Recovery of precious metals from E-waste by sustainable porous membranes (ReMe2)

Project leader
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Partners
Stockholm University
STUNS Energy

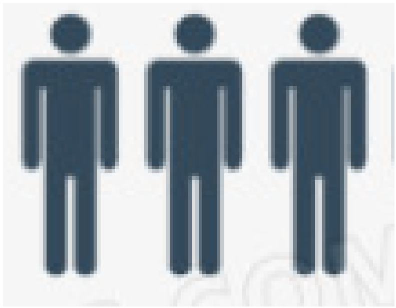
Project duration
2023-11-06 to 2025-06-30

SWEDISH MINING INNOVATION

Med stöd från
VINNOVA Sveriges innovationsmyndighet
Energimyndigheten
FORMAS
Strategiska innovations-program

Background

E-waste generated worldwide in 2022



62 M tonnes **7.75 kg per capita**

Properly recycled

20%

Value of precious metals in E-waste dumped every year

10 billion USD

- **Loss of precious metals**
- **Environmental issues**

Current E-waste recycling technology

Pyrometallurgy

- **Energy intensive**
- **Low selectivity**
- **Environmental unfriendly**

Hydrometallurgy

- **Low capital cost**
- **High selectivity**

Associate techniques

- ❑ **Electrowinning**
- ❑ **Chemical reduction**
- ❑ **Adsorption**

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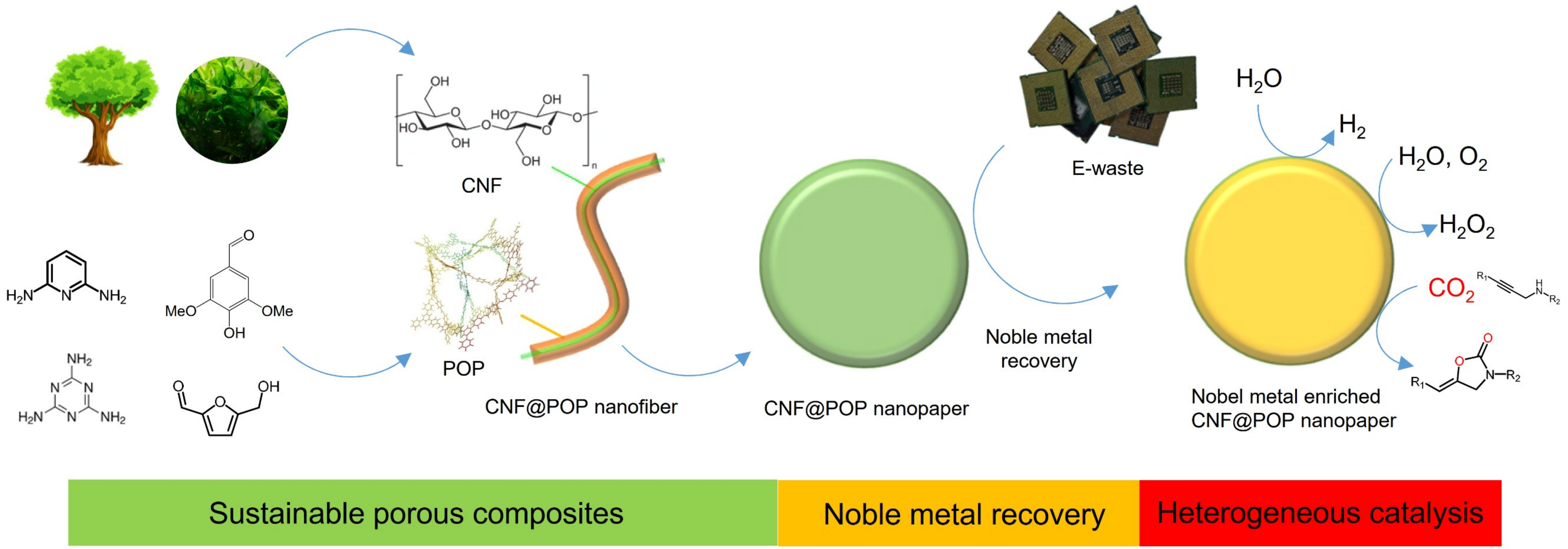
Goals of the project

- **Develop porous organic polymer (POP)-based sorbents and membranes for efficient noble metal capture from electronic waste (E-waste).**

- **Promote E-waste recycling, reduce E-waste disposal, conserve precious metal resources, and advance the concept of “urban mining.”**

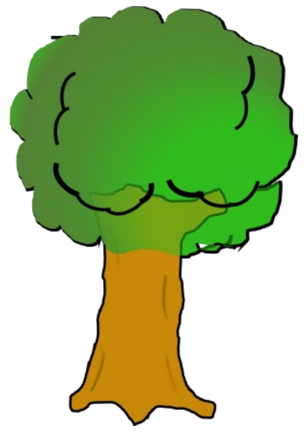
- **Convert the recovered precious metals into efficient catalysts.**



Results so far

Sustainable and effective sorbents
Bio-based POPs

Renewable resource (Biomass)



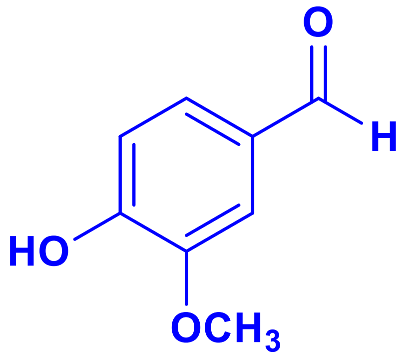
Tree

Cashew nut shell

Sugarcane

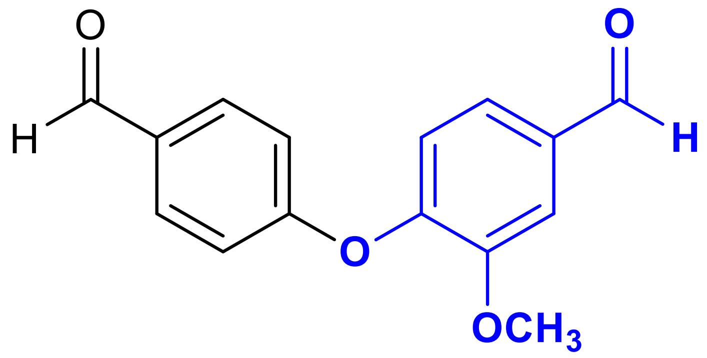
Extraction /conversion

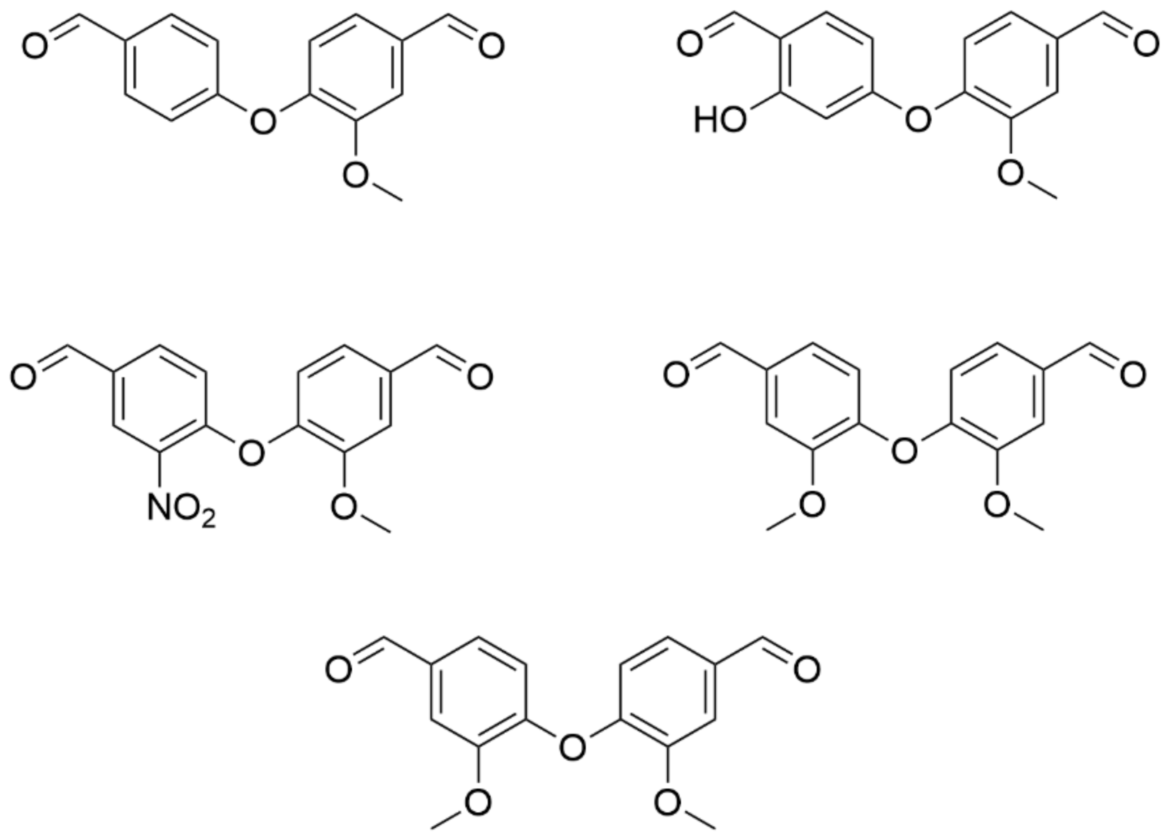
Biomolecules



Vanilli

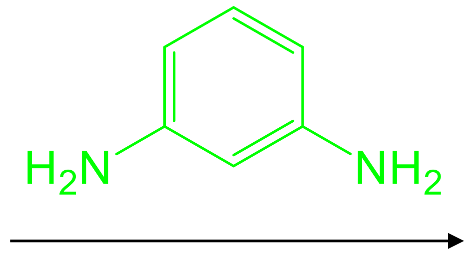
Bio-based monomers



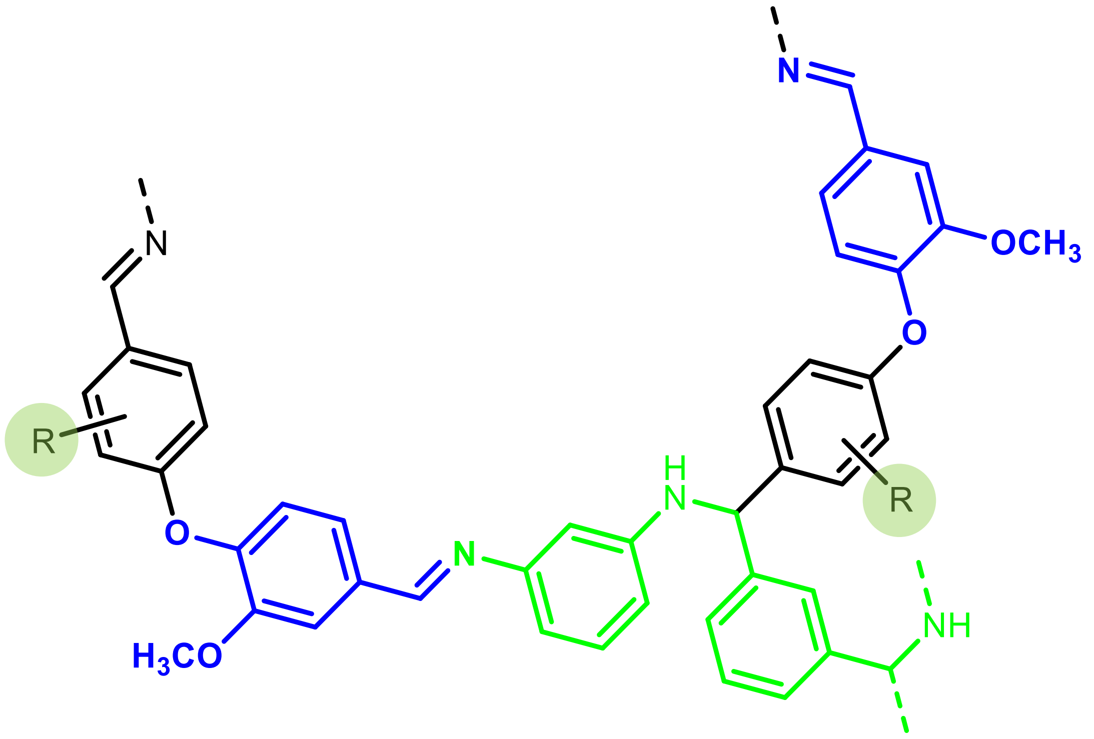


Functionalized bio-based monomers

Bio-based POP



Green polymerization

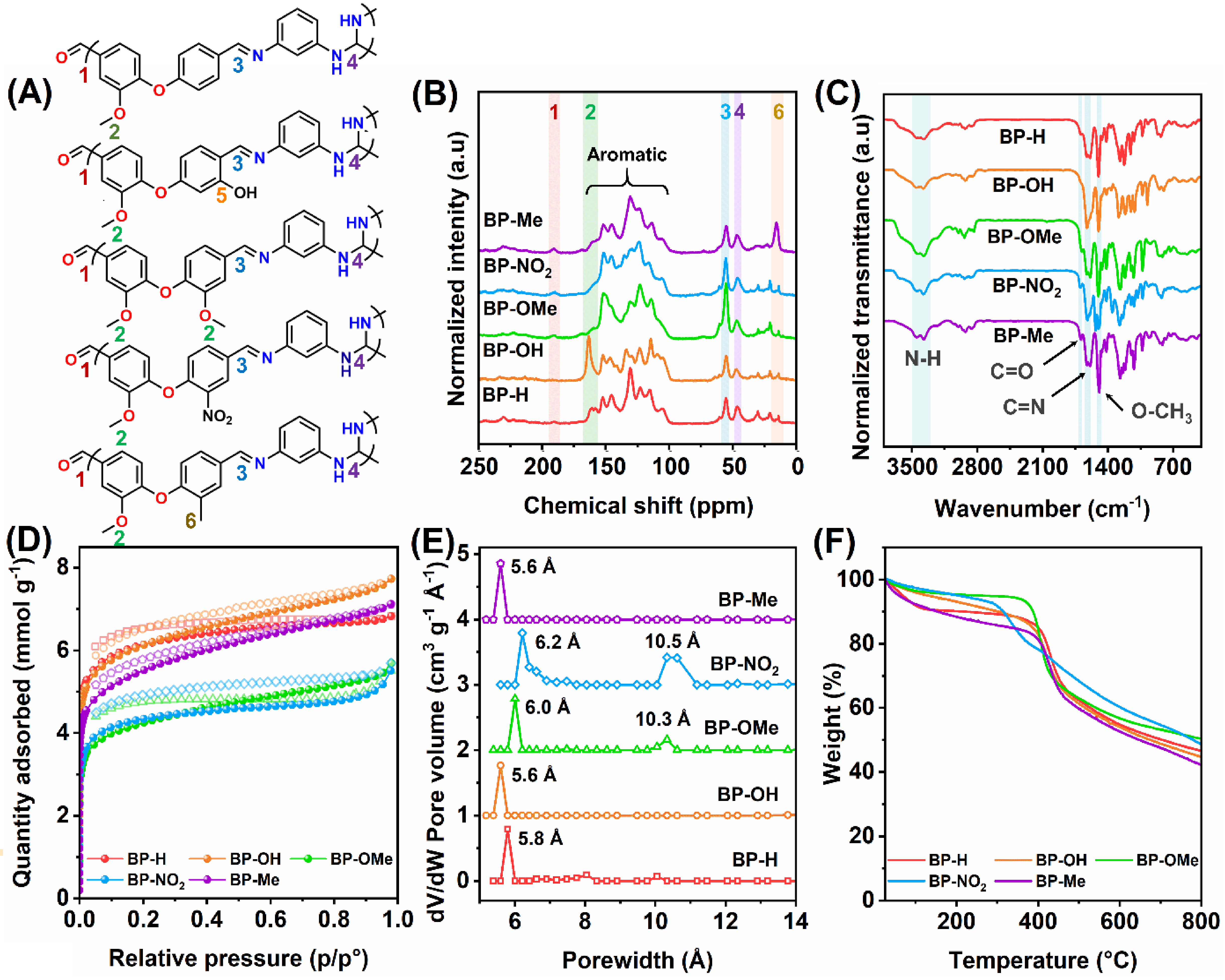


BioPOPs
R = H, OH, NO_2, OMe, or Me

Pros

- Derived from sustainable and abundant feedstock
- Cost-efficient
- Scalable
- Tunable surface chemistry and porosity

Results so far

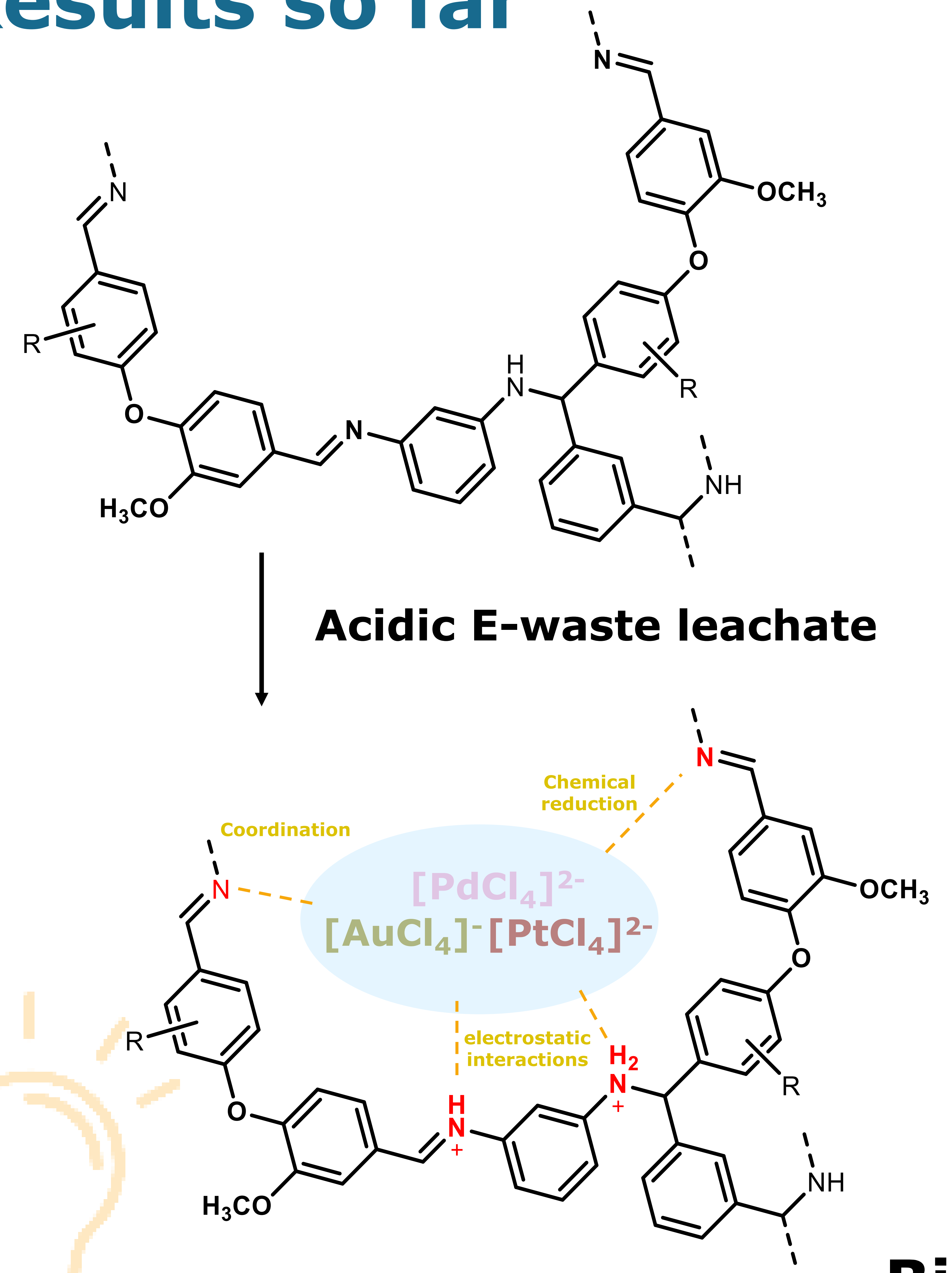


Characterization of bio-based POPs

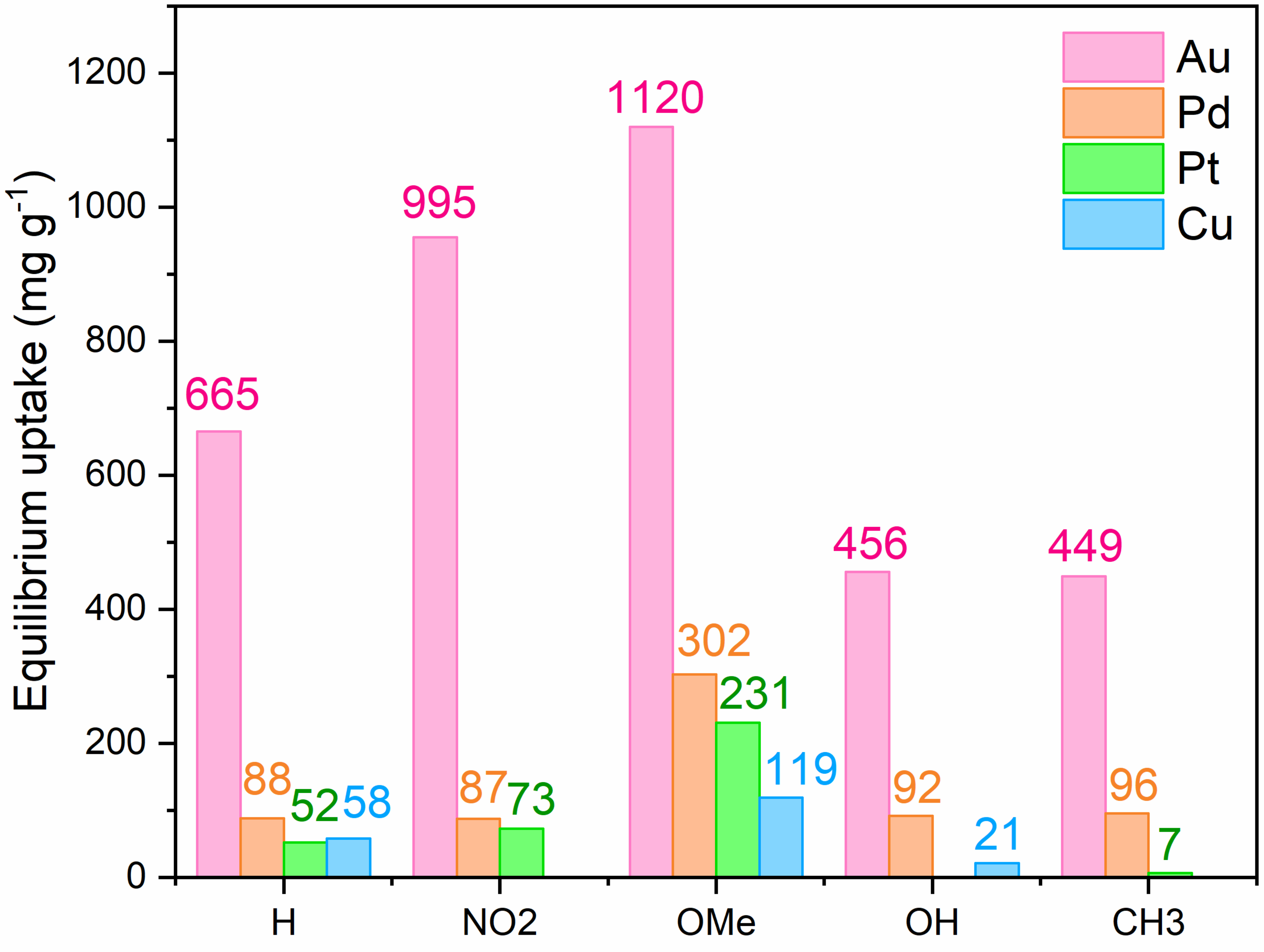
- **Branching network:** imine and aminal linkages
- **Highly porous:** specific surface areas up to 600 m^2/g
-

  Rich microporosity: pore size ~5-10 Å
- **High thermal stability:** up to 400°C

Results so far

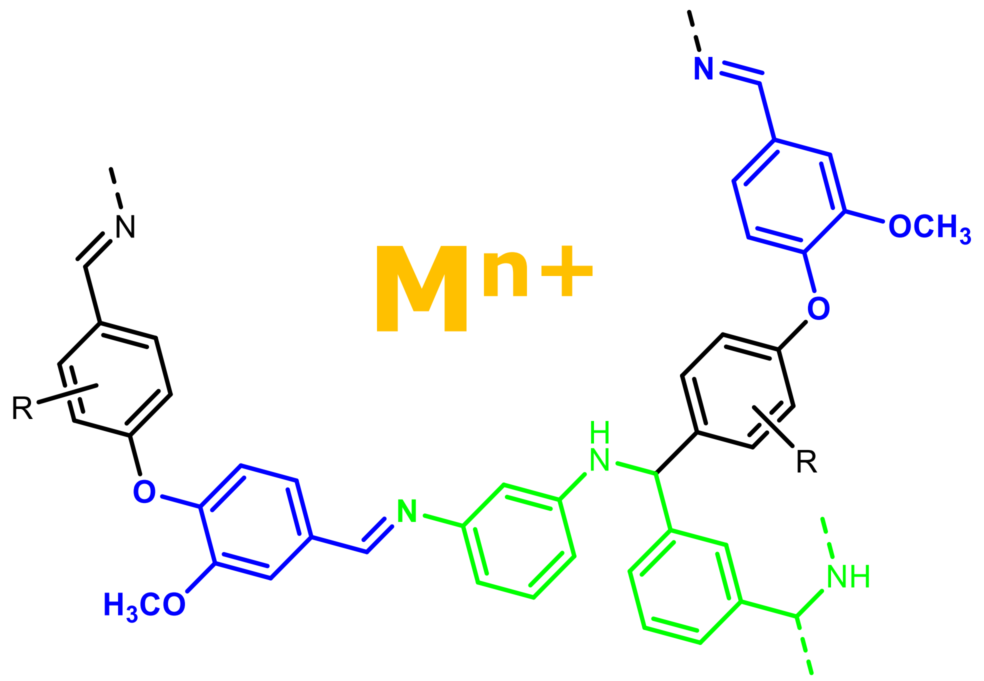


Noble metal capture



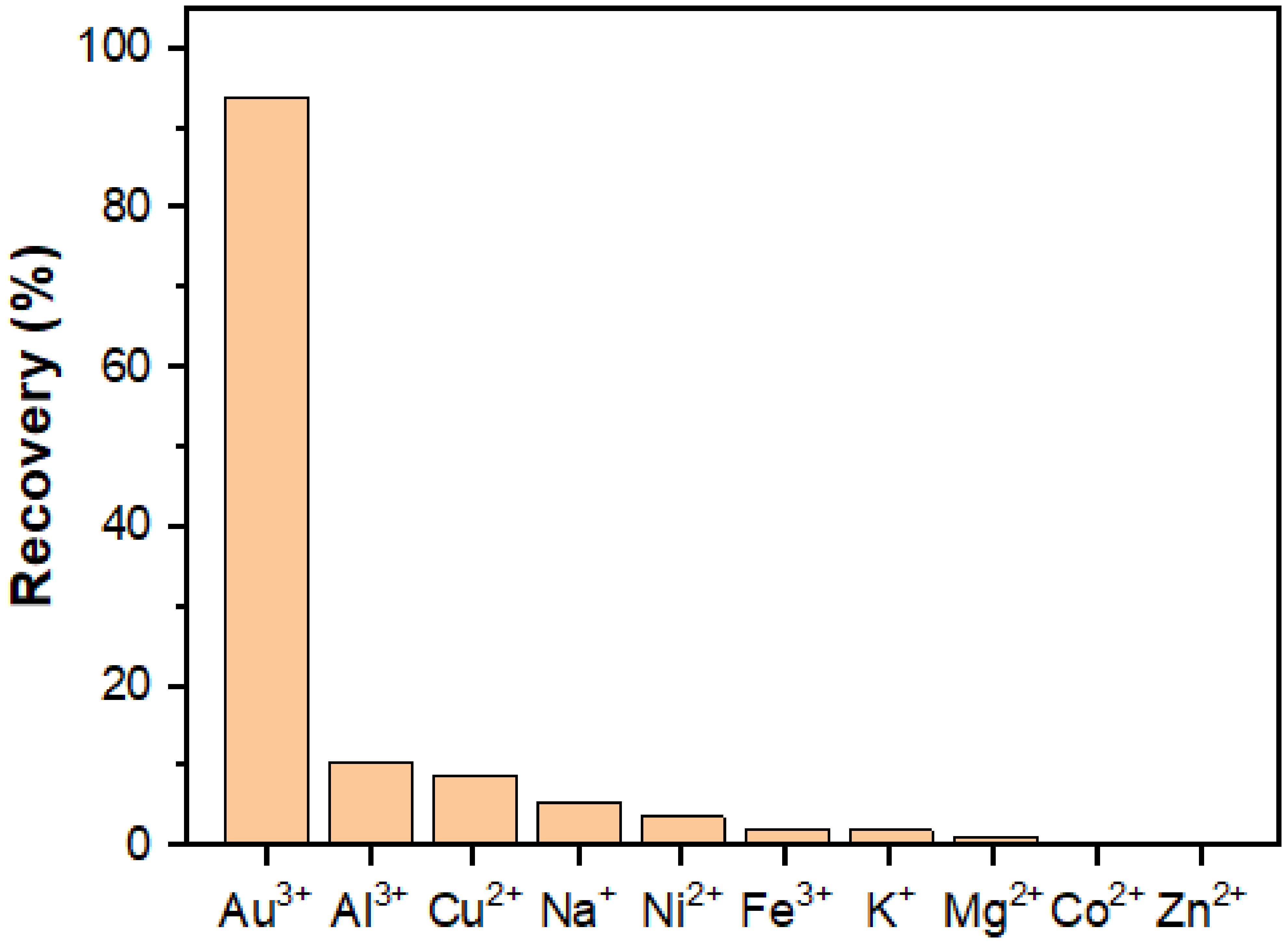
BioPOPs (R = H, OH, NO_2, OMe, or Me)

Results so far

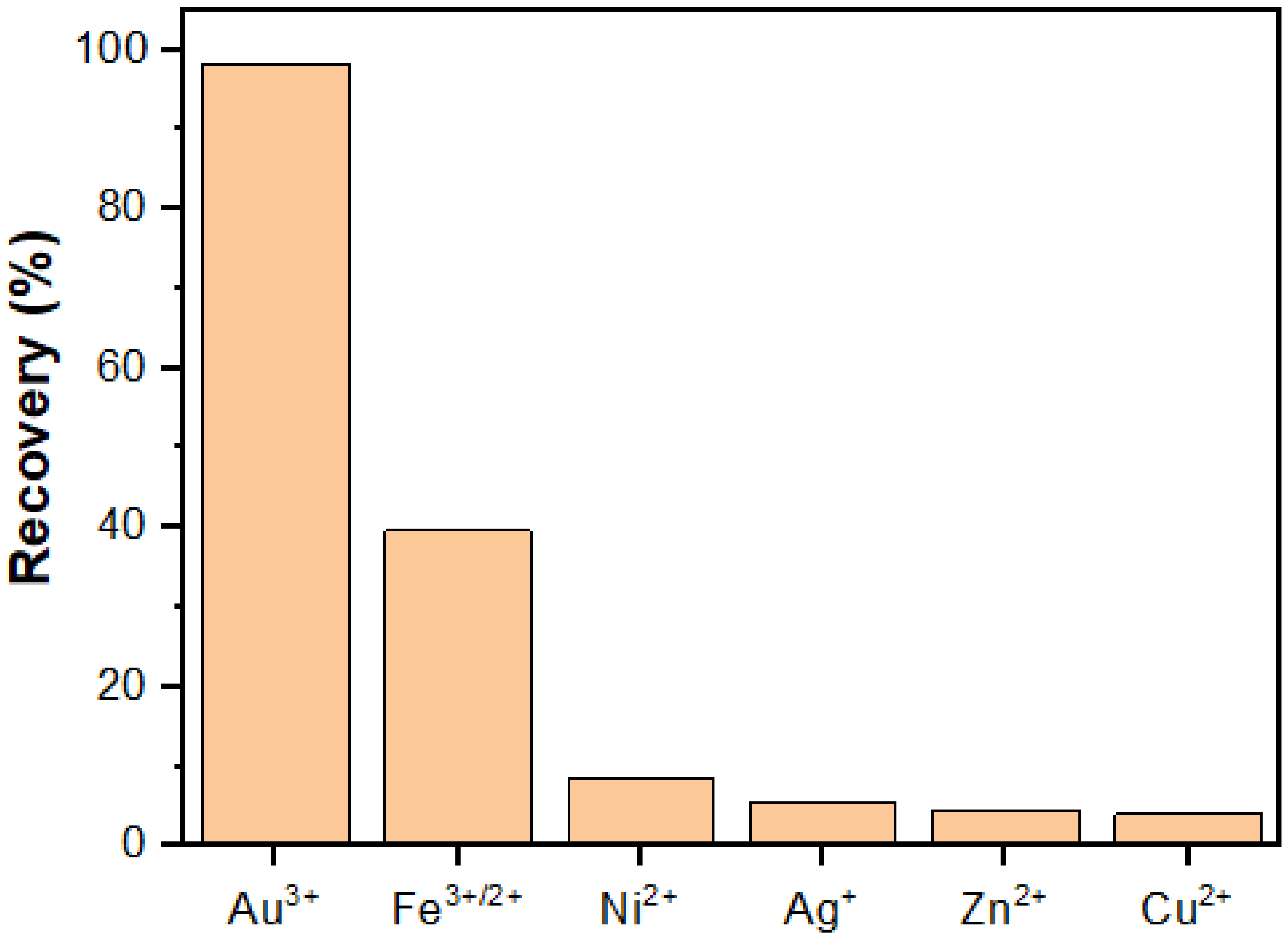


Noble metal capture

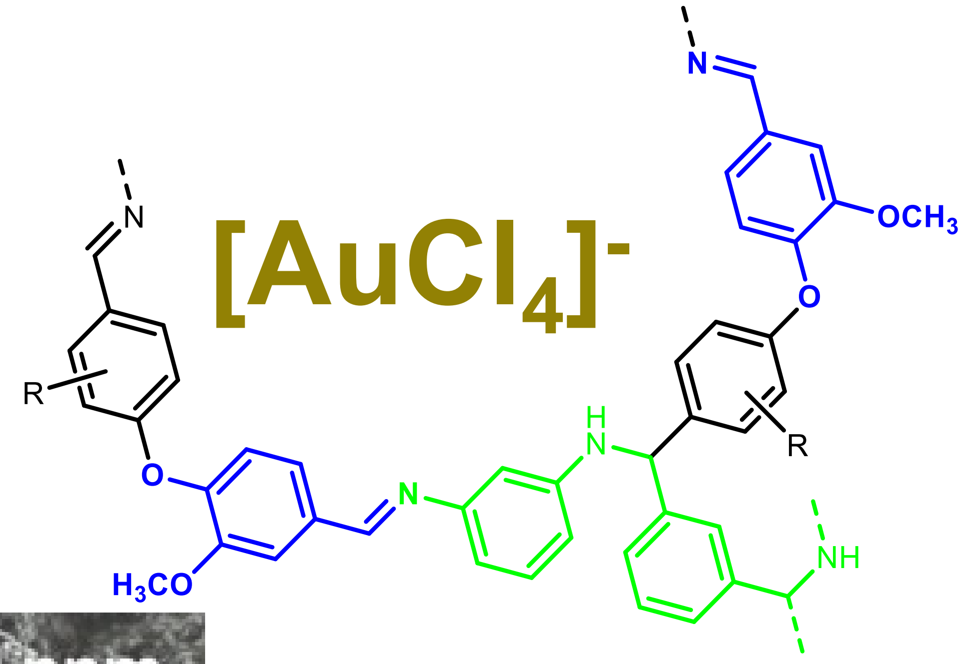
**Simulated metal leachate
(100 ppm of each metal species)**



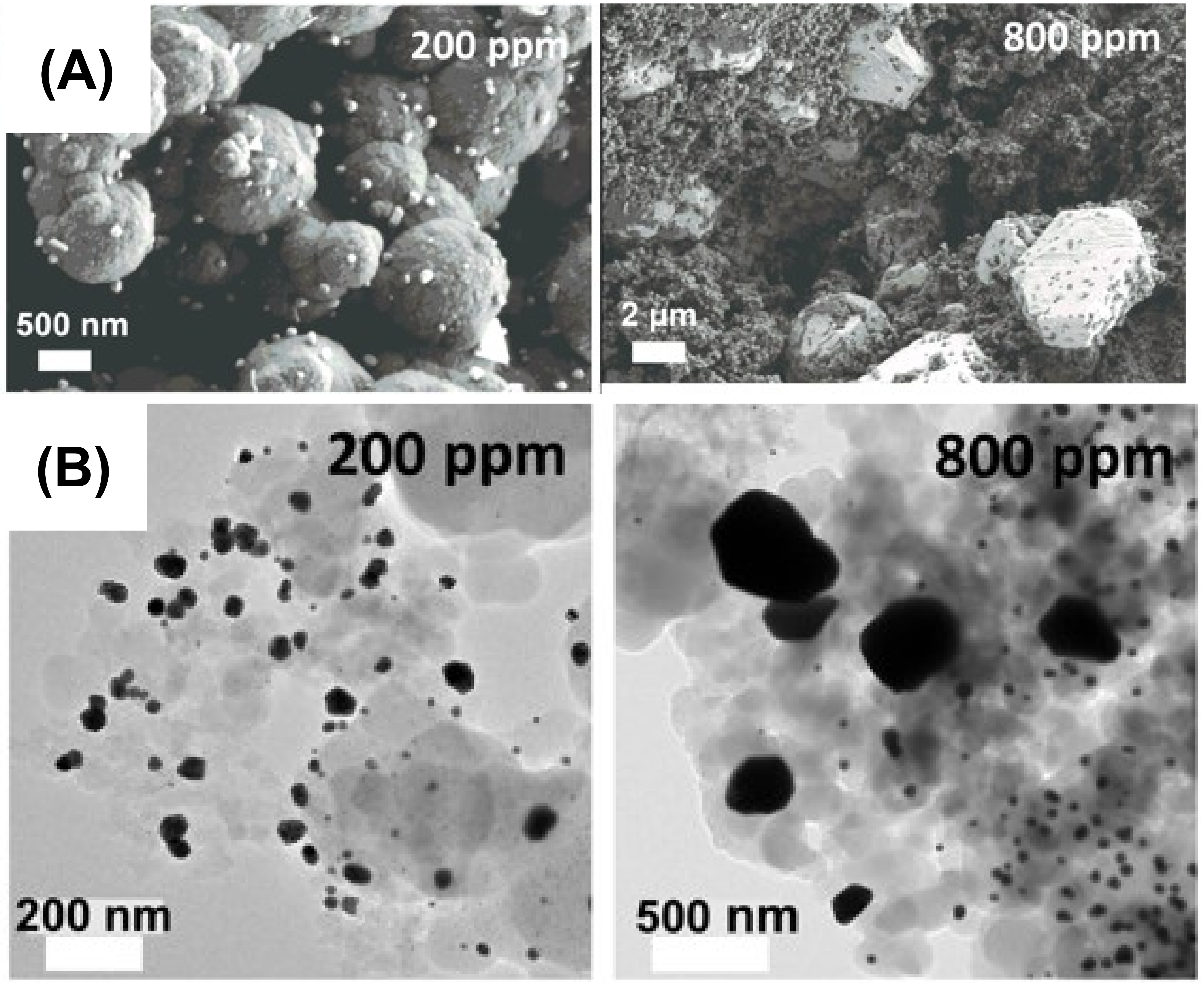
E-waste leachate

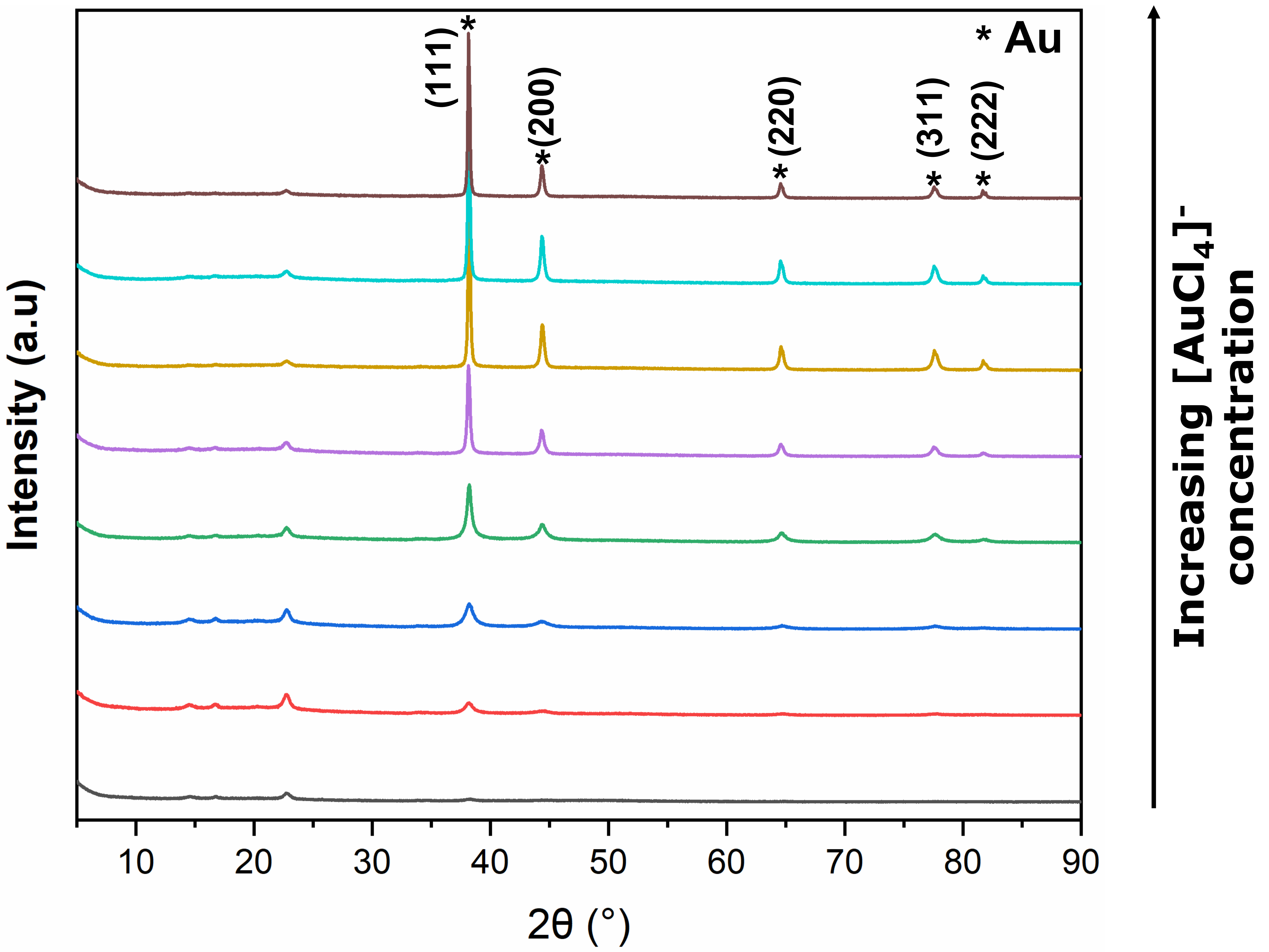


Results so far



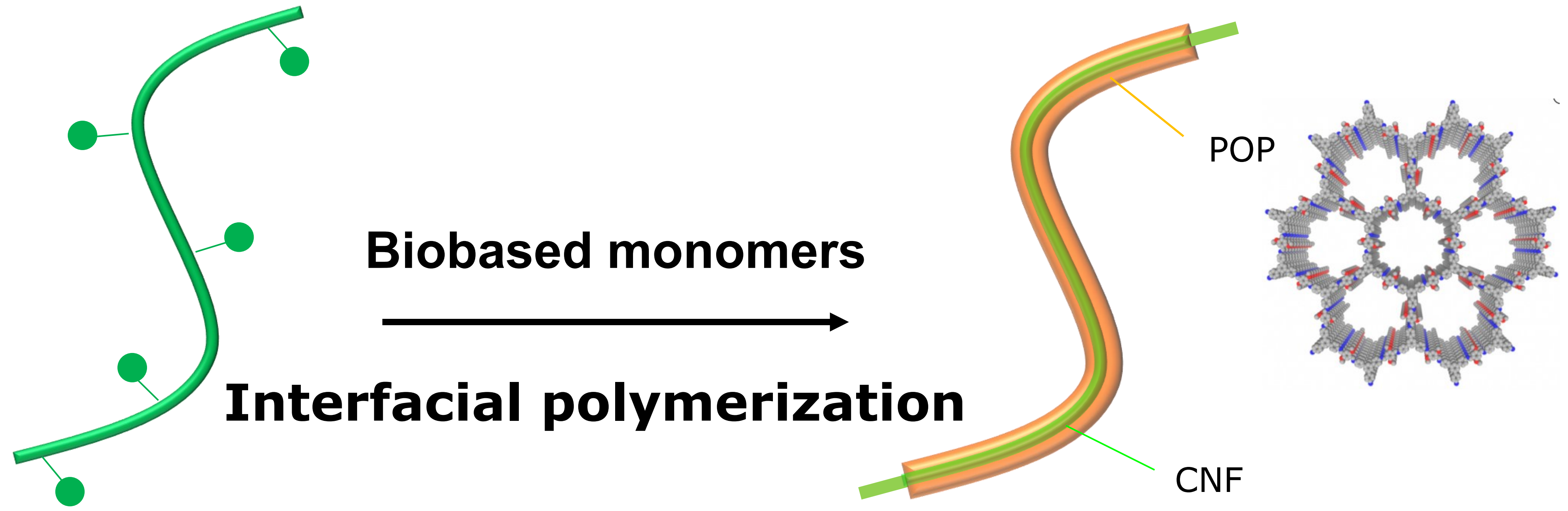
Noble metal capture





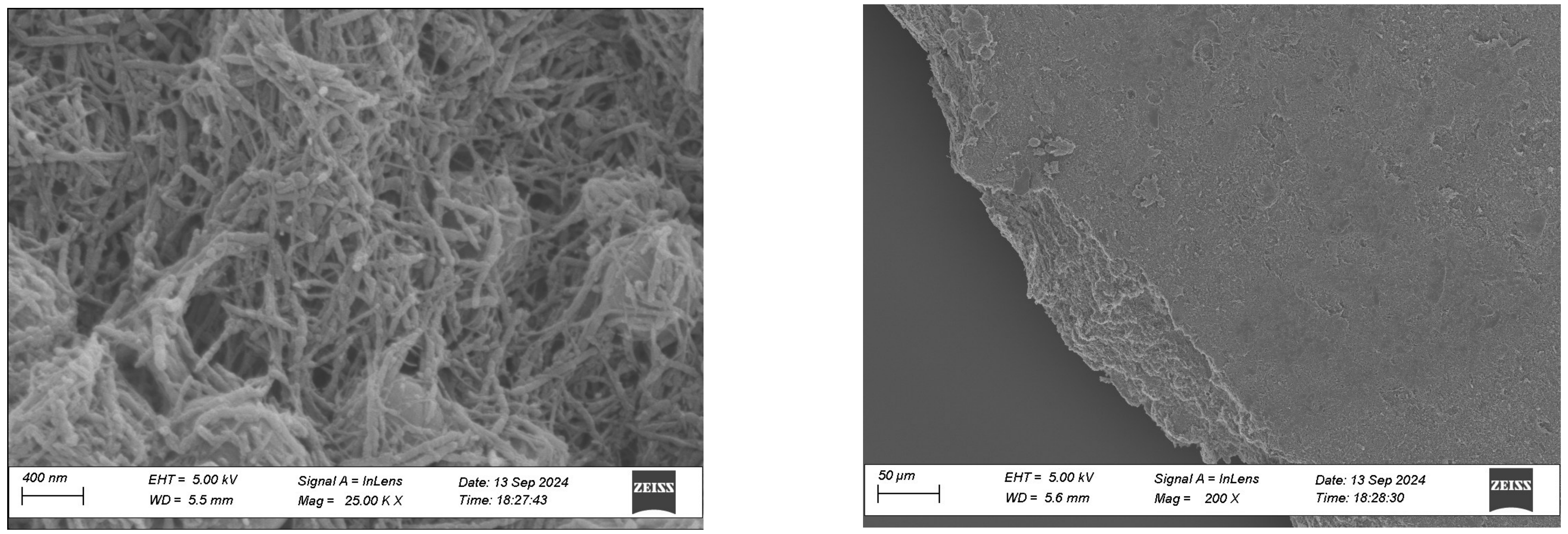
Results so far

Processing of bio-based POPs into membranes

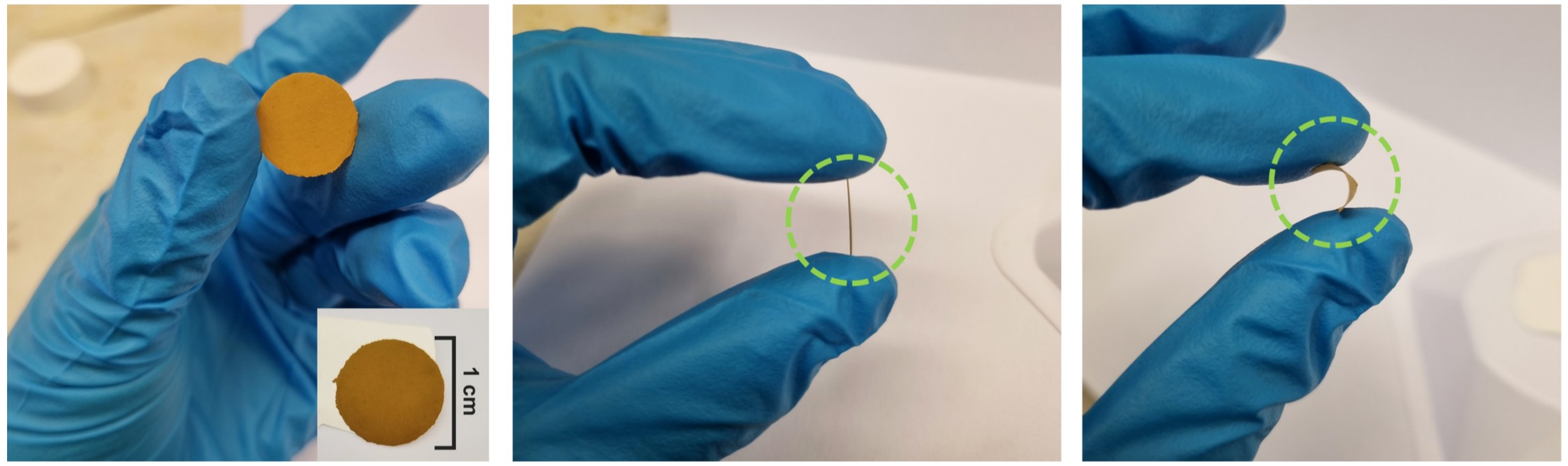


Cellulose nanofiber (CNF)

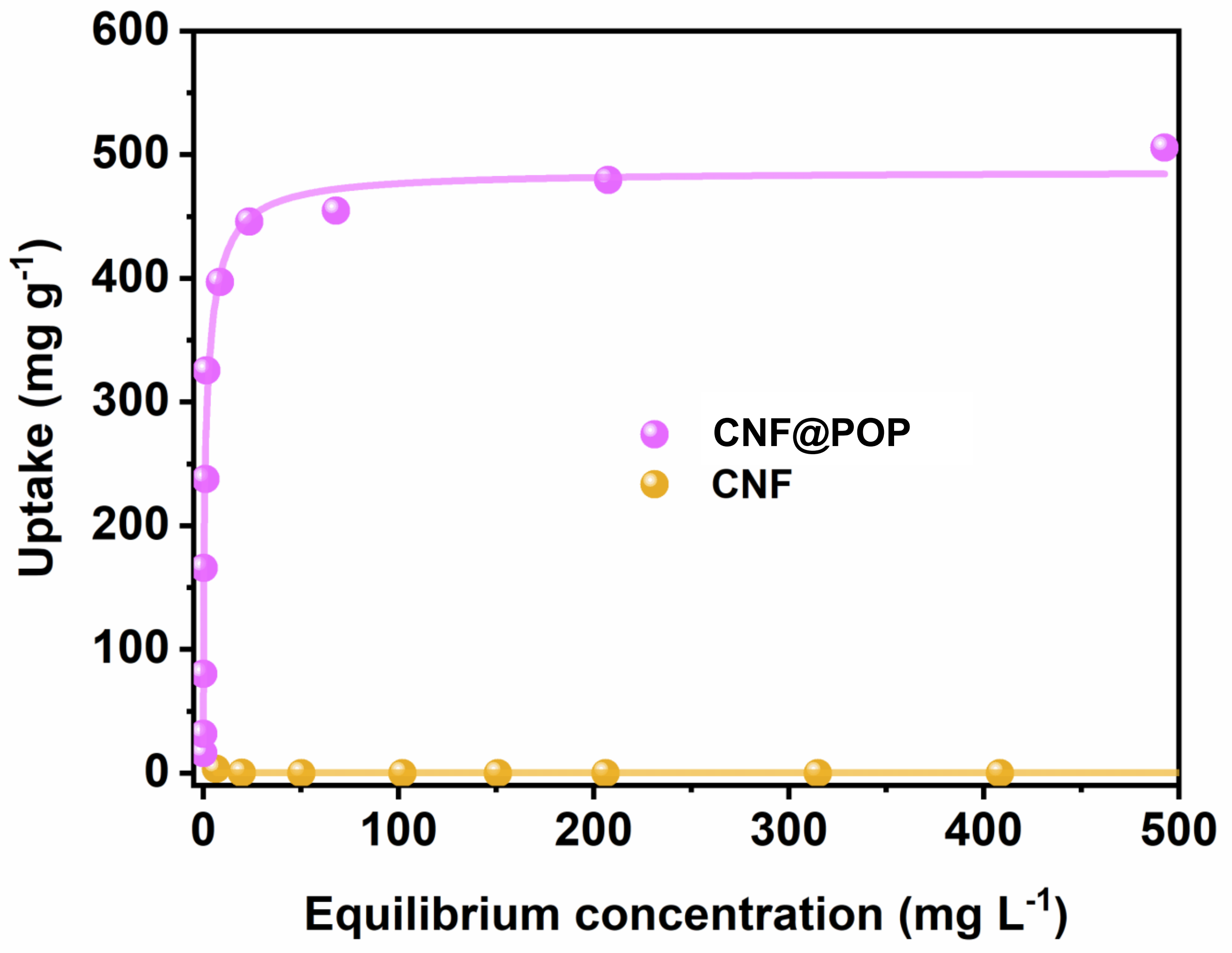
CNF@POP

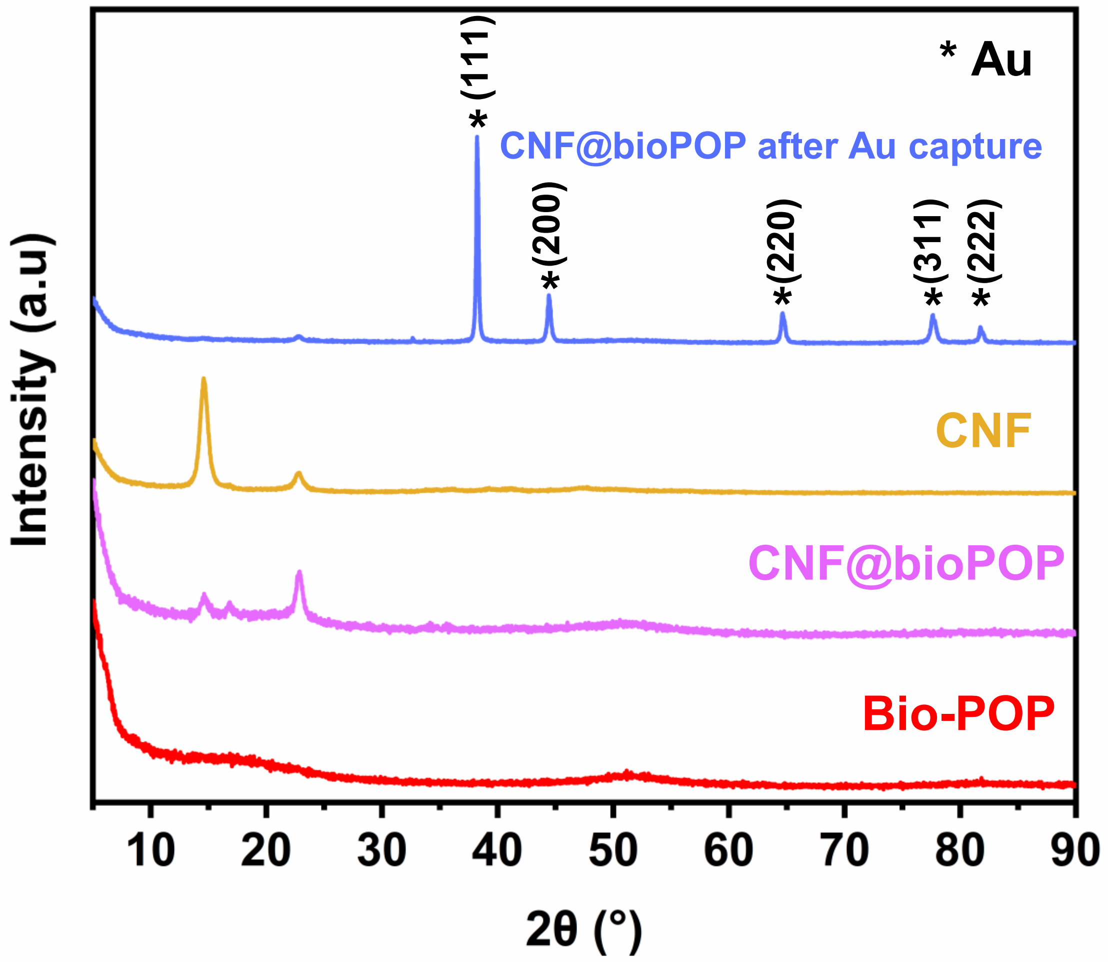


SEM images of CNF@bio-POP nanopaper



Freestanding CNF@bio-POP nanopaper





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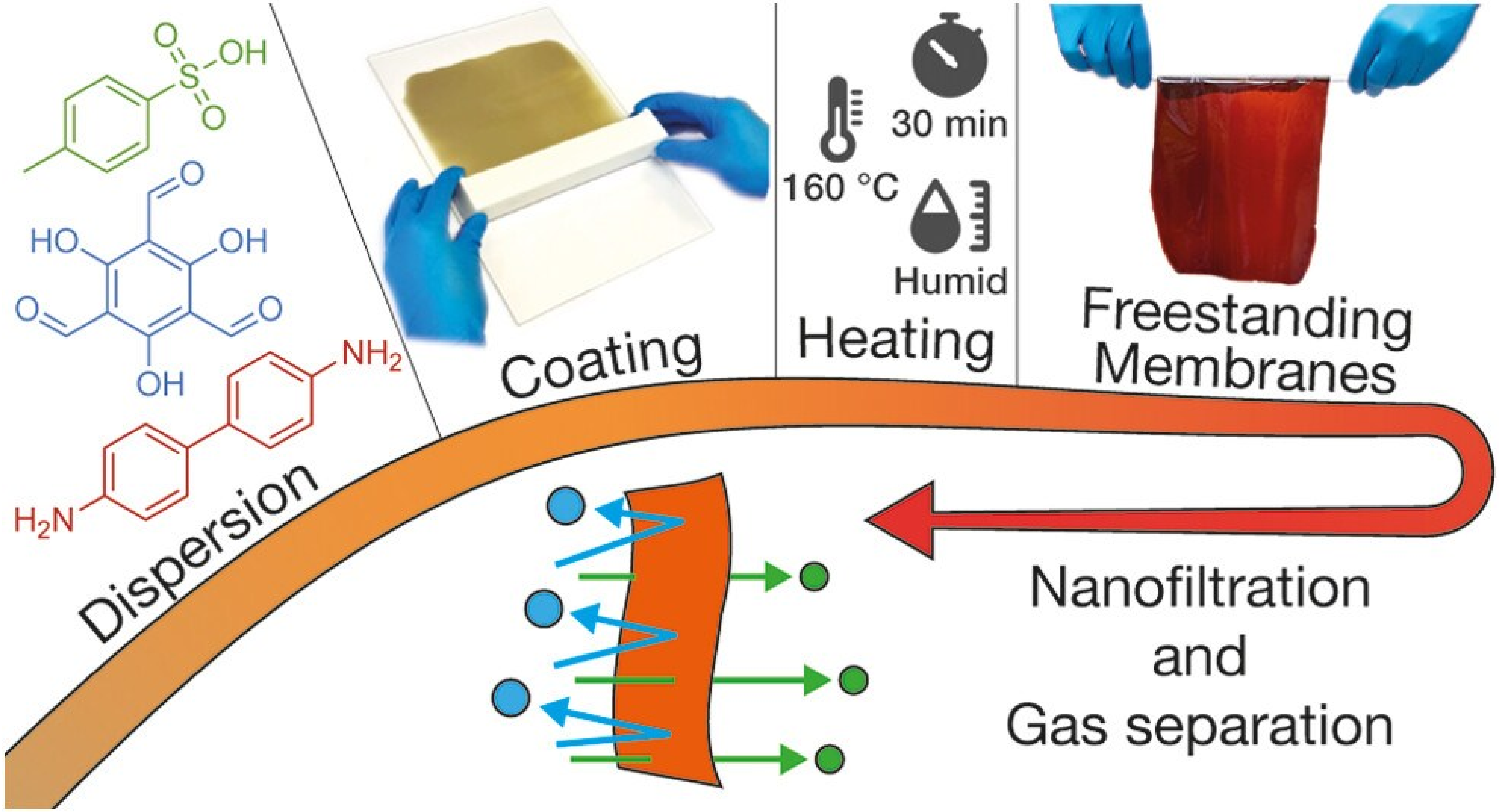
Results so far

Scalable fabricaiton of freestanding porous organic polymer membranes



- **Defect-free structure**
- **High microporosity**
- **Scalable fabrication process**
- **Excellent mechanical strength**
- **Potential for precious metal recovery through membrane separation**

K. Eliasson, F. Jiang, M Åhlén, M Strømme, C Xu*, *J. Am. Chem. Soc.*, 2025, 147, 29270

Upcoming activities and next step

- Scale up the synthesis and engineering of porous organic polymers (POPs).
- Evaluate the materials for the recovery of noble metals from various secondary waste sources.
- Develop prototypes to advance the practical applications of POP materials in noble metal recovery.
- Convert the recovered noble metals on POPs into high-value products.

Mining innovation for a sustainable future

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