

# **Integration of printed supercapacitor modules and irreversible electrochromic displays**

**Hamed Pourkheirollah**

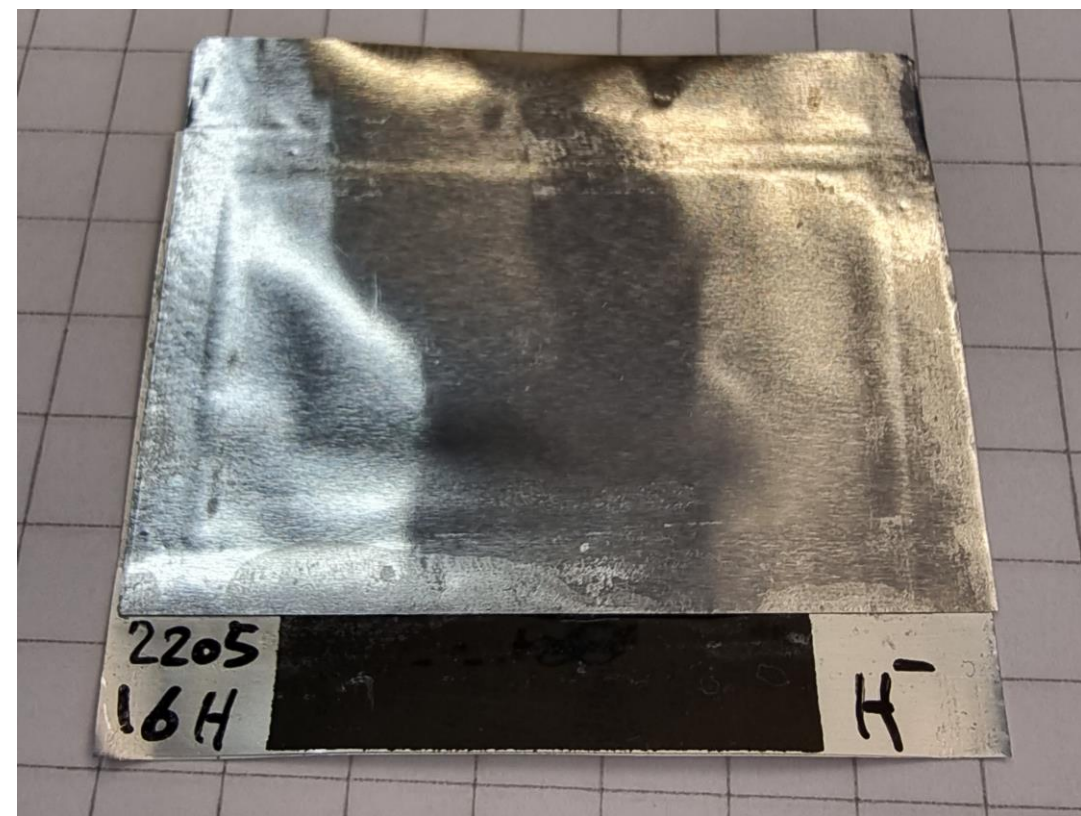
**ESR of European Marie-Curie Project CHARISMA**

**Tampere University, Tampere, Finland**

**Supervisor: Professor Donald Lupo**



An ECD indicator

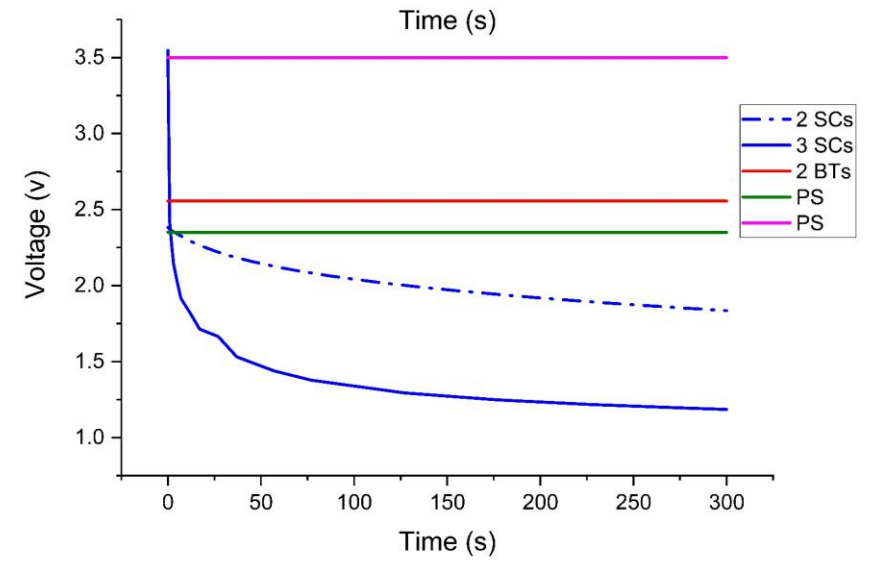
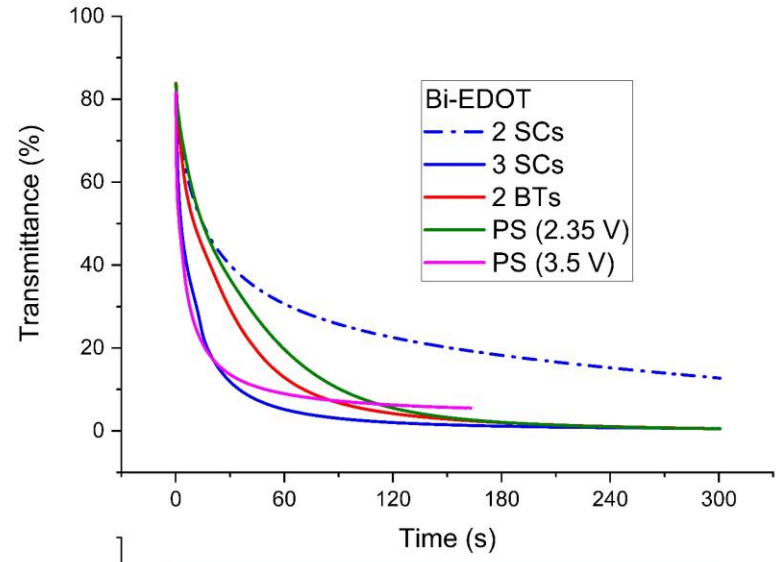
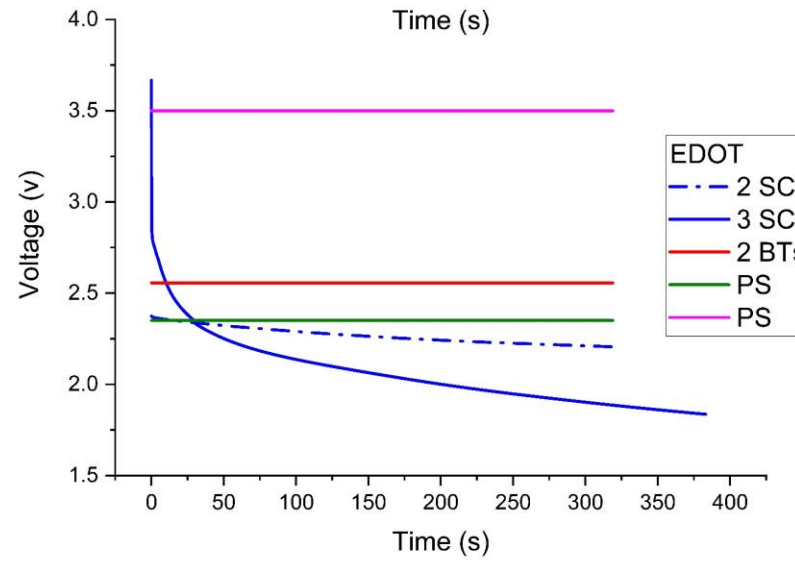
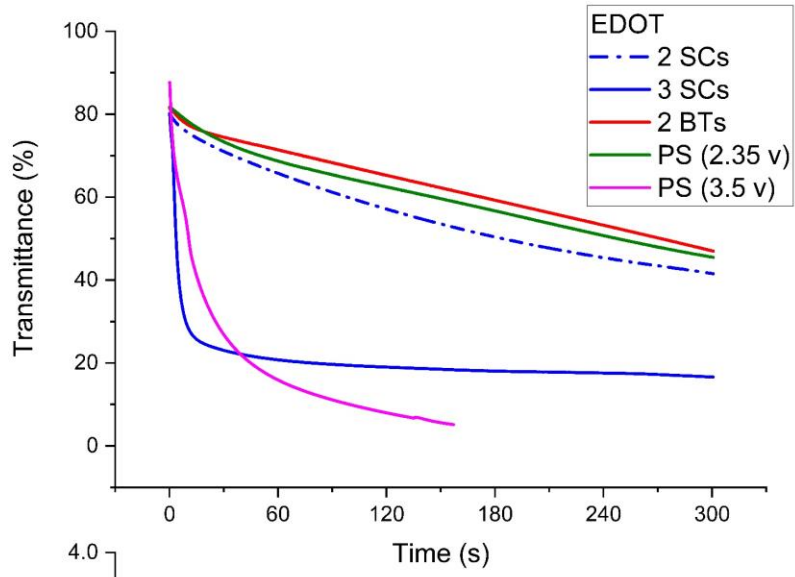


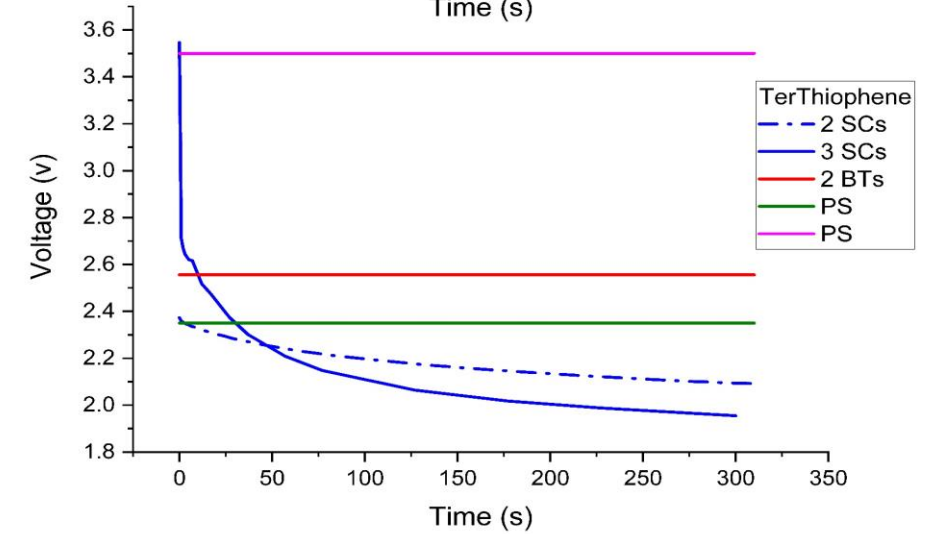
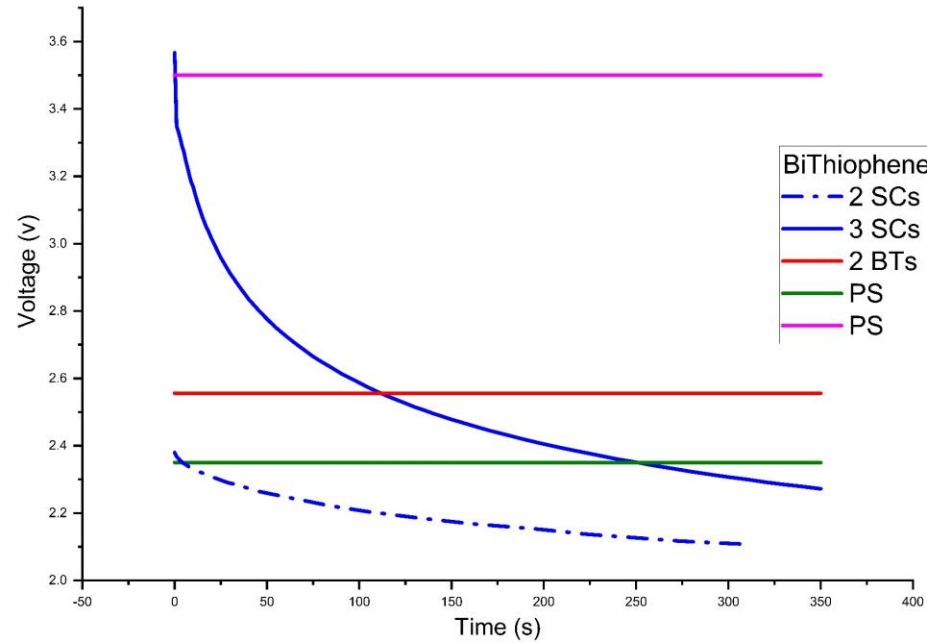
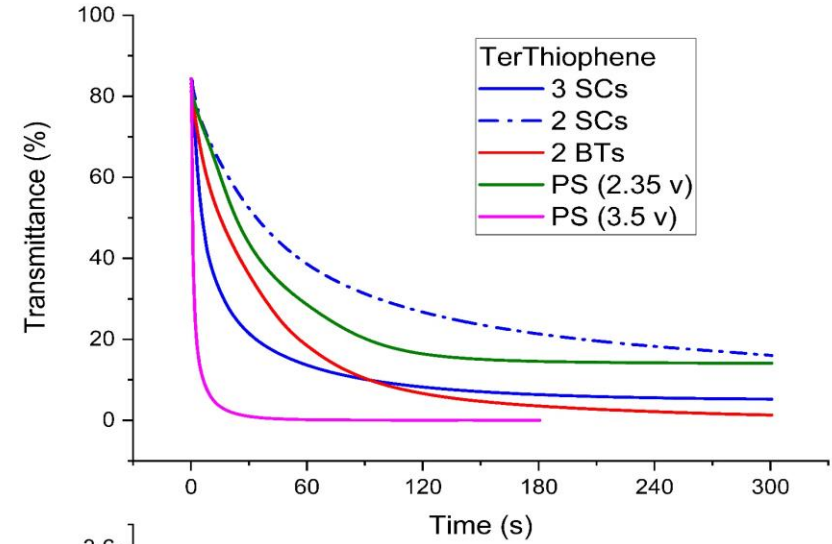
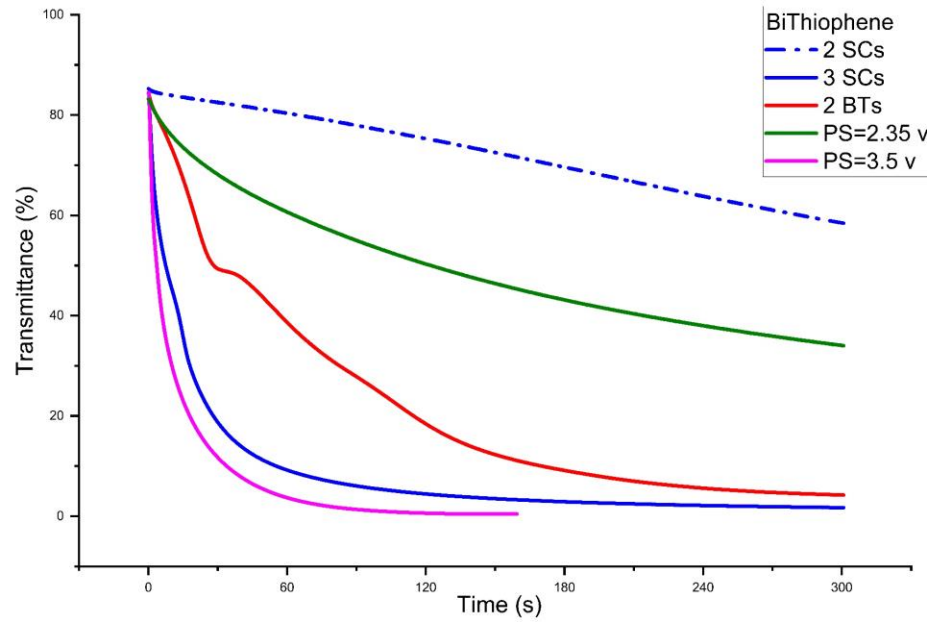
A Supercapacitor

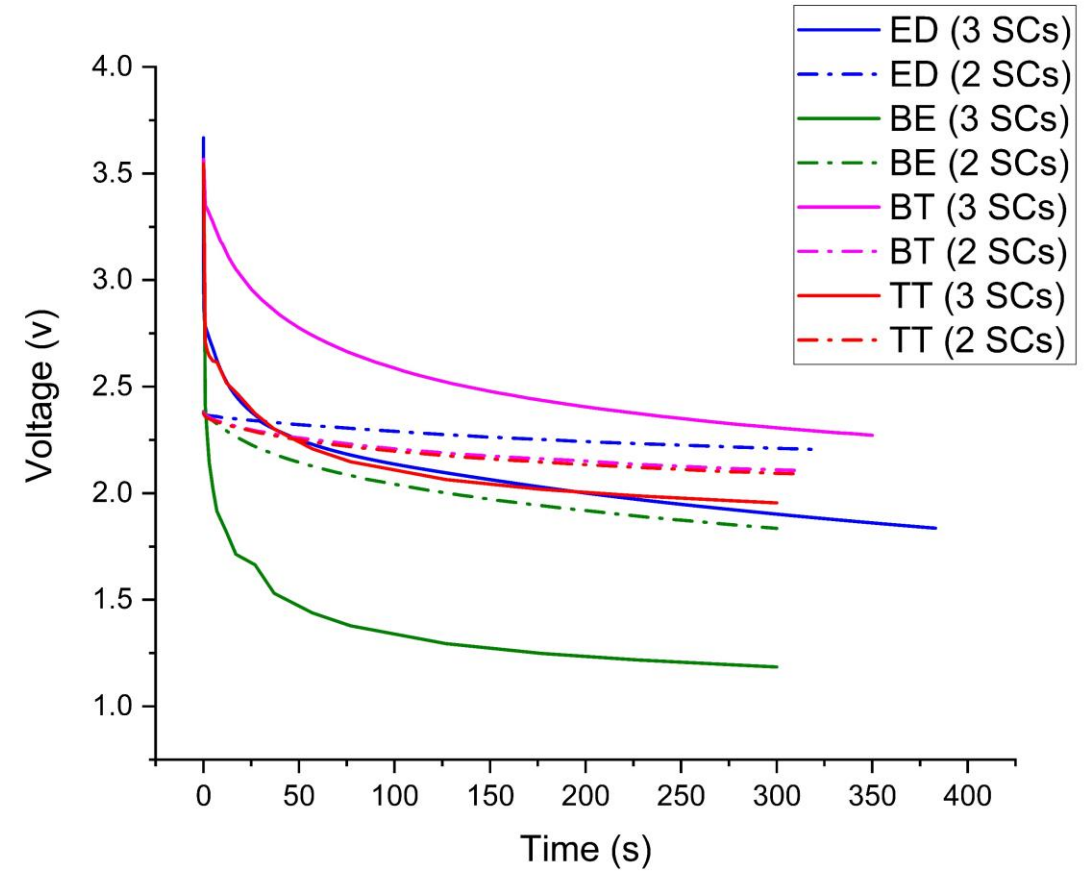
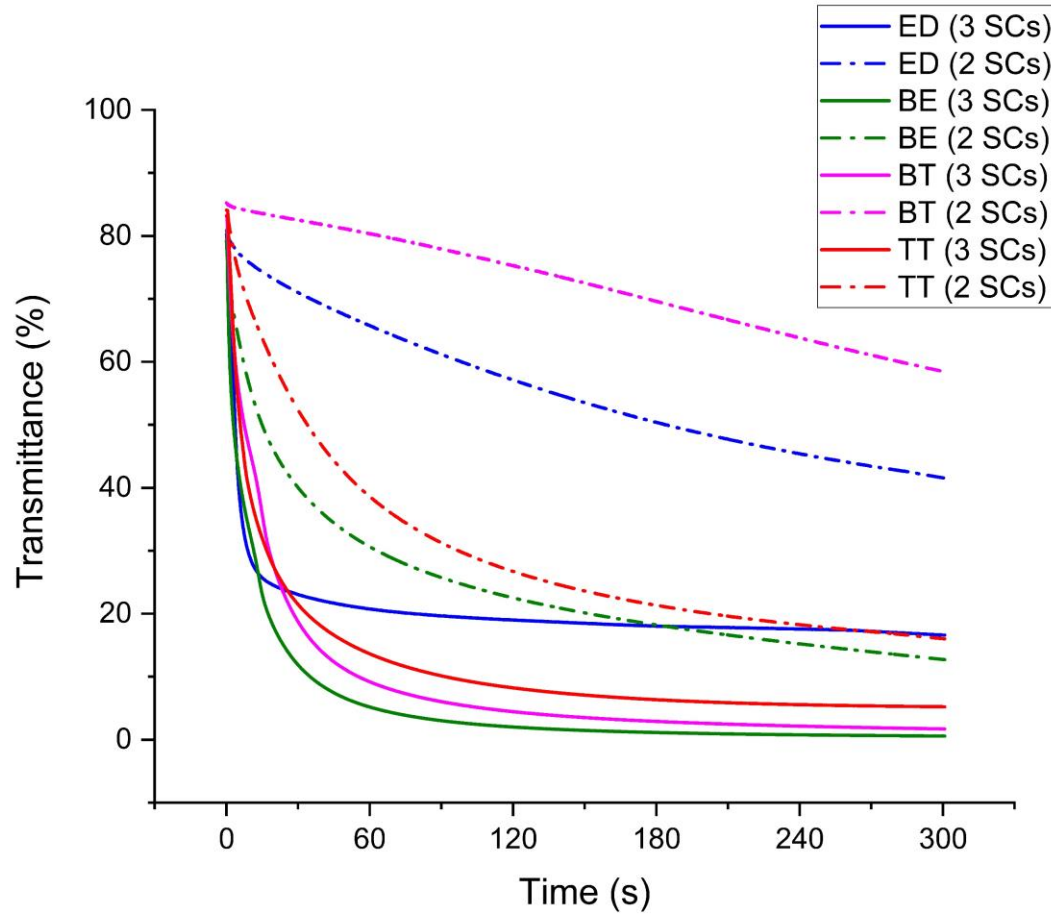
## ECD

## SCs

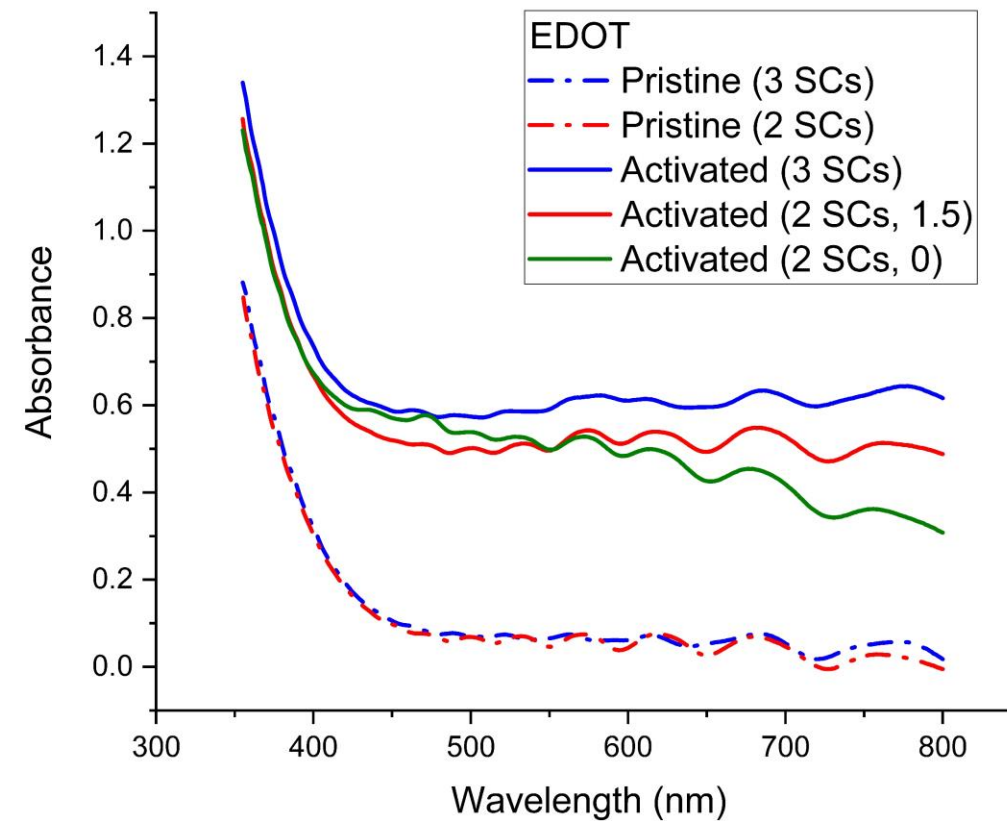
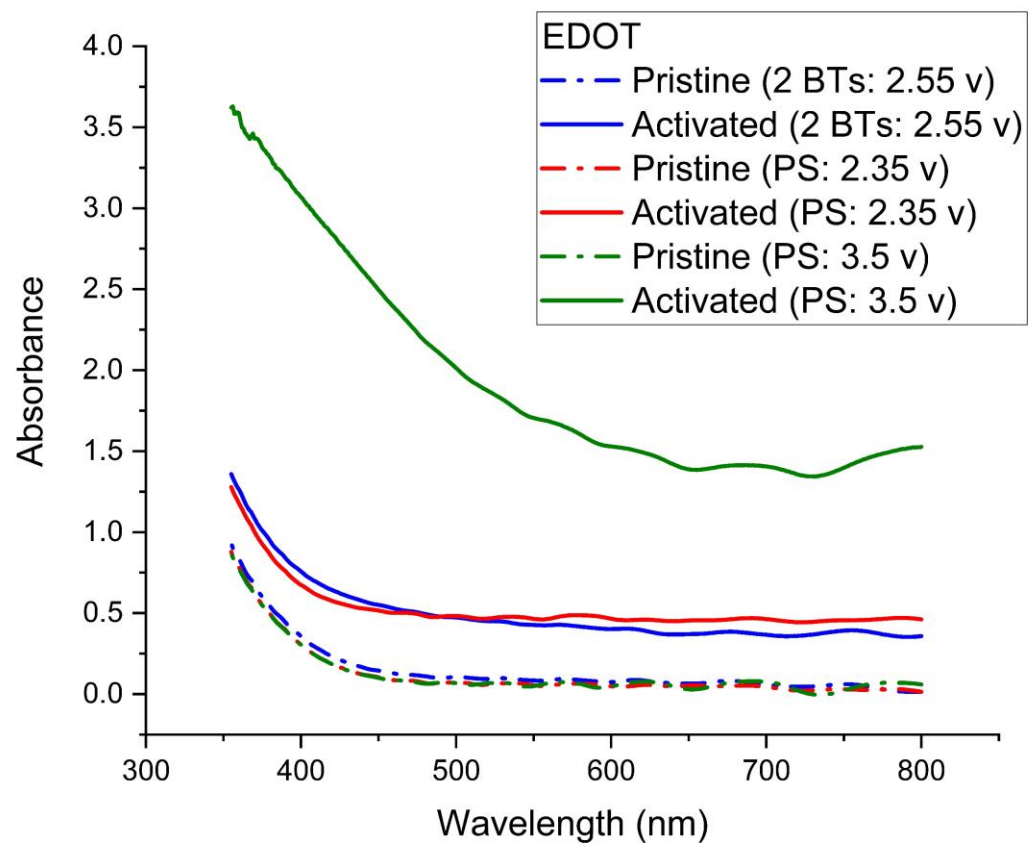
Monomer System	Activation Potential (V)	Coloration Efficiency (Cm <sup>2</sup> /C)	Number of SCs	Initial Voltage (V)	Overall Capacitance (mF)	Equivalent Series Resistance (Ω)
EDOT	2.5	9	1	1.2	170	7.5
BiEDOT	2.0	24	2	2.4	85	15
BiThiophene	2.6	21	3	3.55	60	22
TerThiophene	2.3	49				

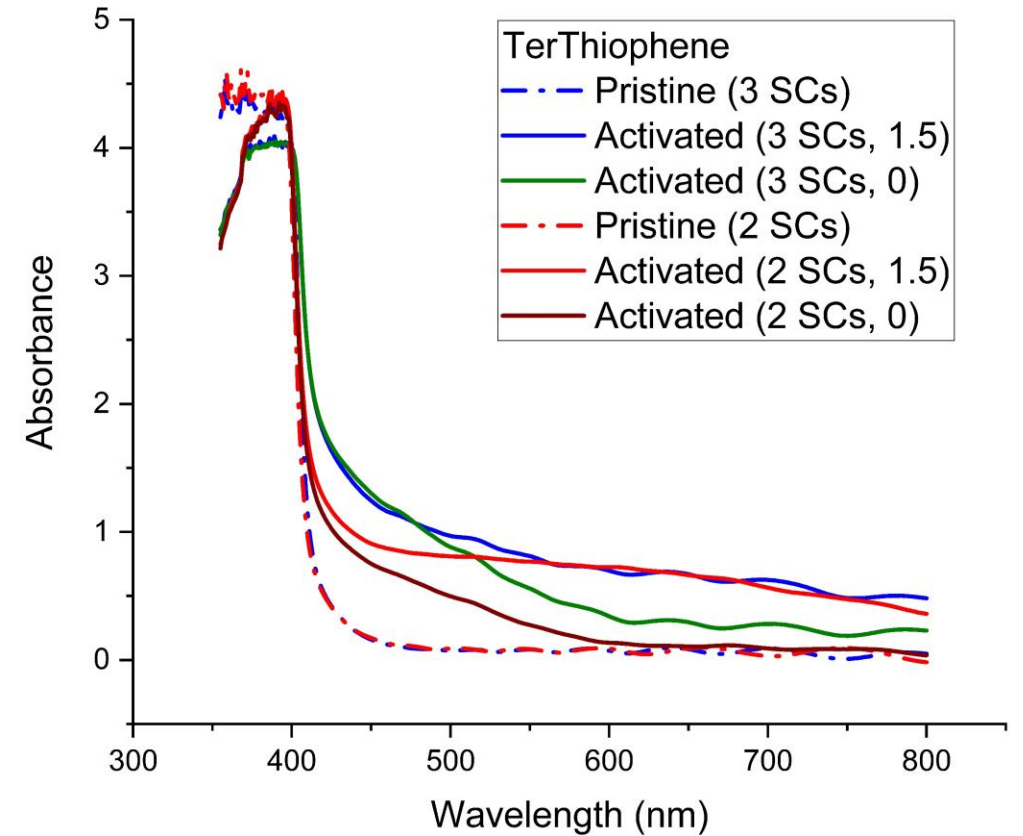
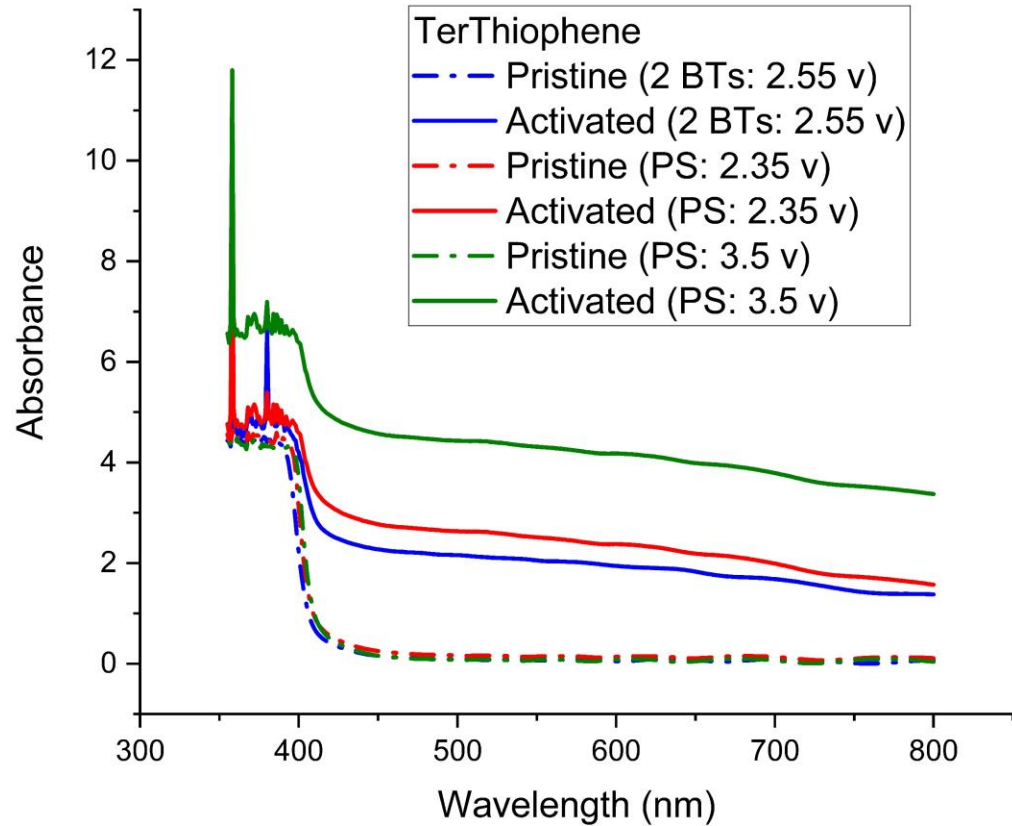




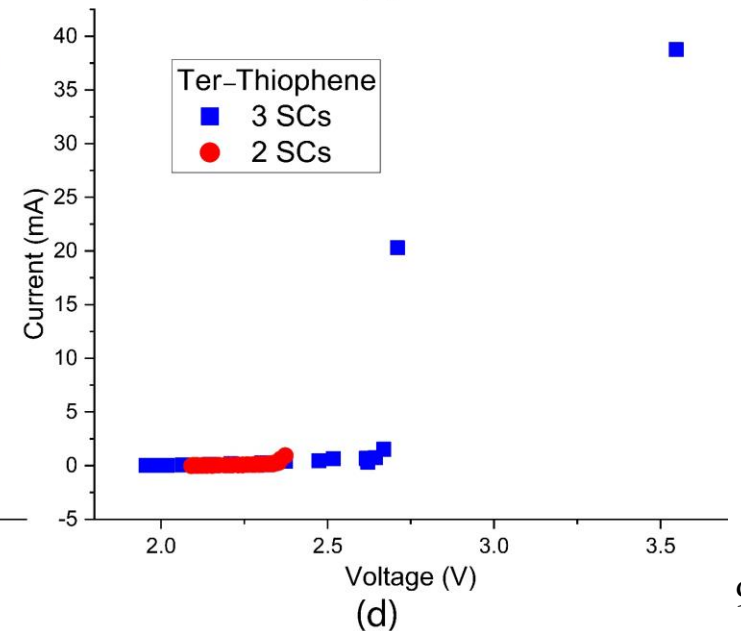
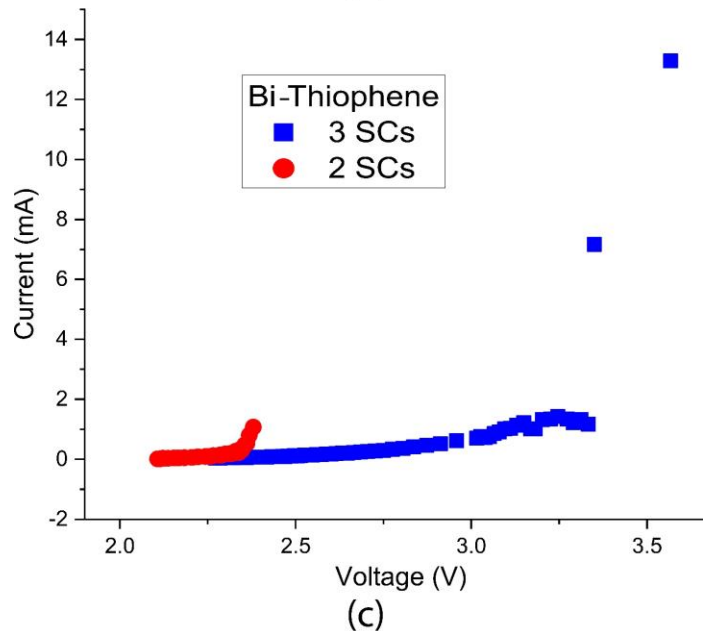
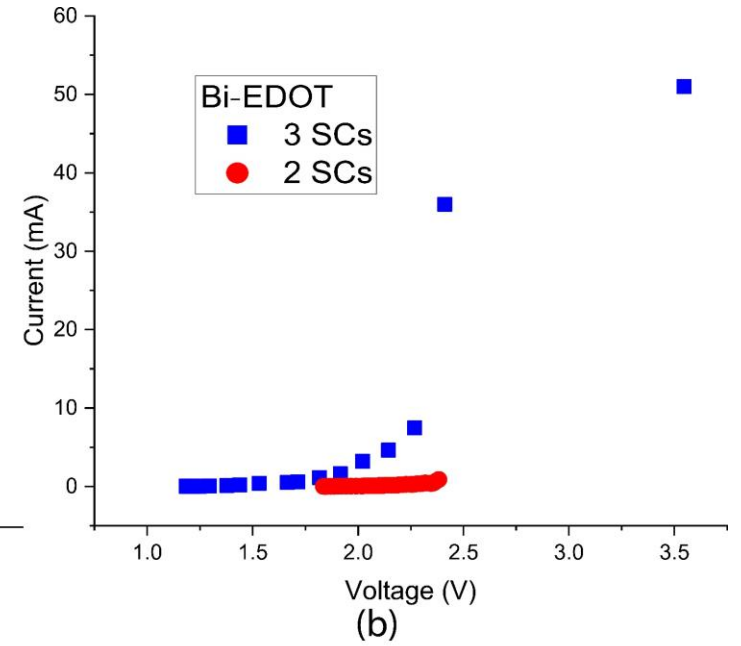
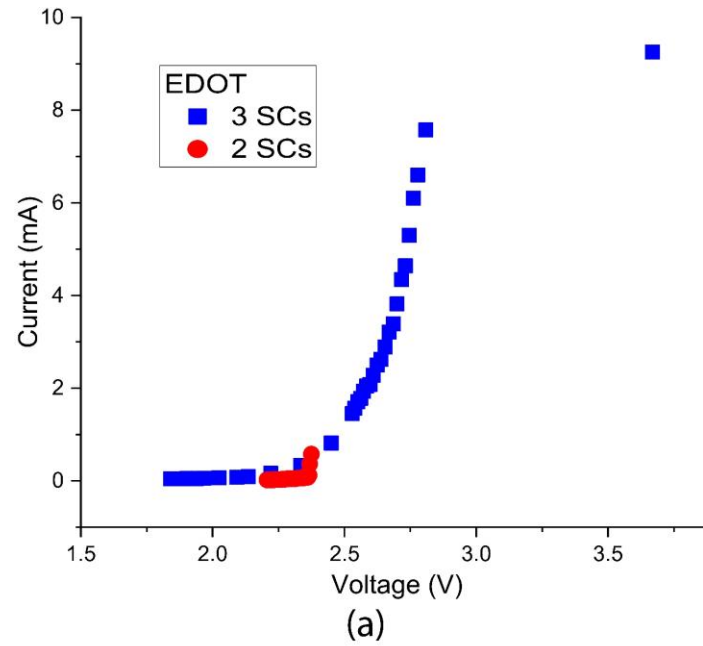
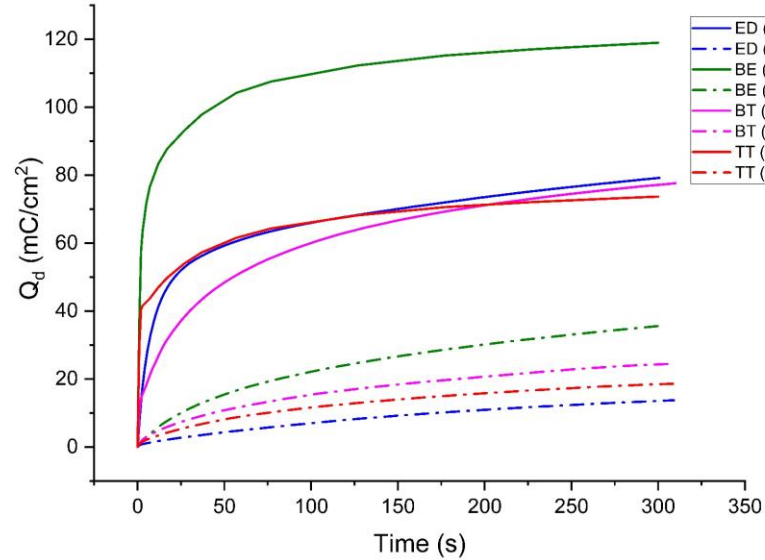
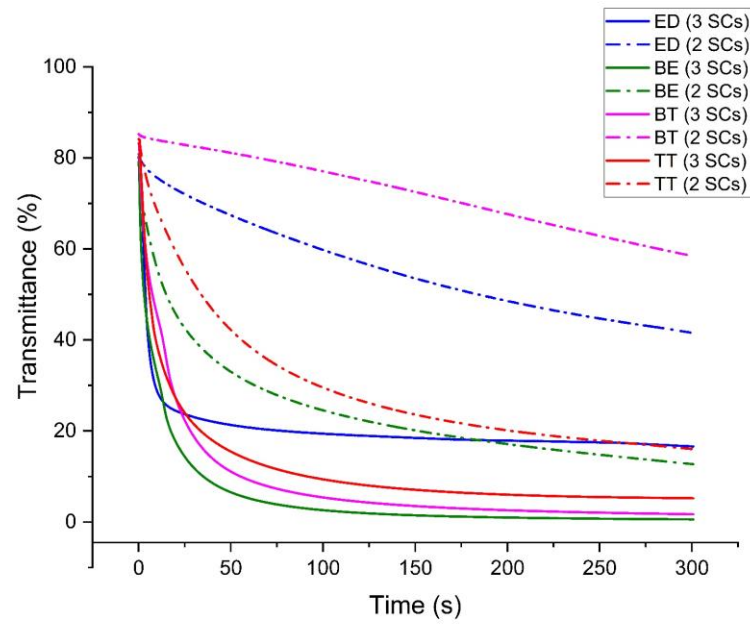








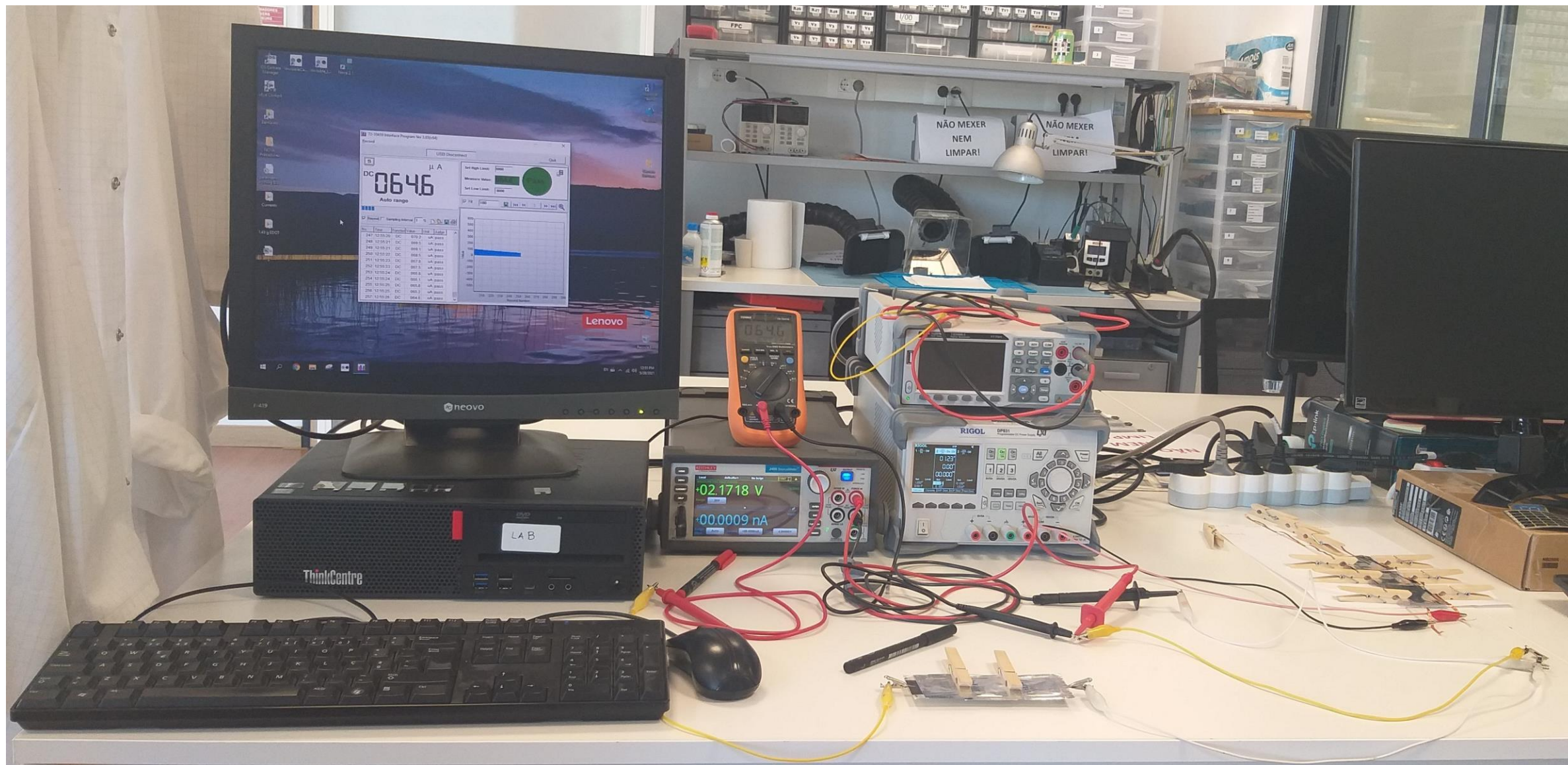




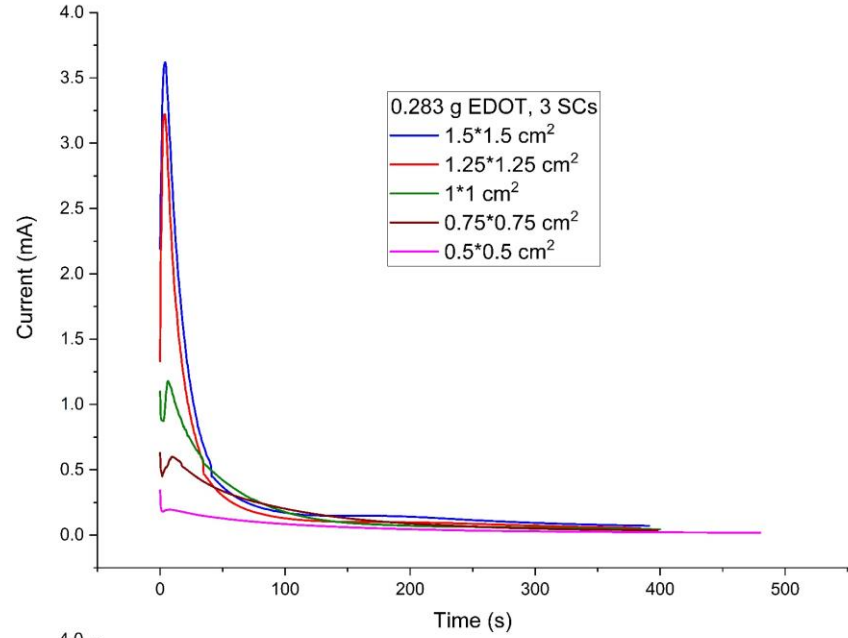
## What we did at Ynvisible S.A?

- manufacturing ECDs sheet to sheet.
- ECDs were made (4 different EDOT concentrations and 5 sizes):
  - ❑ Sizes (cm \* cm):
    - 0.5 \* 0.5
    - 0.75 \* 0.75
    - 1 \* 1
    - 1.25 \* 1.25
    - 1.5 \* 1.5
  - ❑ EDOT Concentrations (mM):
    - 140 (Ynvisible standard)
    - 100
    - 60
    - 20
- ECDs were activated and characterized using 2-3 SCs

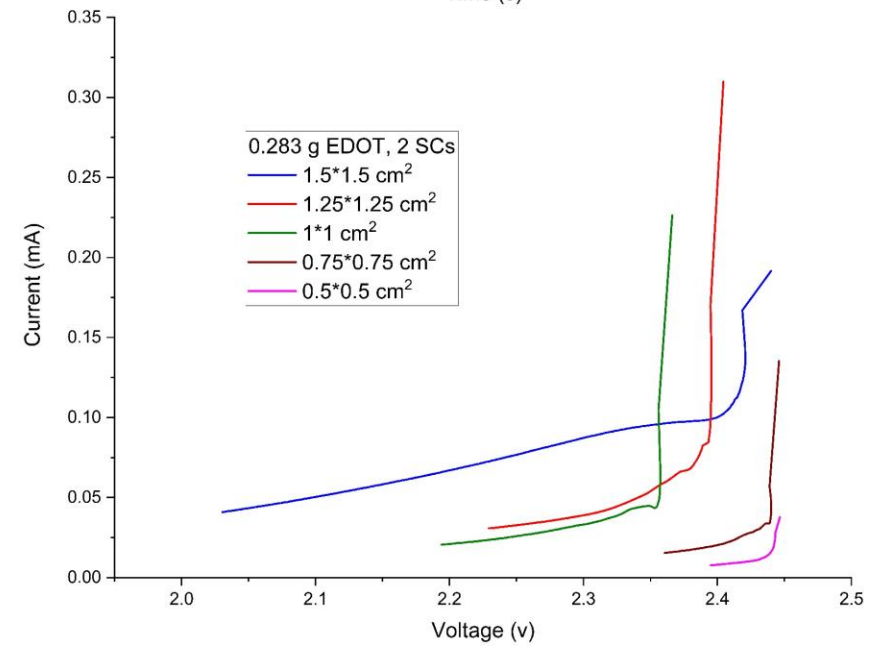
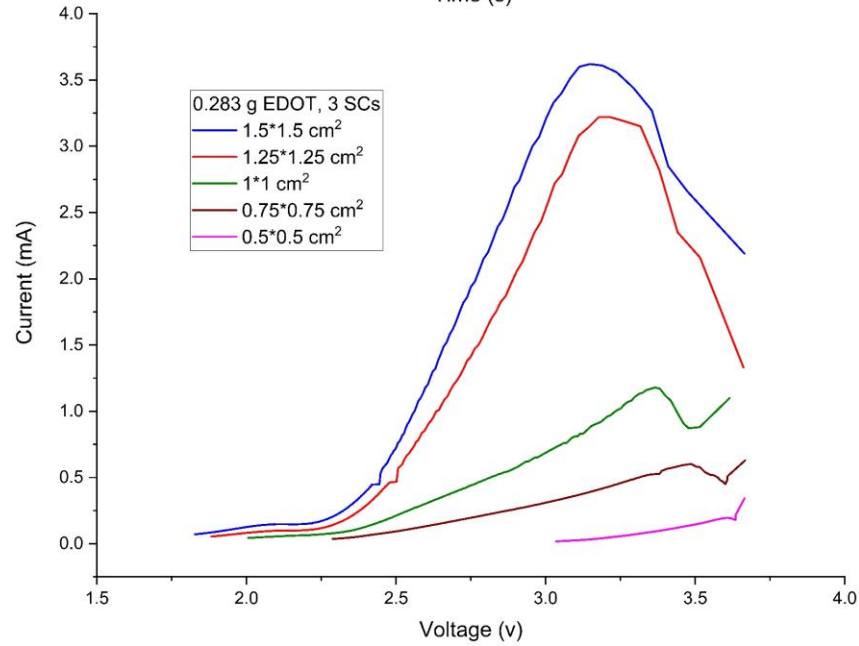
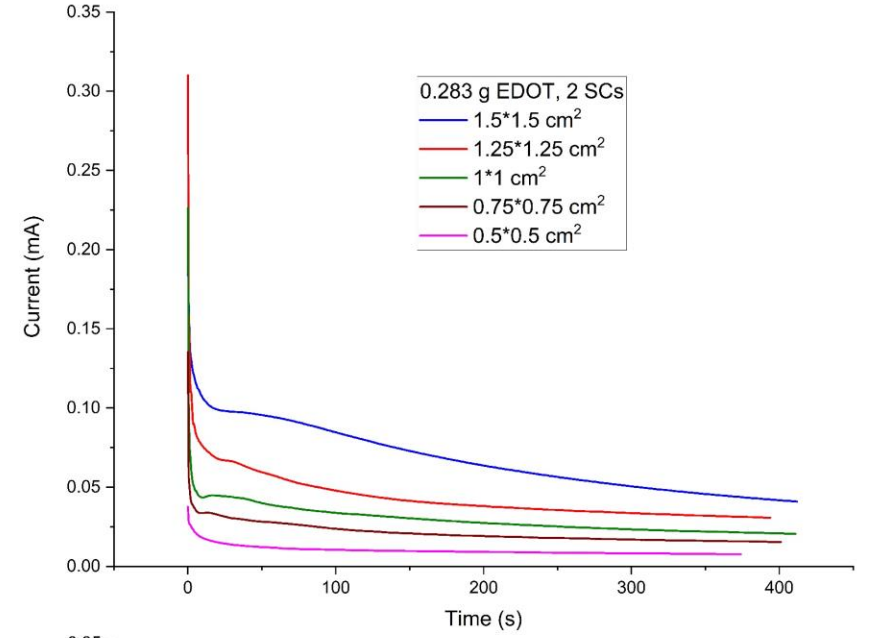
## Activation and characterization set-up

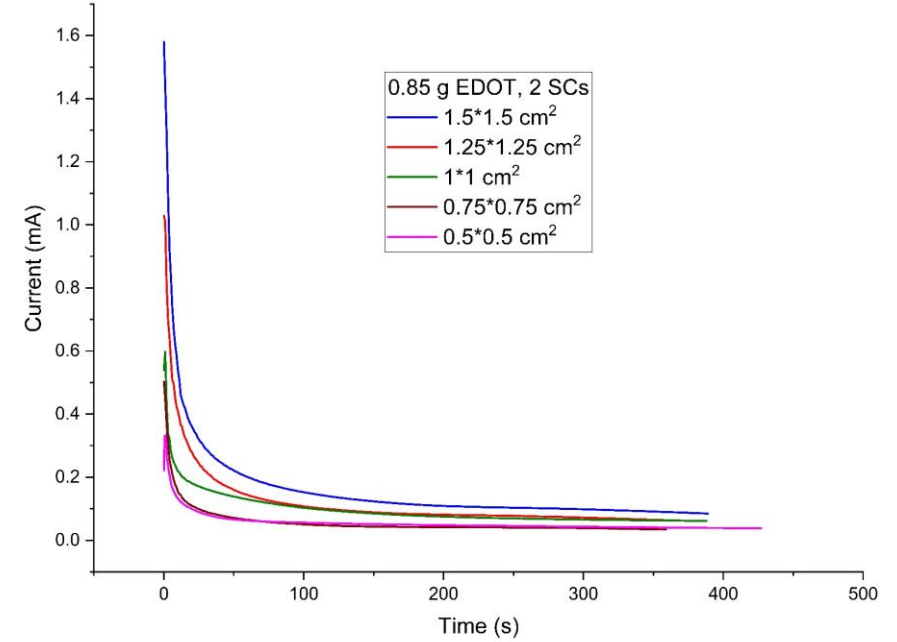
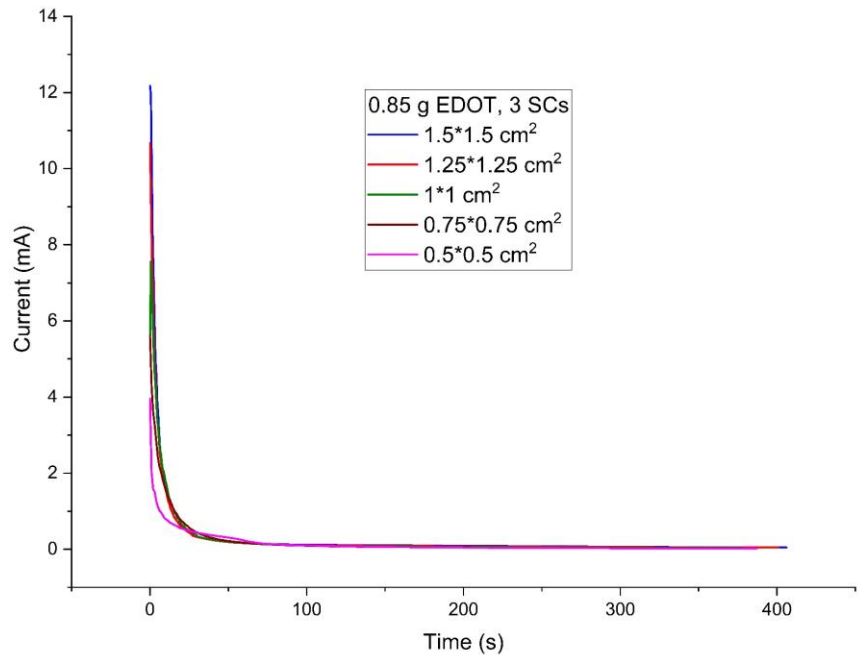




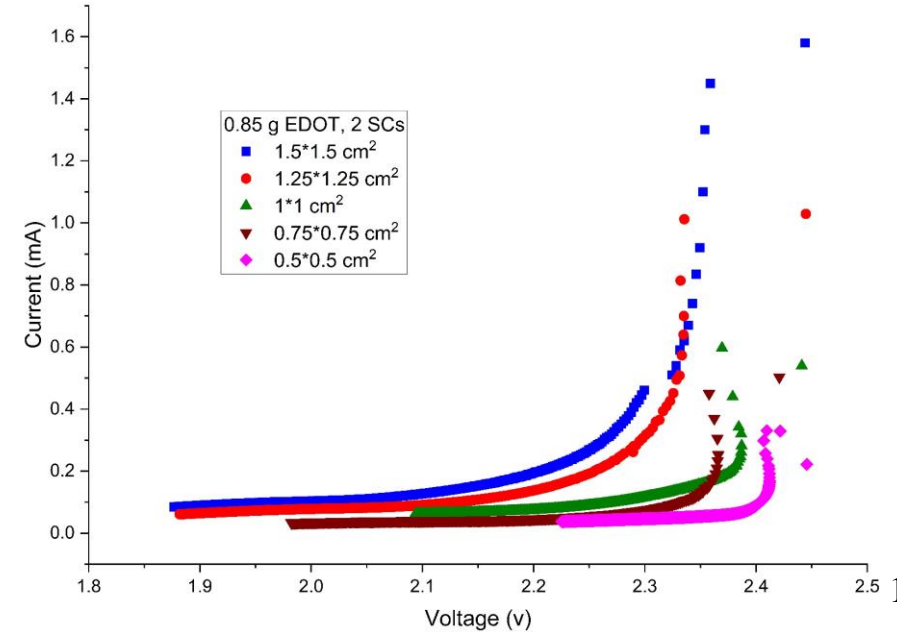
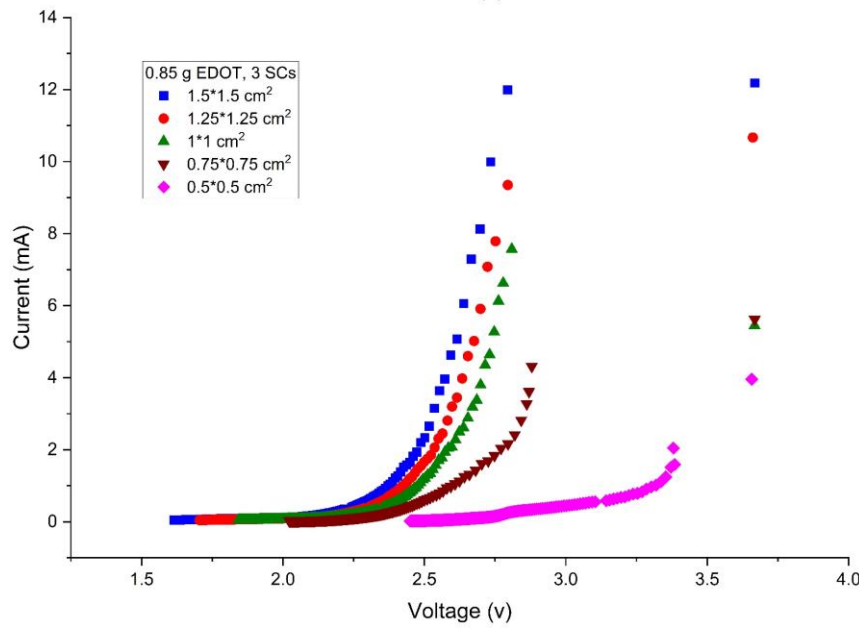


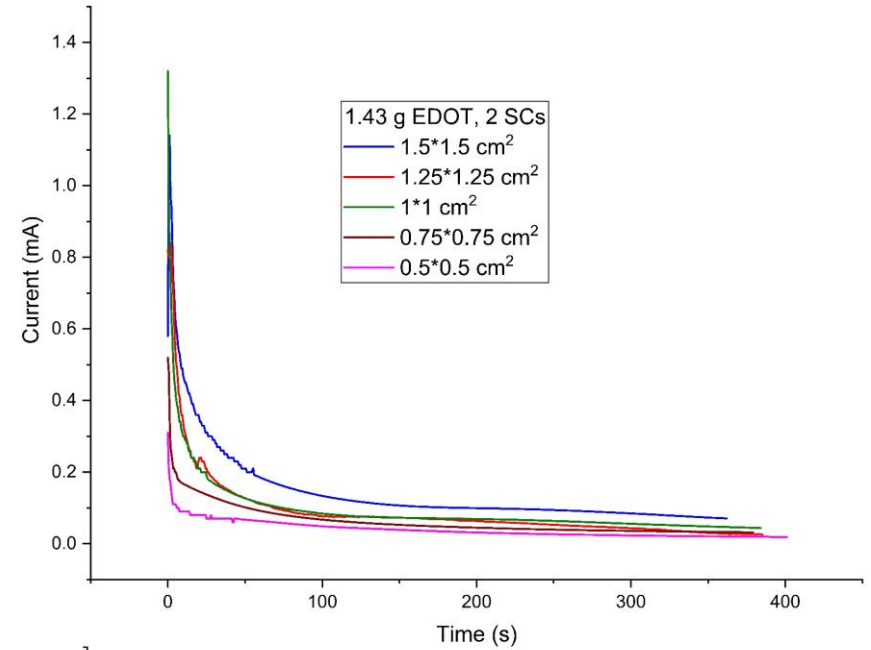
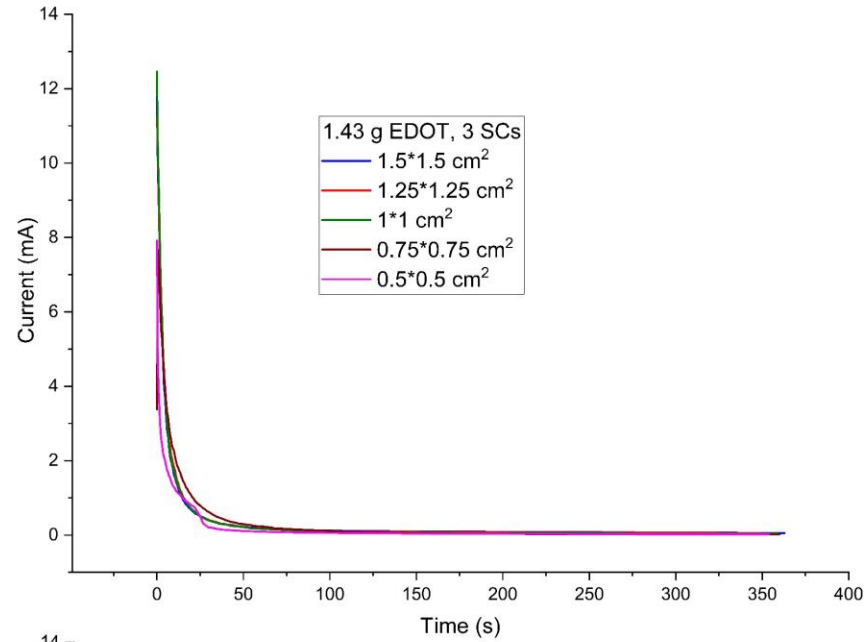
**0.283 g EDOT  
20 mM**



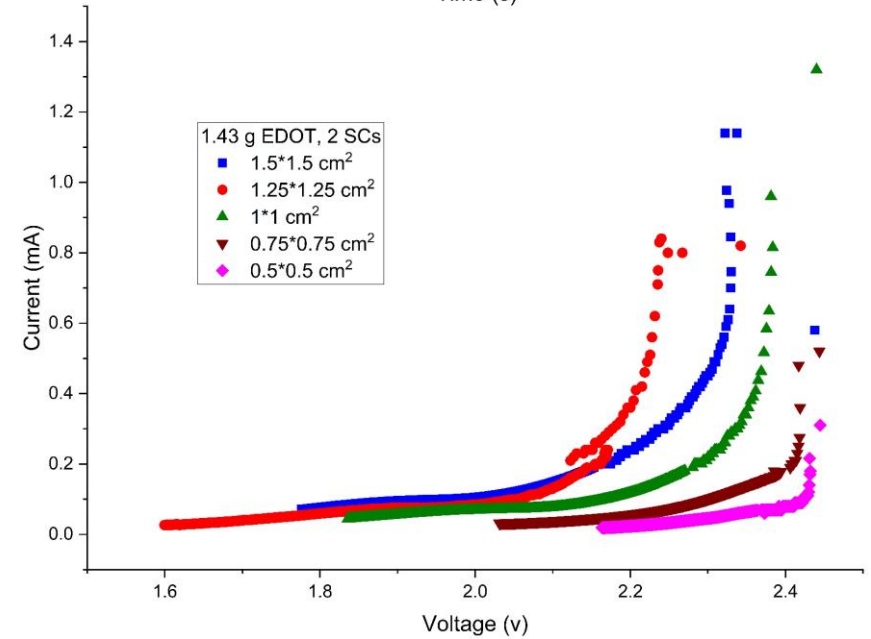
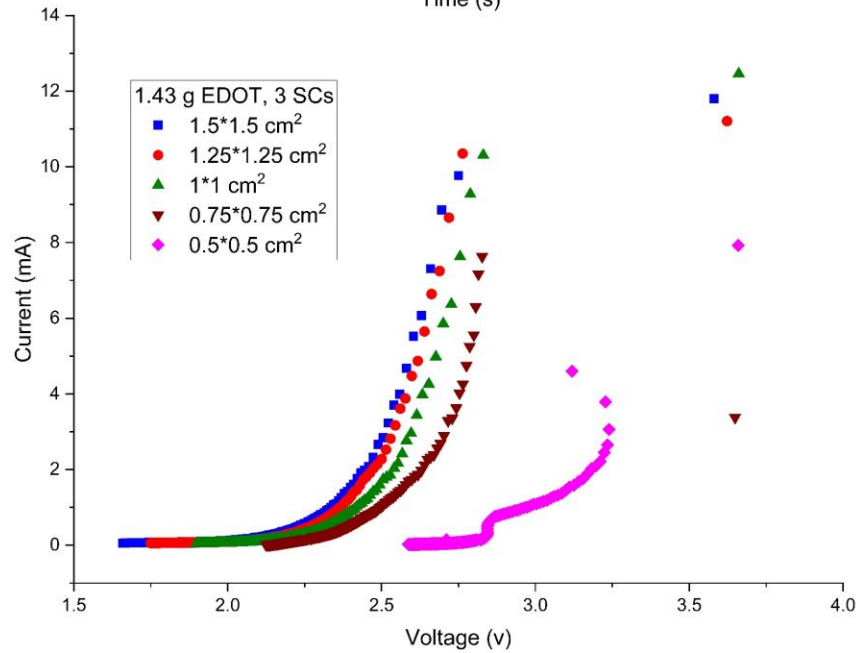


**0.85 g EDOT  
60 mM**



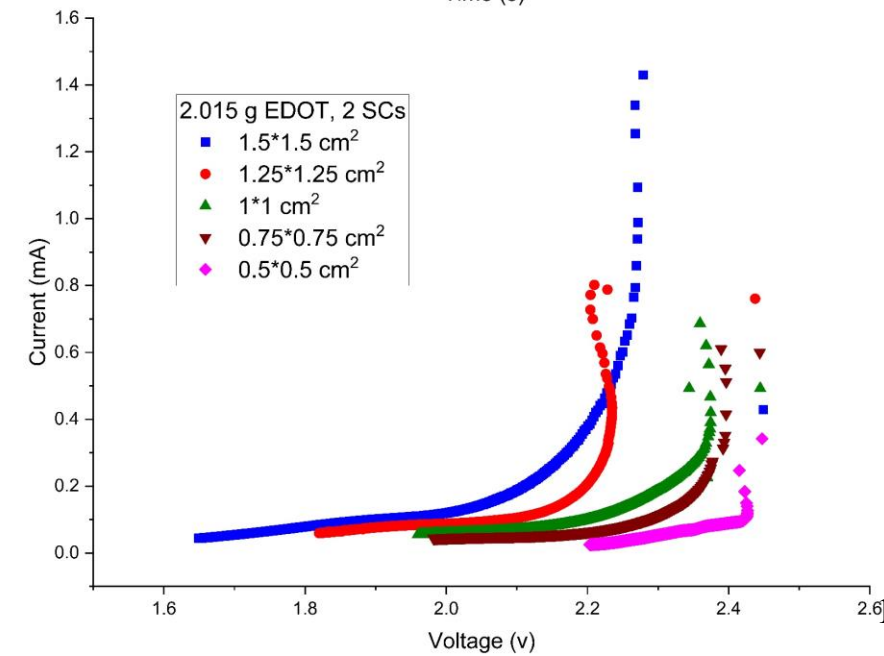
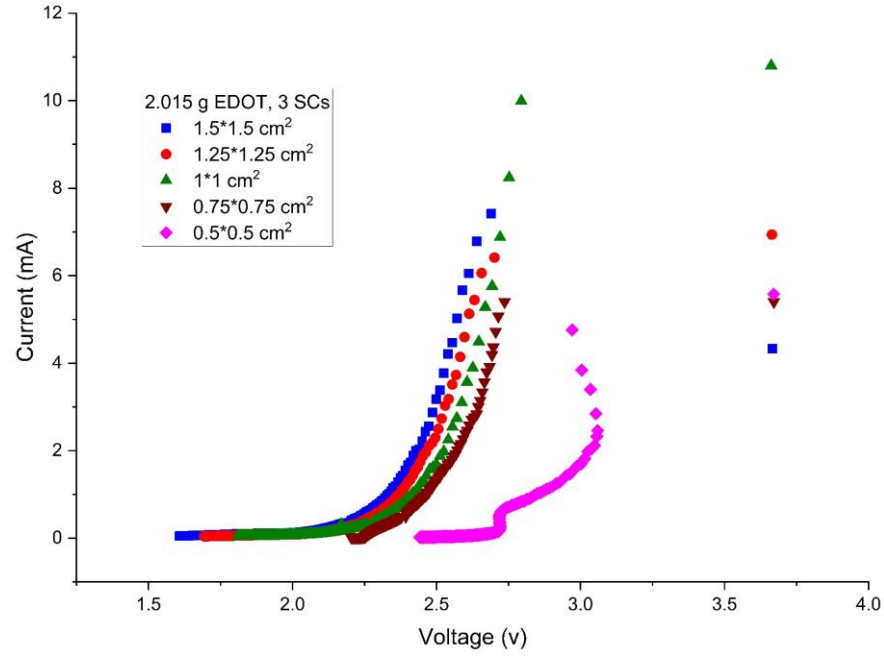
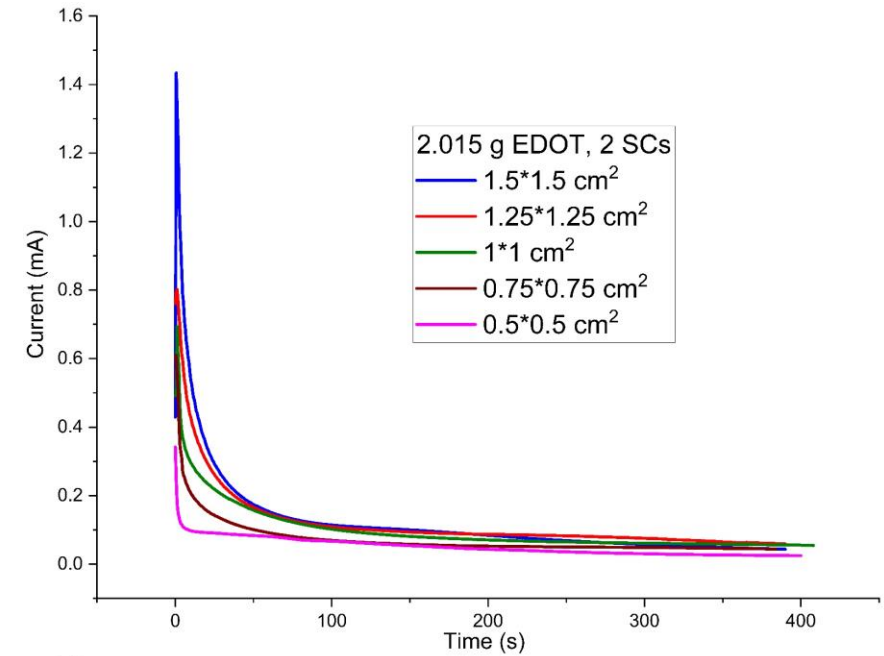
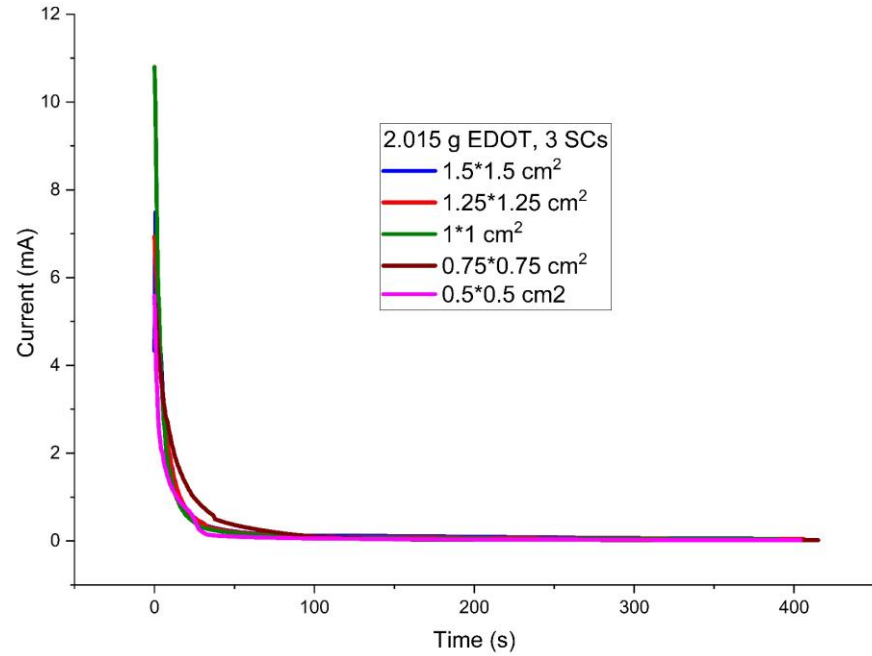


**1.43 g EDOT  
100 mM**

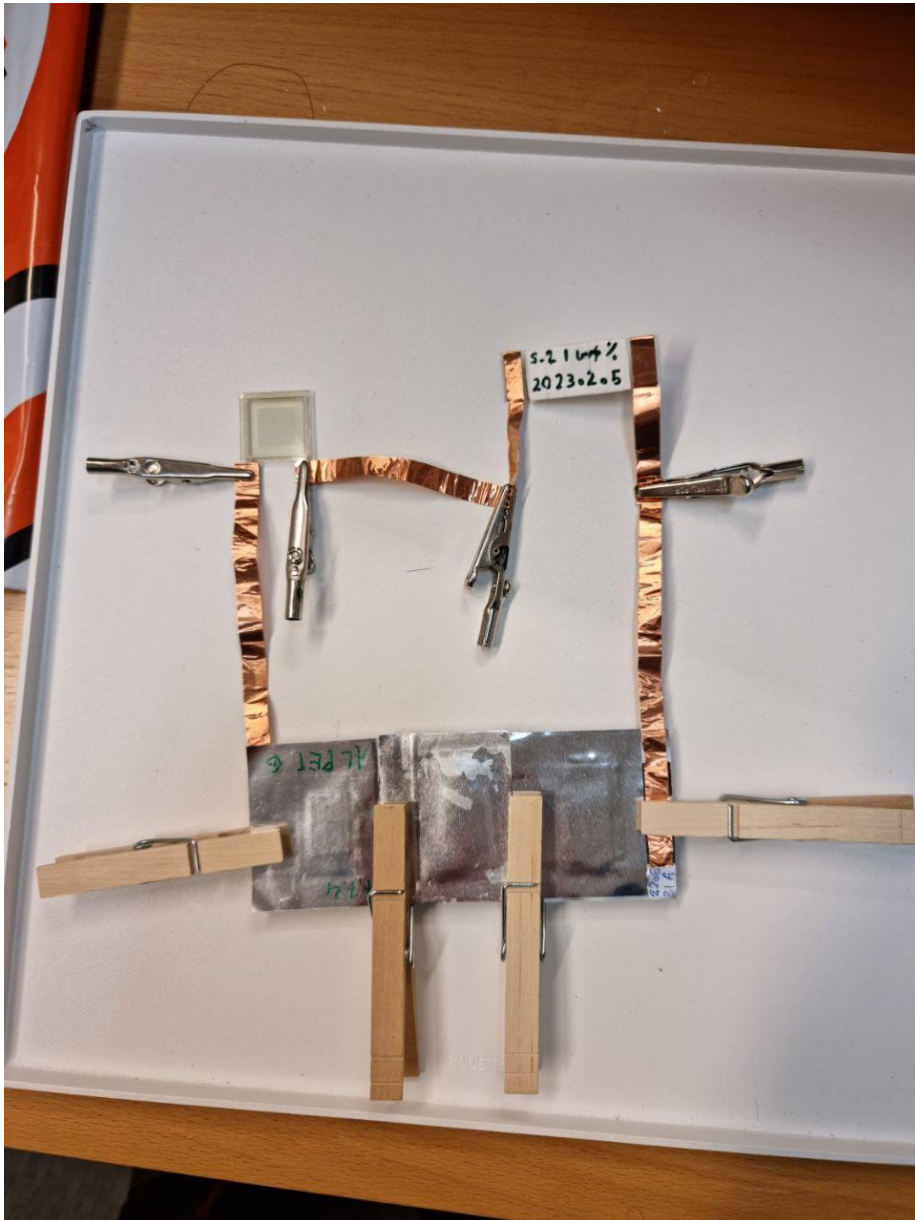




**2.015 g EDOT  
140 mM**



## 1- Outside temperature!

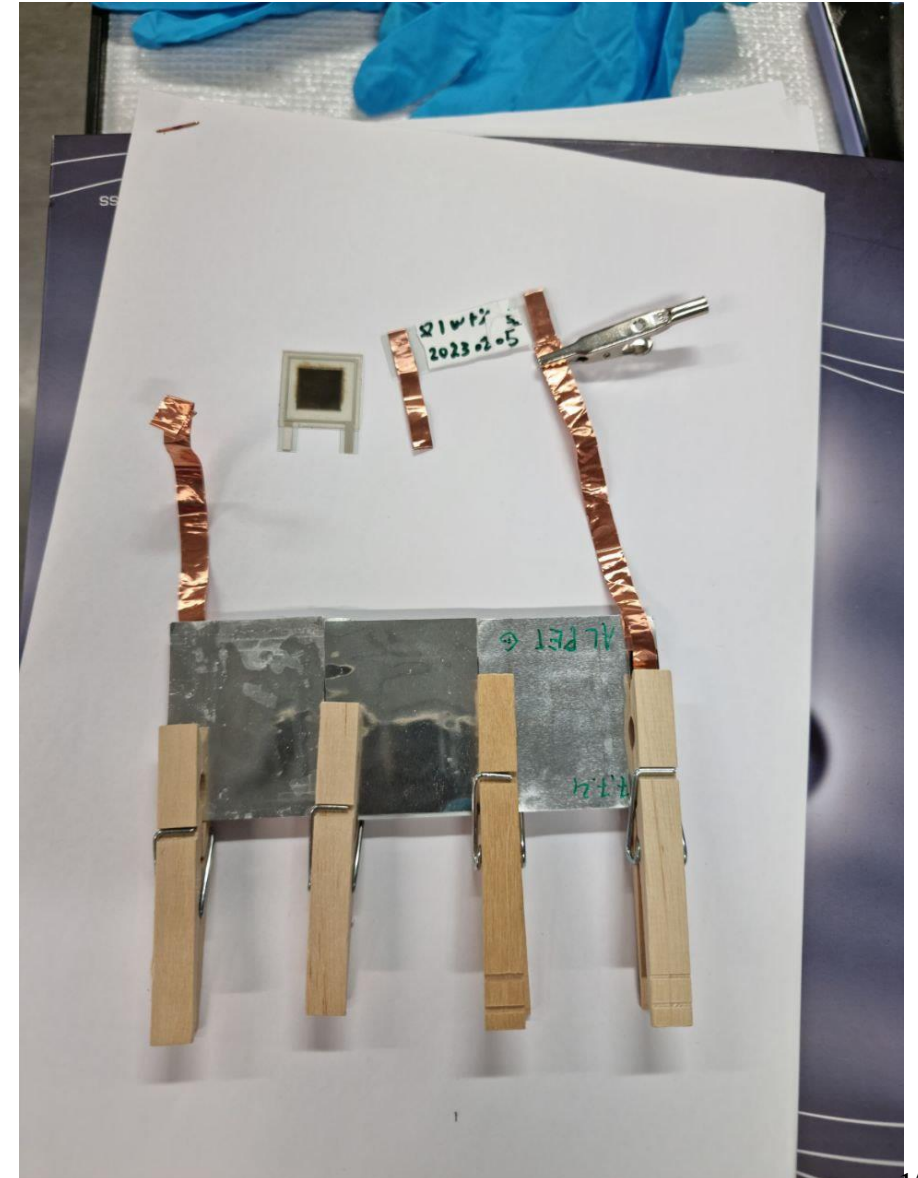


## 2- Inside the temperature chamber



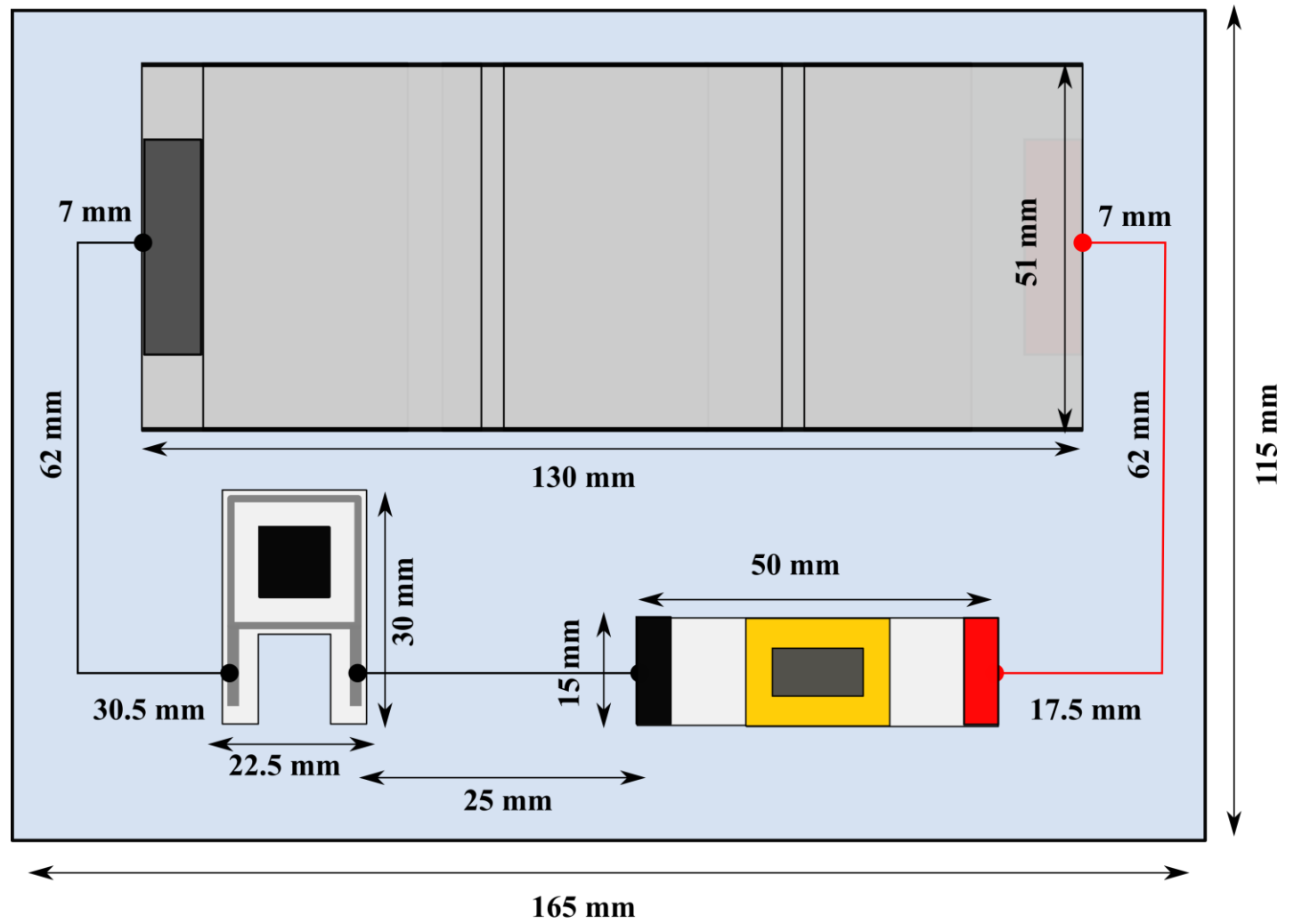
Cooling Process  
2.5 °C /min  
+30 °C to -10 °C

Transition: Started at  
11 °C  
Maximum current:  
100 uA at 6 °C







# CHARISMA Integration



**CHARISMA SMART LABEL**

-  **BOTTOM-SIDE CONTACT**
-  **TOP-SIDE CONTACT**



# CHARISMA Integration





## Thank You All for Your Attention

Special thanks to:

- ✓ TAU LFE group
- ✓ Professor Lupo
- ✓ Professor Mäntysalo
- ✓ Dr. Jari Keskinen
- ✓ All my CHARISMA colleagues



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