

CONTROLLED AND SOLVENT-FREE SYNTHESIS OF POLYPYRROLE FOR ENERGY STORAGE APPLICATIONS

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Why Solvent-Free Polypyrrole for Supercapacitor ?

- **Supercapacitors:** rapidly storing and releasing high electrical power
- **Enhancing performance:** conducting polymers + carbon materials
- **Traditional methods face:** solubility challenges, delamination, and harmful solvent

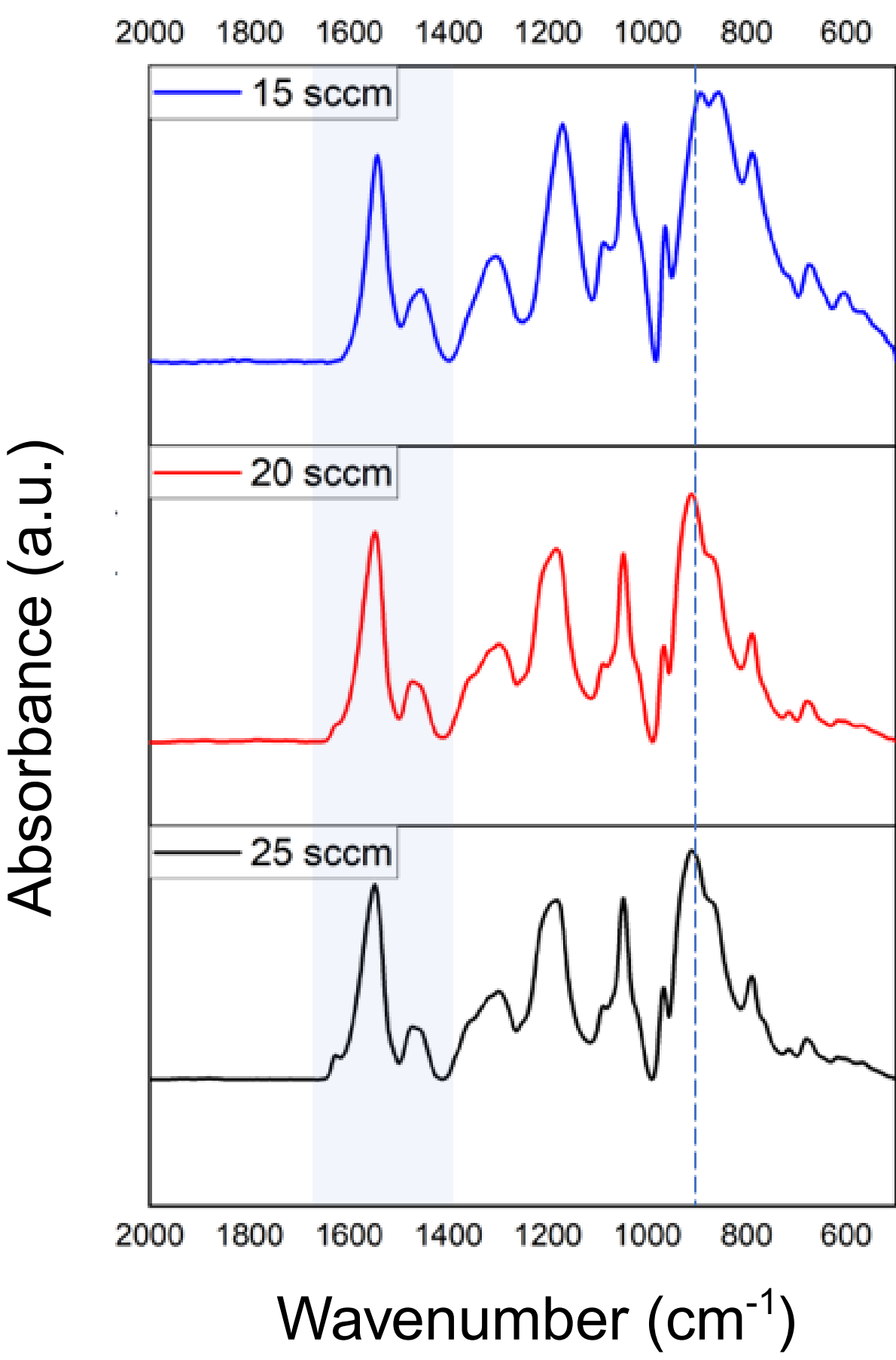
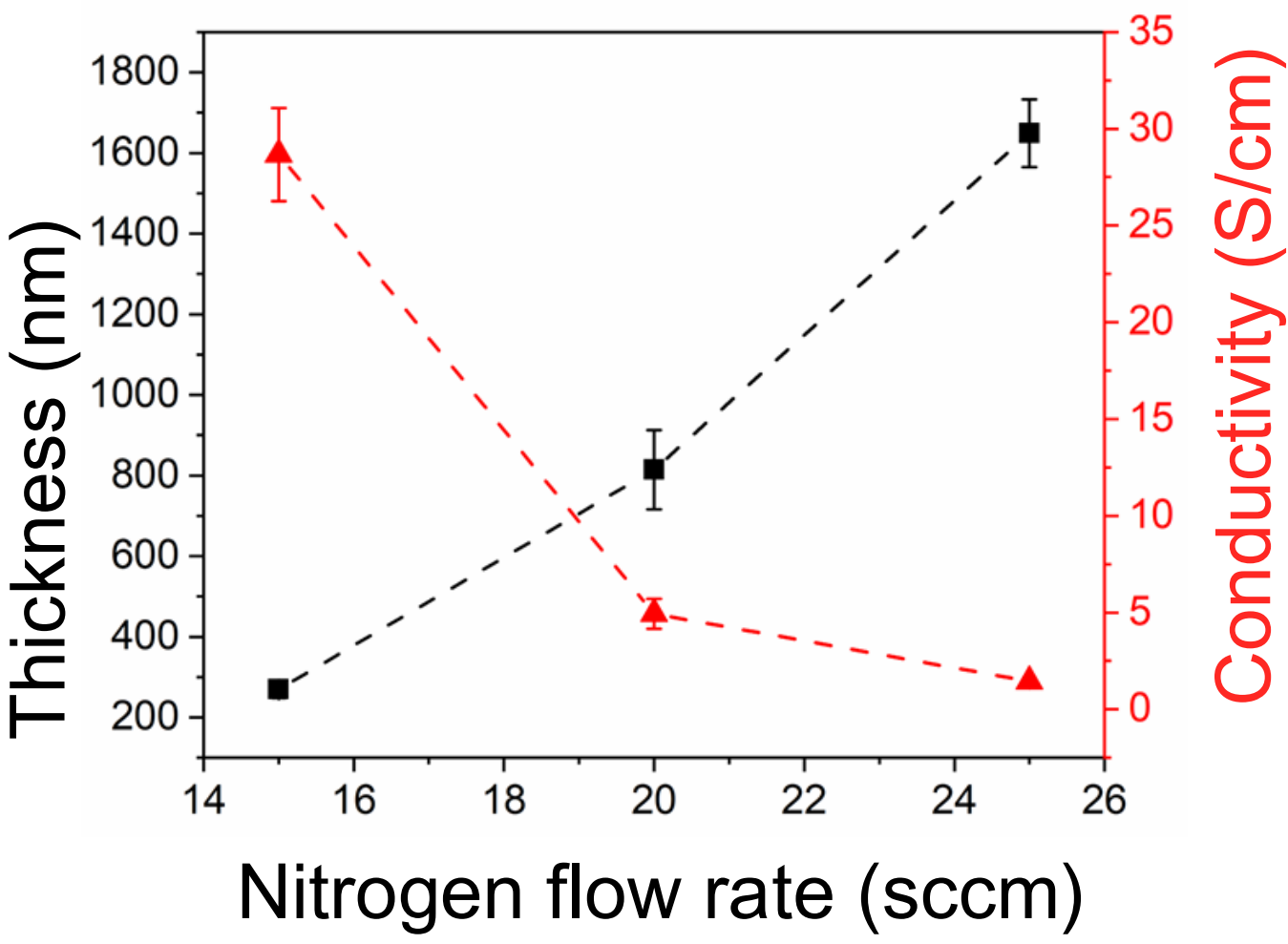


Innovation: oCVD Technique

- Oxidative chemical vapor deposition
- Solvent-free method
- Simultaneous synthesis, doping, and film formation
- Conformal coatings of PPy on carbon materials

Parameters	Value
Chamber pressure	300 mTorr
Stage temperature	40° C
RR→Reactant ratio [Ox]/[Mo] (sccm/sccm)	[0.5 sccm/2.5 sccm] 0.2
Nitrogen flow	15 – 25 sccm
Deposition time	30 – 120 min
Substrate	Si wafers, Glass, Fabric

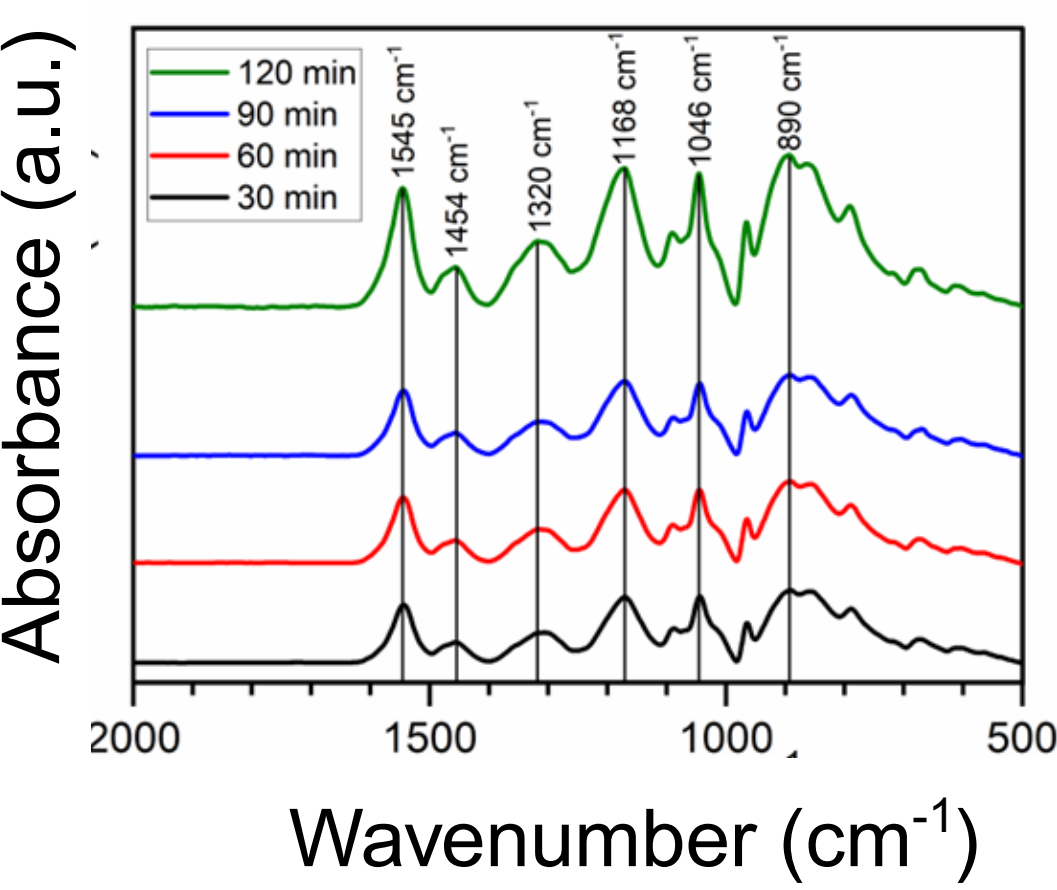
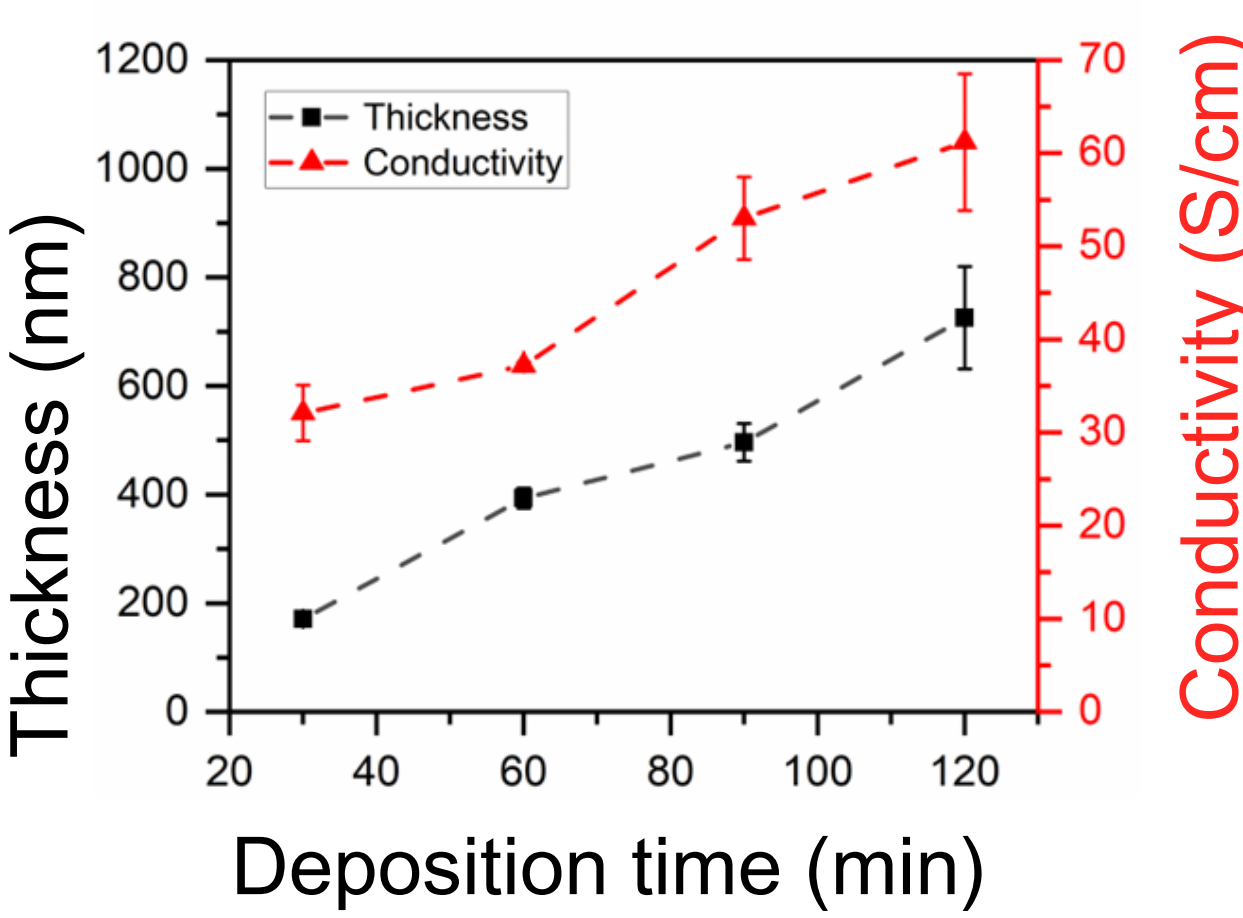
Effect of Nitrogen Flow and Time on oCVD Process



Nitrogen as oxidant carrier gas

impacting distribution of the oxidant onto the substrate

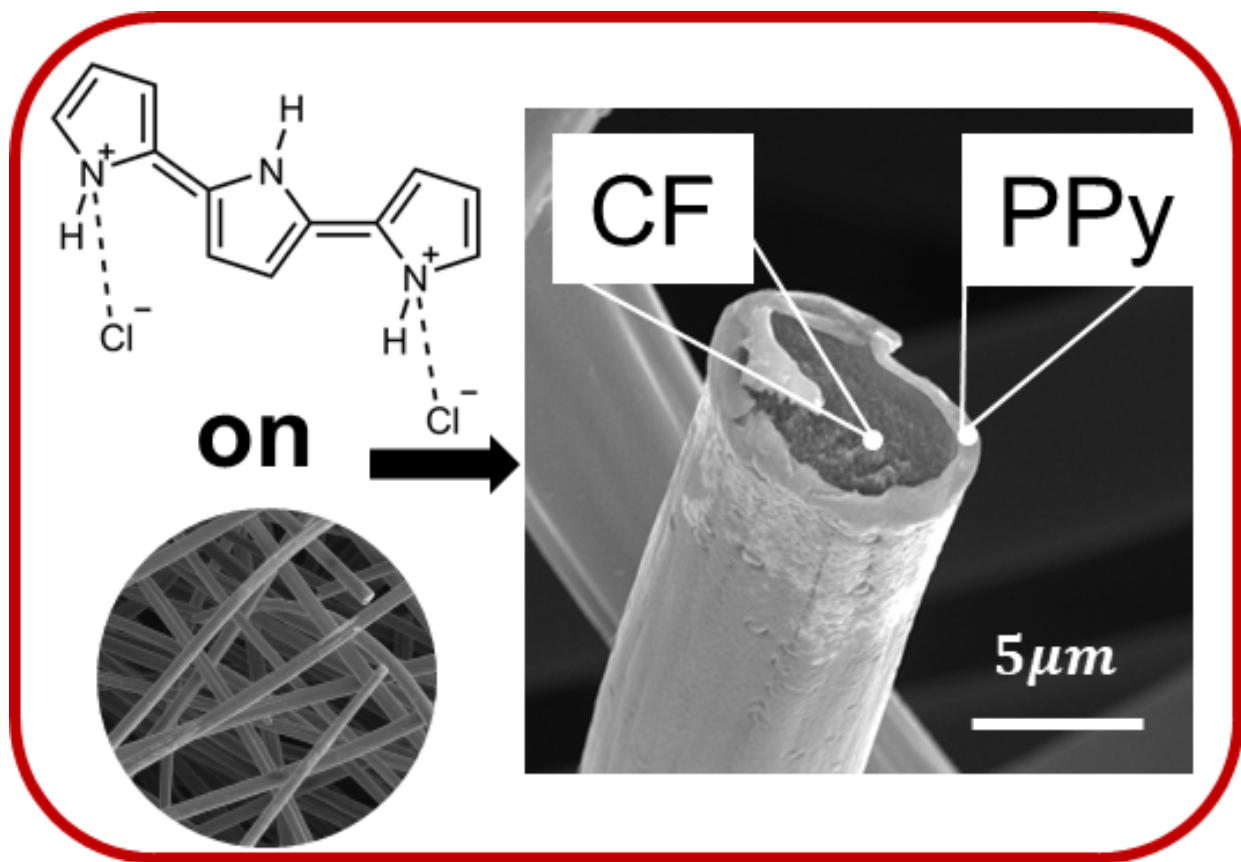
influencing the **thickness** and **electrical conductivity**



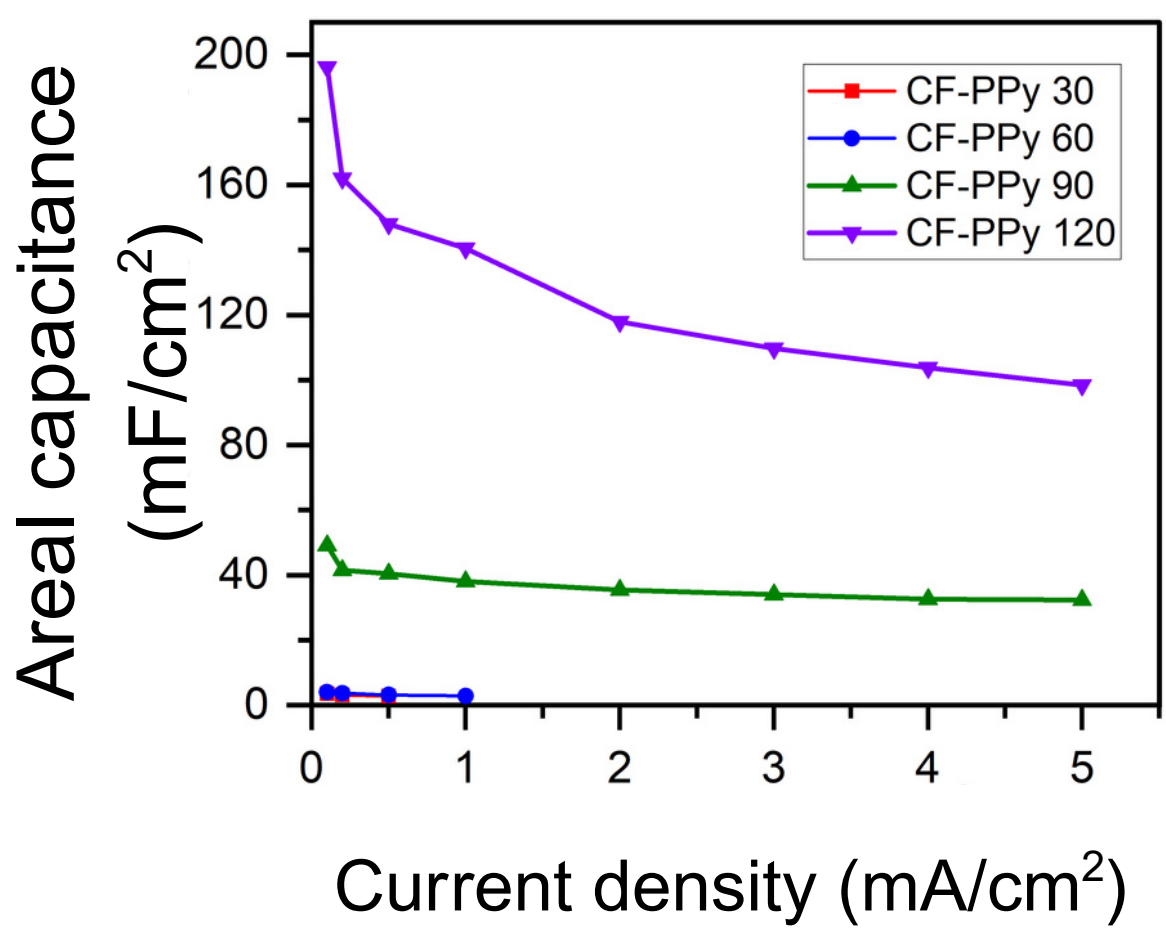
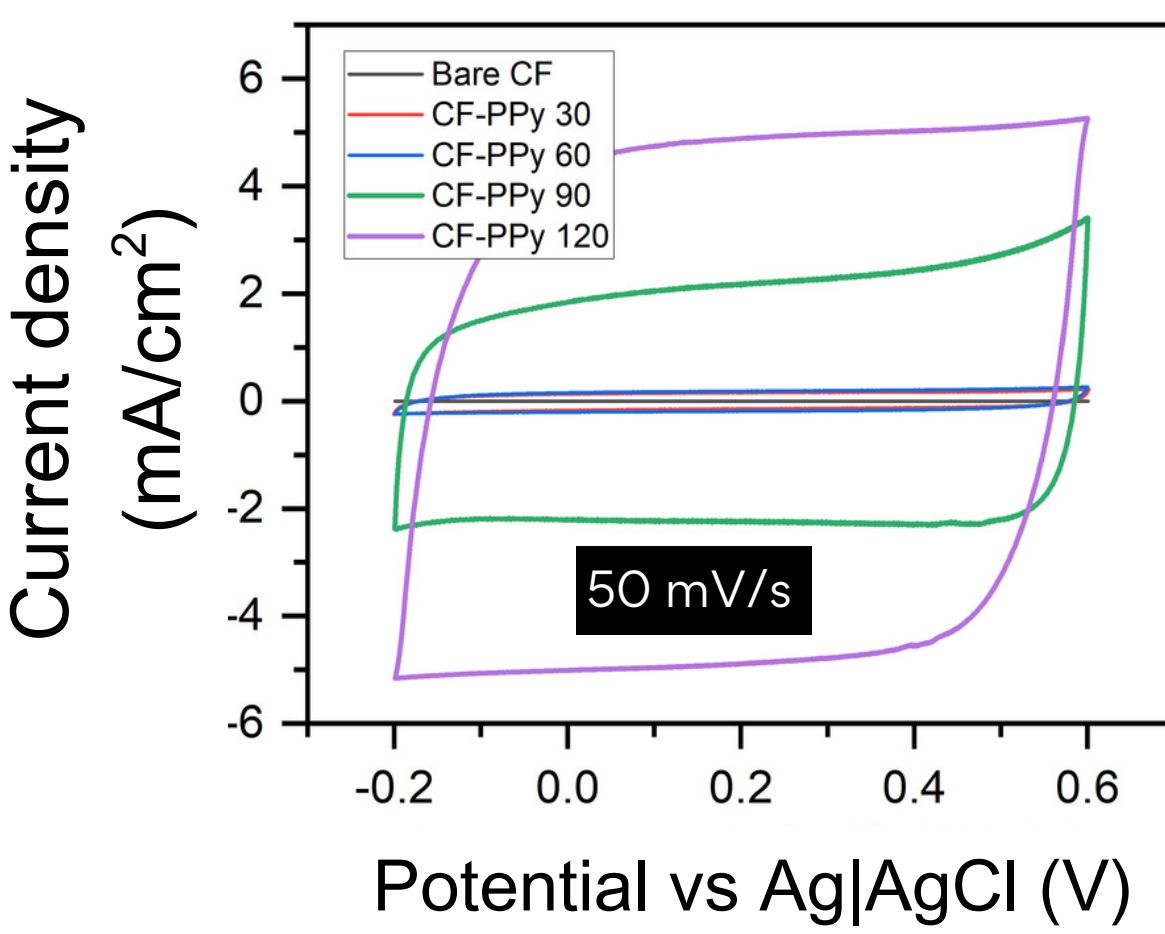
Extending the **deposition time** → increasing the film **thickness** and enhancing **conductivity**

Energy Storage Relevance

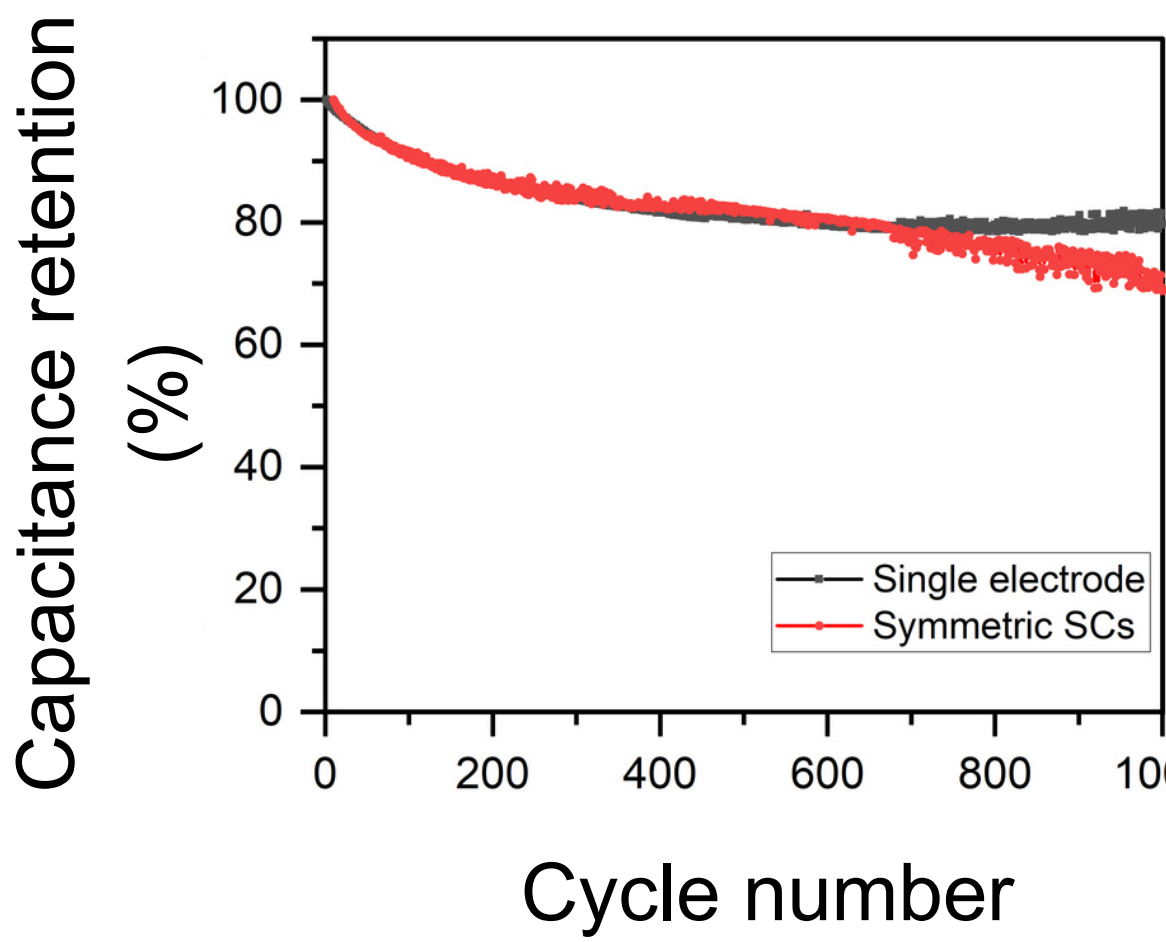
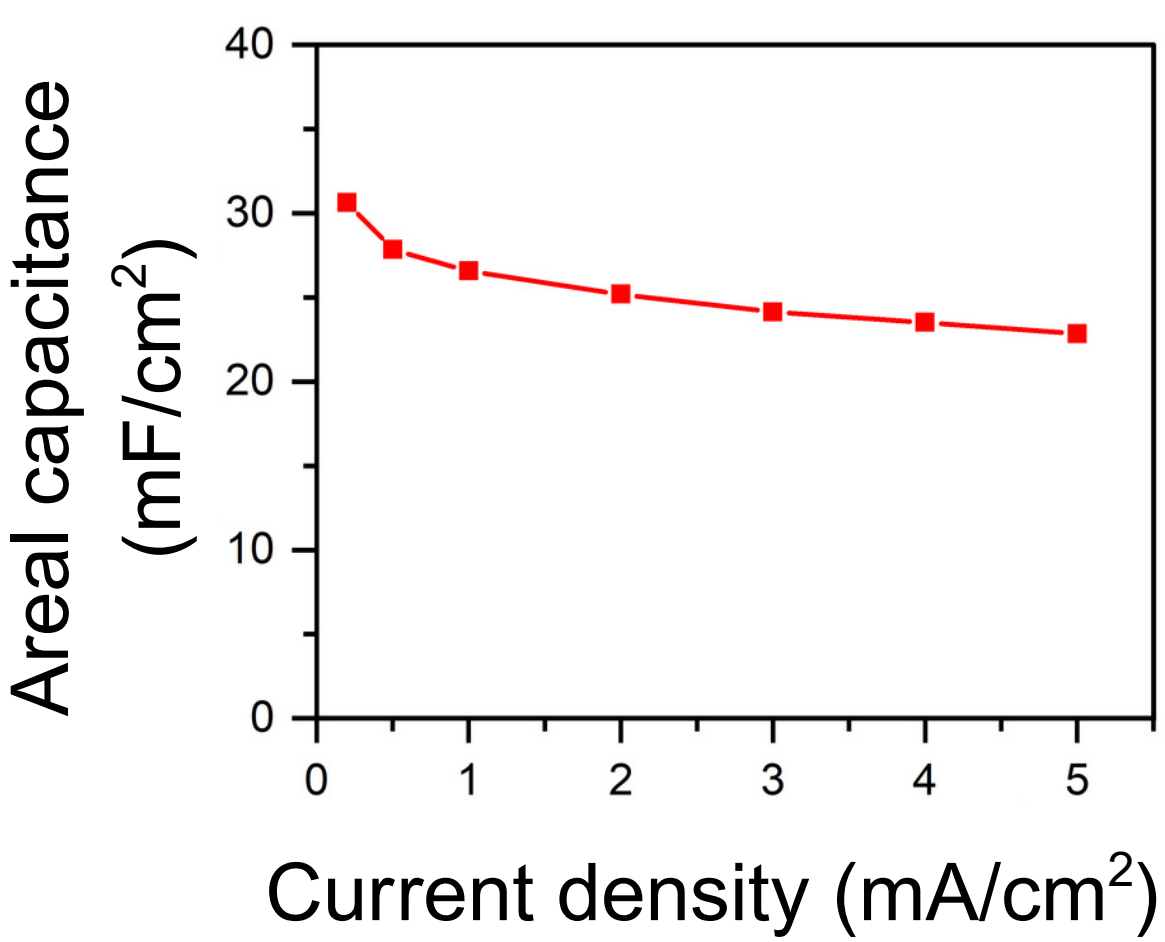
Development of electrodes for supercapacitor



Effect of deposition time on electrode performance



Symmetric supercapacitor device



Outlook

- Simulate the oCVD process with CFD
- Assemble a supercapacitor + solid electrolytes

References:

1. Fauzi, F. & Bose, R. K. *Appl. Surf. Sci. Adv.*, **2025**, 5, 100673
2. Fauzi, F., et al. *ACS Appl. Energy Mater.*, **2025**, 8, 4656–4668