vol. 124, 109-115 .

[2] Alexis E. Abelow, Kristin M. Persson, Edwin W.H. Jager, Magnus Berggren, Ilya Zharov, *Electroresponsive Nanoporous Membranes by Coating Anodized Alumina with Poly(3,4-ethylenedioxythiophene) and Polypyrrole.* 2014, 299, 190–197.