

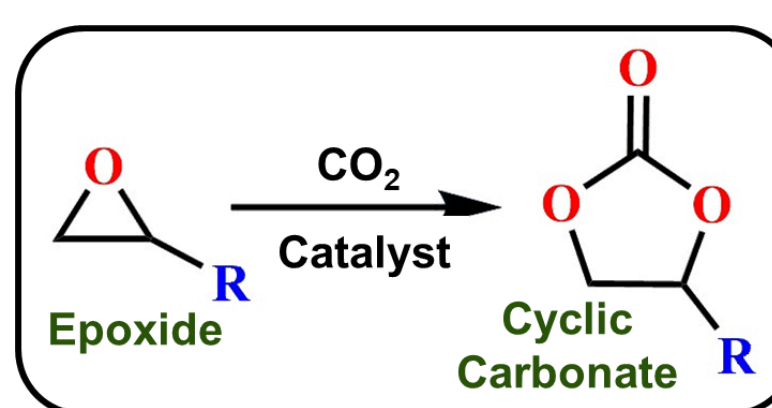
Research background

❑ The growing atmospheric concentration of CO₂ that contributes to global warming is a matter of great concern.

✓ To address this, non-redox CO₂ fixation route has been studied.

Cyclic Carbonate can be used as:

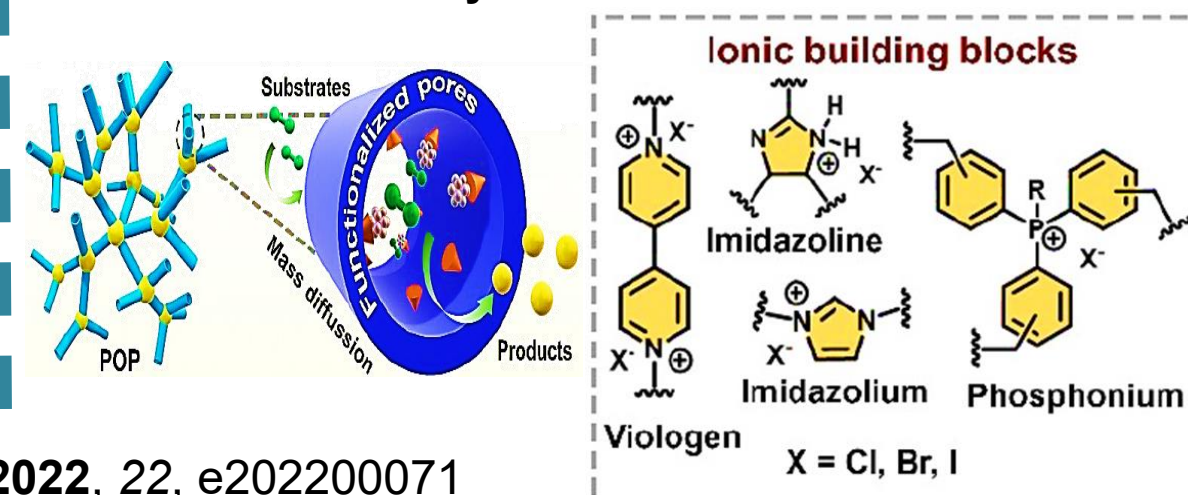
- ✓ Polar Aprotic Solvents
- ✓ Electrolytes for Li-ion Batteries
- ✓ Fuel Additives
- ✓ Monomers for Polycarbonate Synthesis



Ionic Porous Organic Polymers (iPOPs) for Non-Redox CO₂ Fixation

Requirements of POP to act as a catalyst for CO₂ conversion:

- ✓ Heteroatom-rich (O,N) building block
- ✓ Functional groups (like -OH, -NH)
- ✓ Large surface area
- ✓ Hierarchical porosity for mass transport
- ✓ Cost-efficient synthesis route

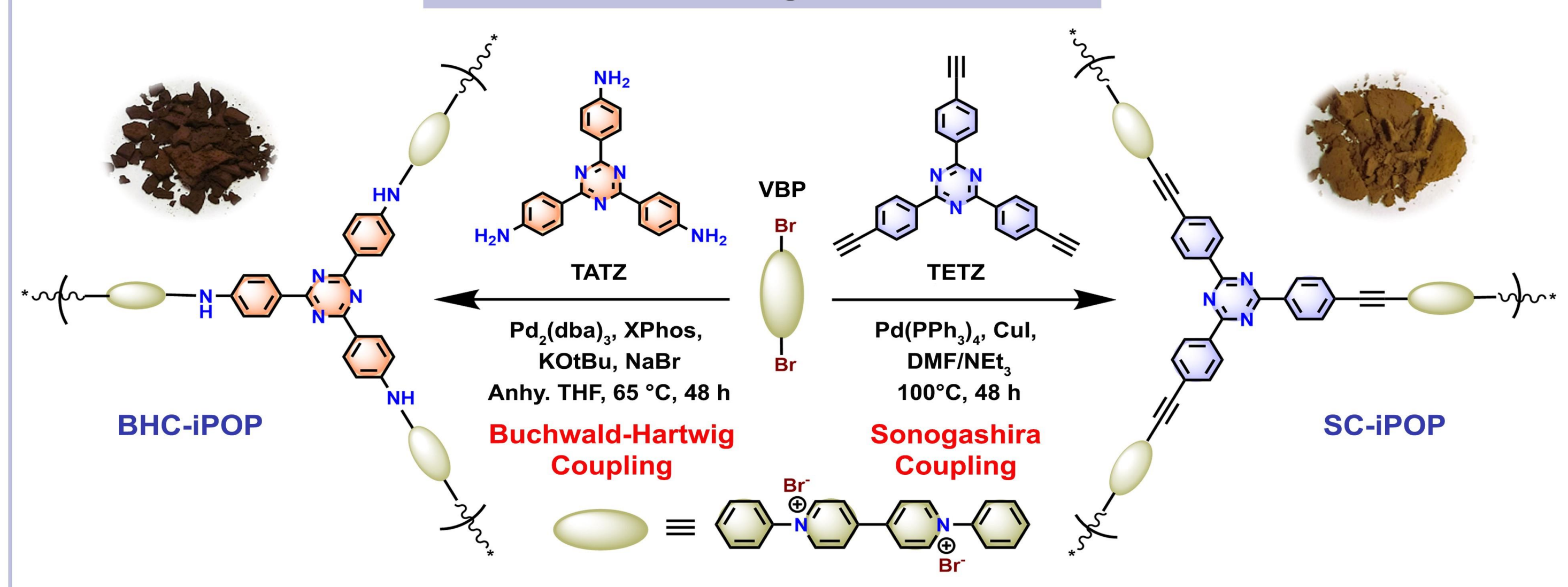


The production of cyclic carbonate is a highly atom-efficient process

Patra and coworkers, Chem. Rec. 2022, 22, e202200071

Design and Fabrication of iPOPs

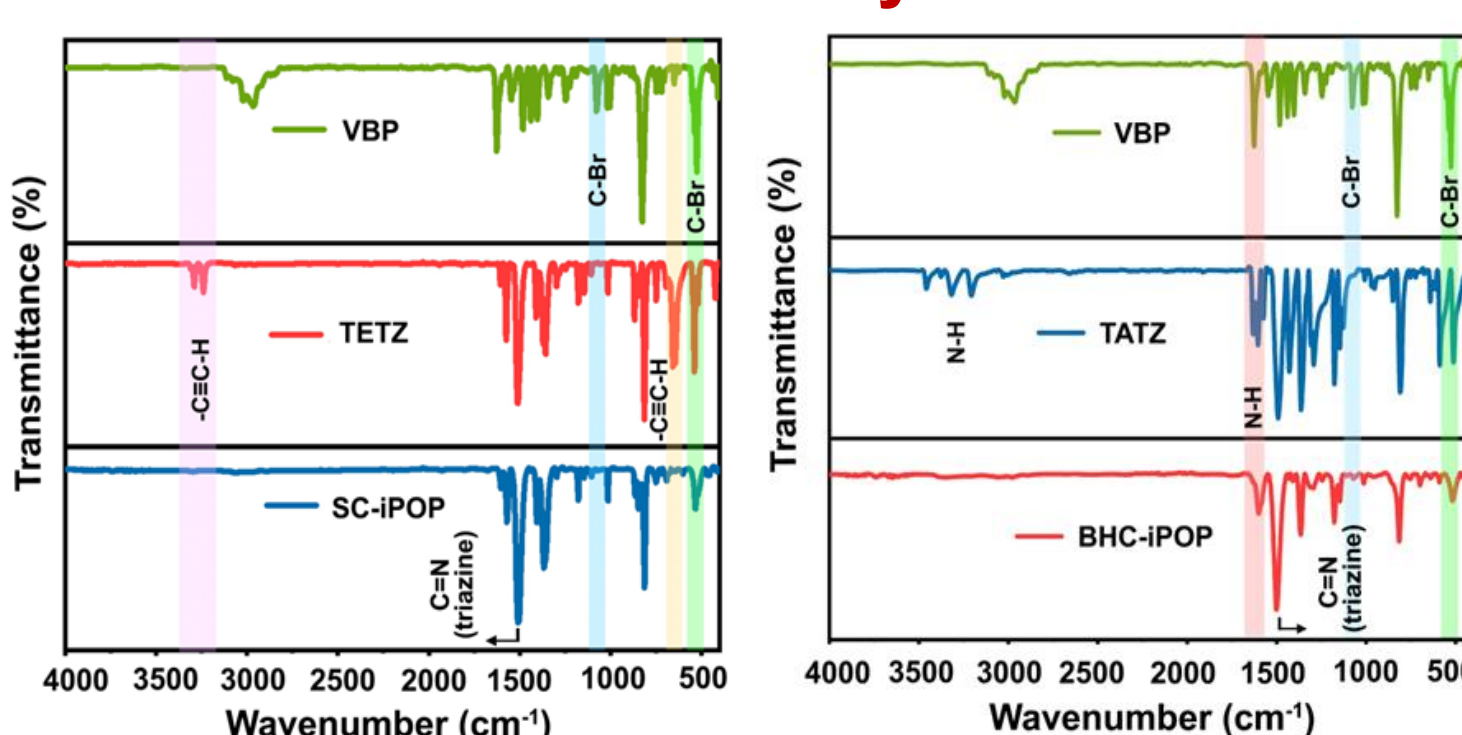
Fabrication of Viologen-based iPOPs



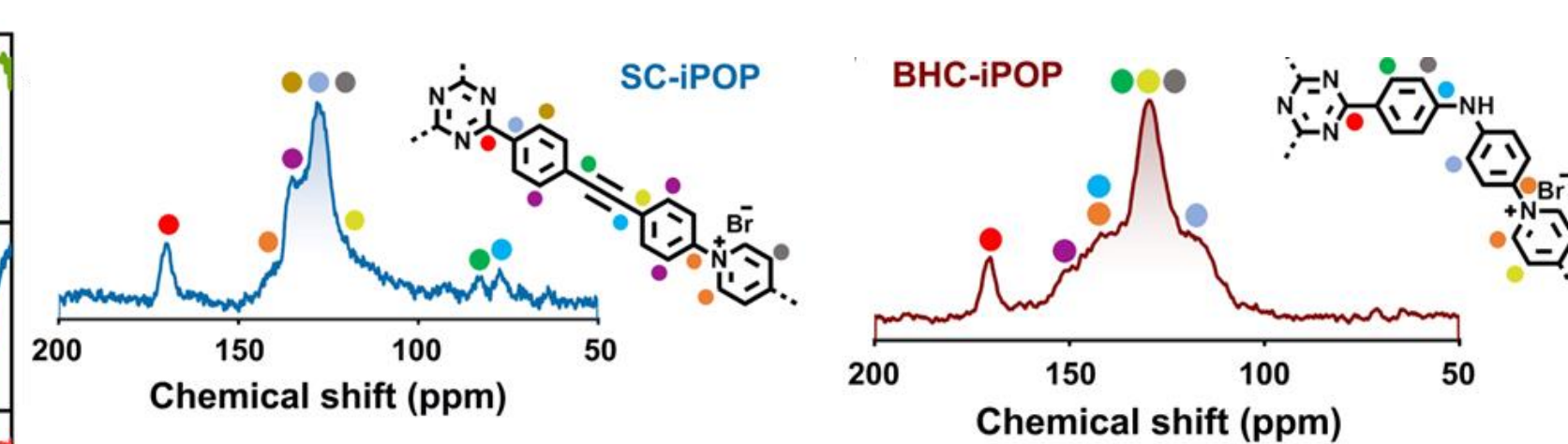
- ❑ Fabricated two novel viologen-based iPOPs (BHC-iPOP and SC-iPOP), which differ in functional linkages
- ❑ Synthesis procedure followed: Buchwald-Hartwig Coupling and Sonogashira-Hagihara Coupling
- ❑ SC-iPOP possesses a similar structure to that of BHC-iPOP, except for the acetylenic connecting linkages compared to NH linkages in the porous network.

Characterizations of iPOPs

FTIR Analysis



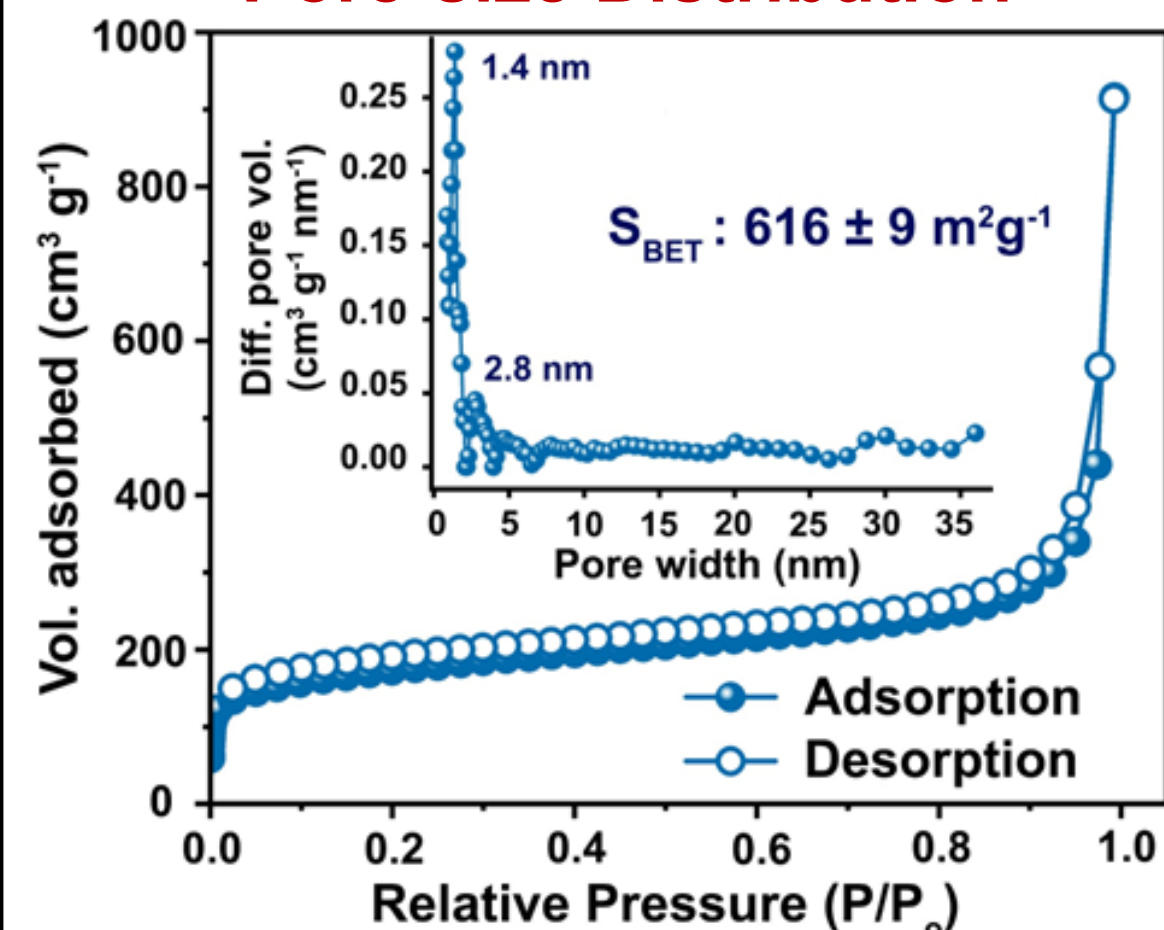
¹³C-SS NMR



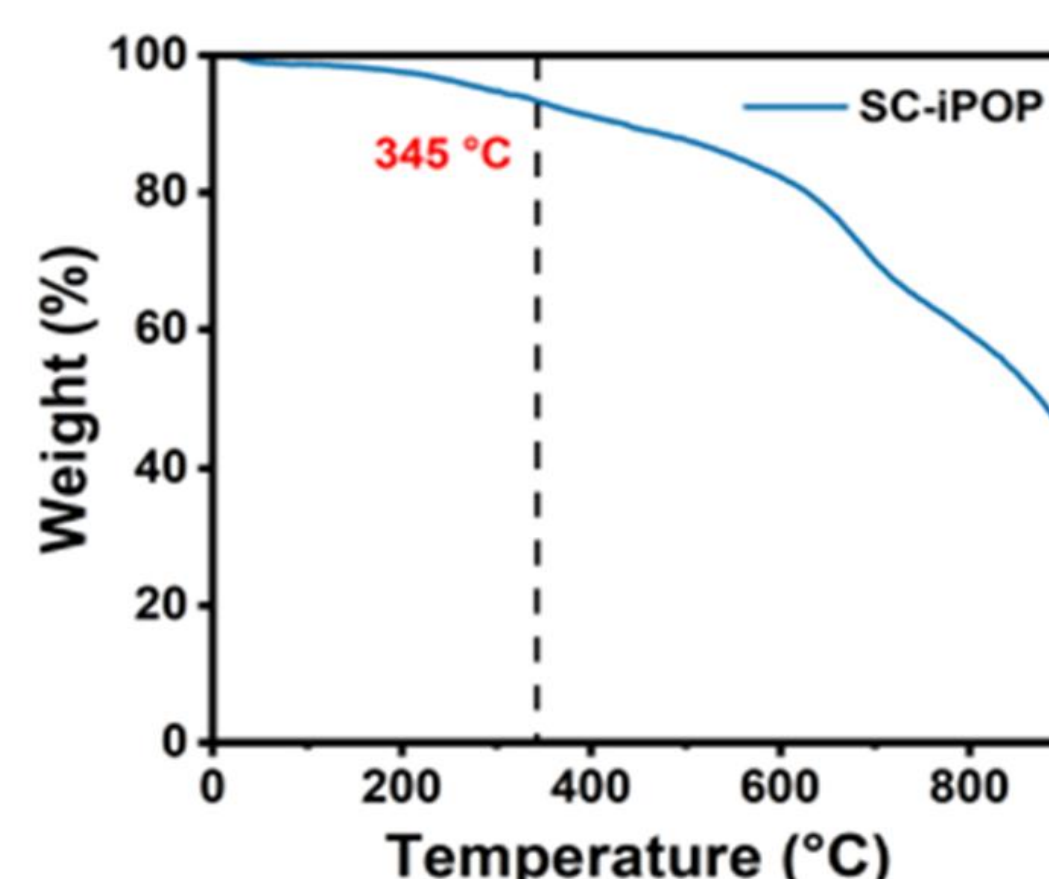
❖ Structural integrity of the fabricated iPOPs was confirmed by FTIR analysis and ¹³C solid-state NMR spectroscopy

Characterizations of iPOPs

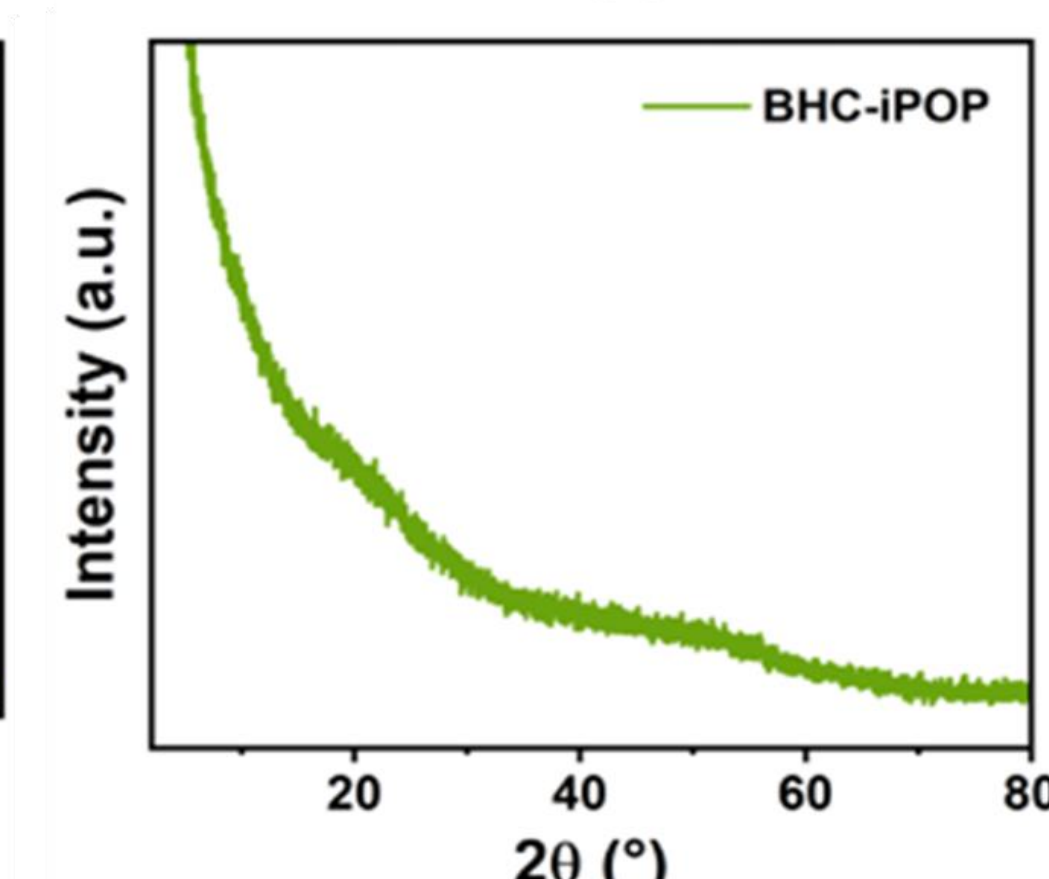
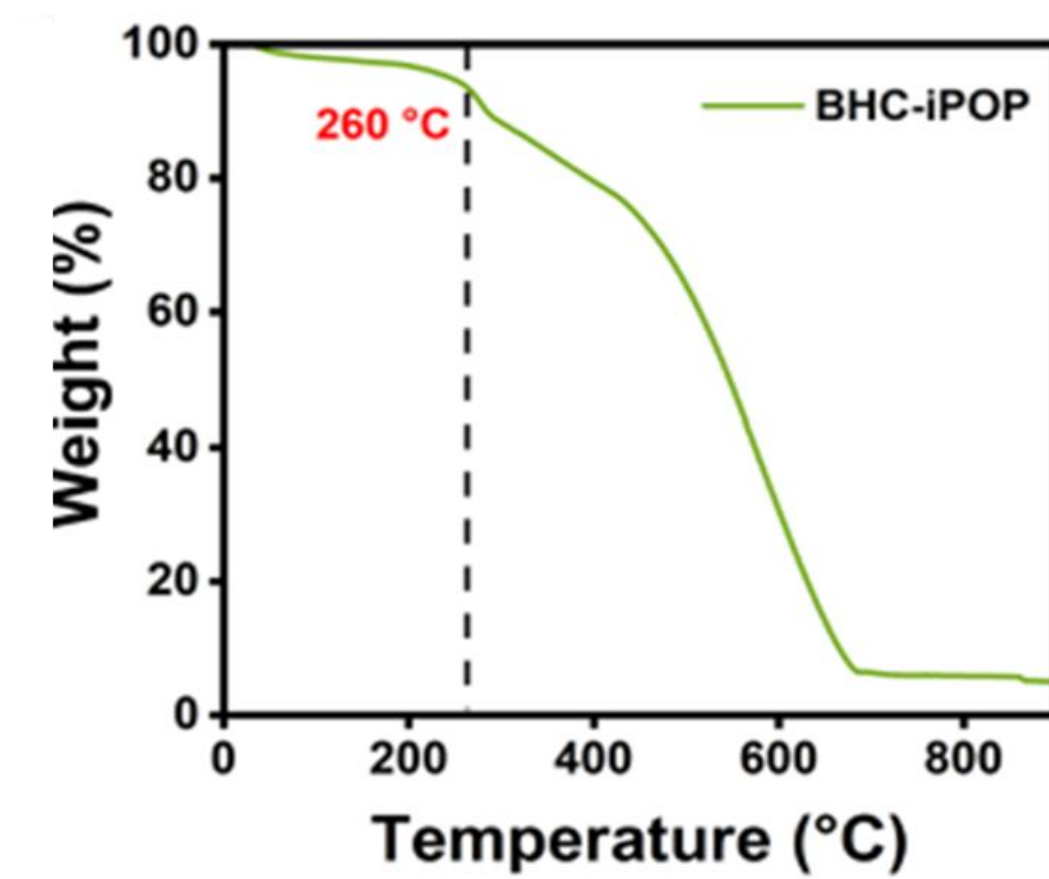
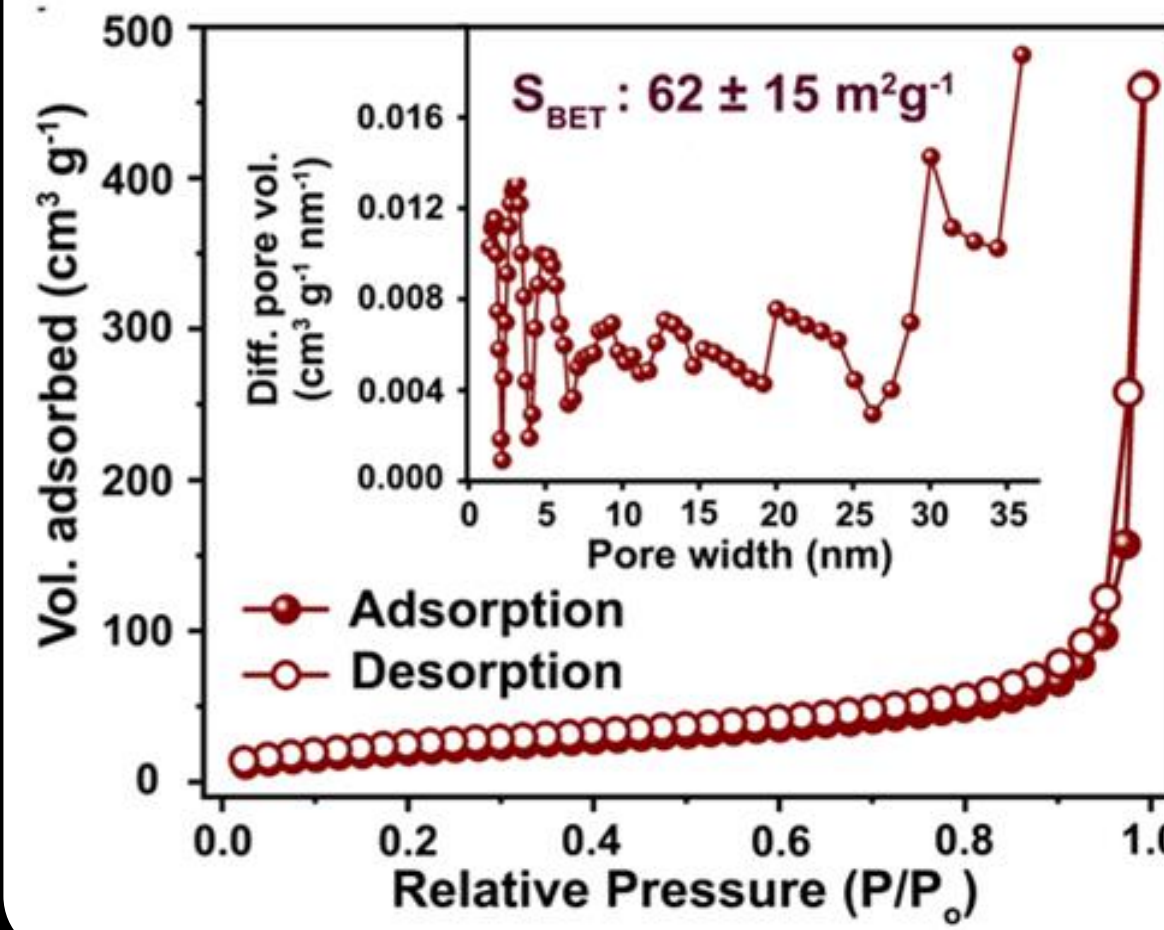
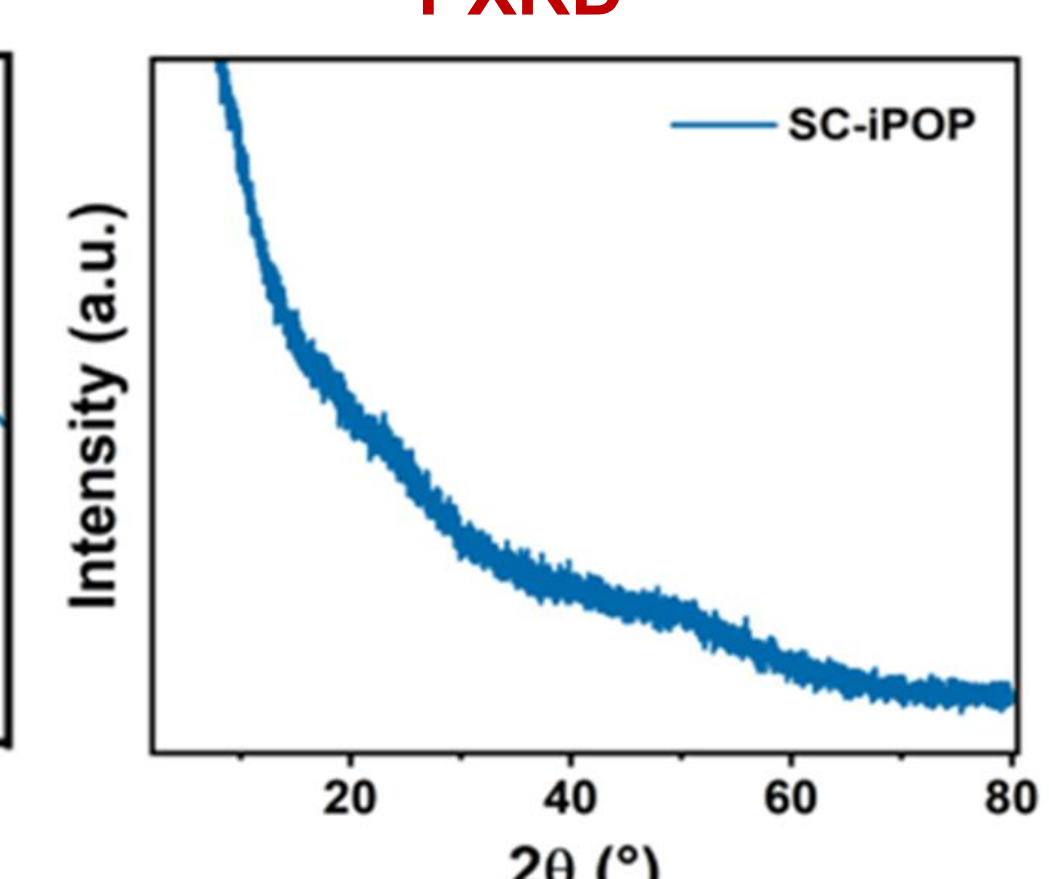
N₂ Sorption Isotherm and Pore-size Distribution



TGA



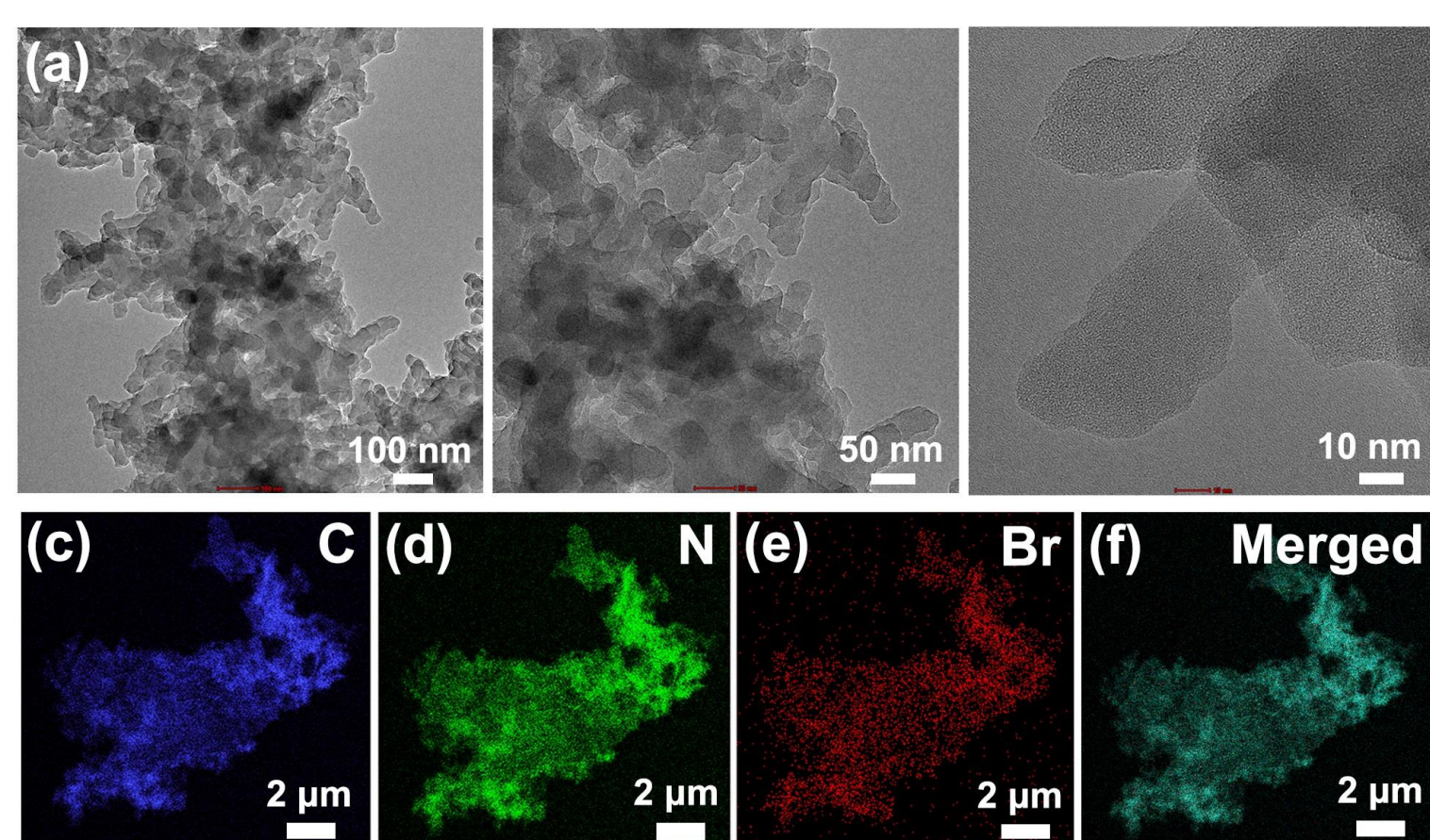
PXRD



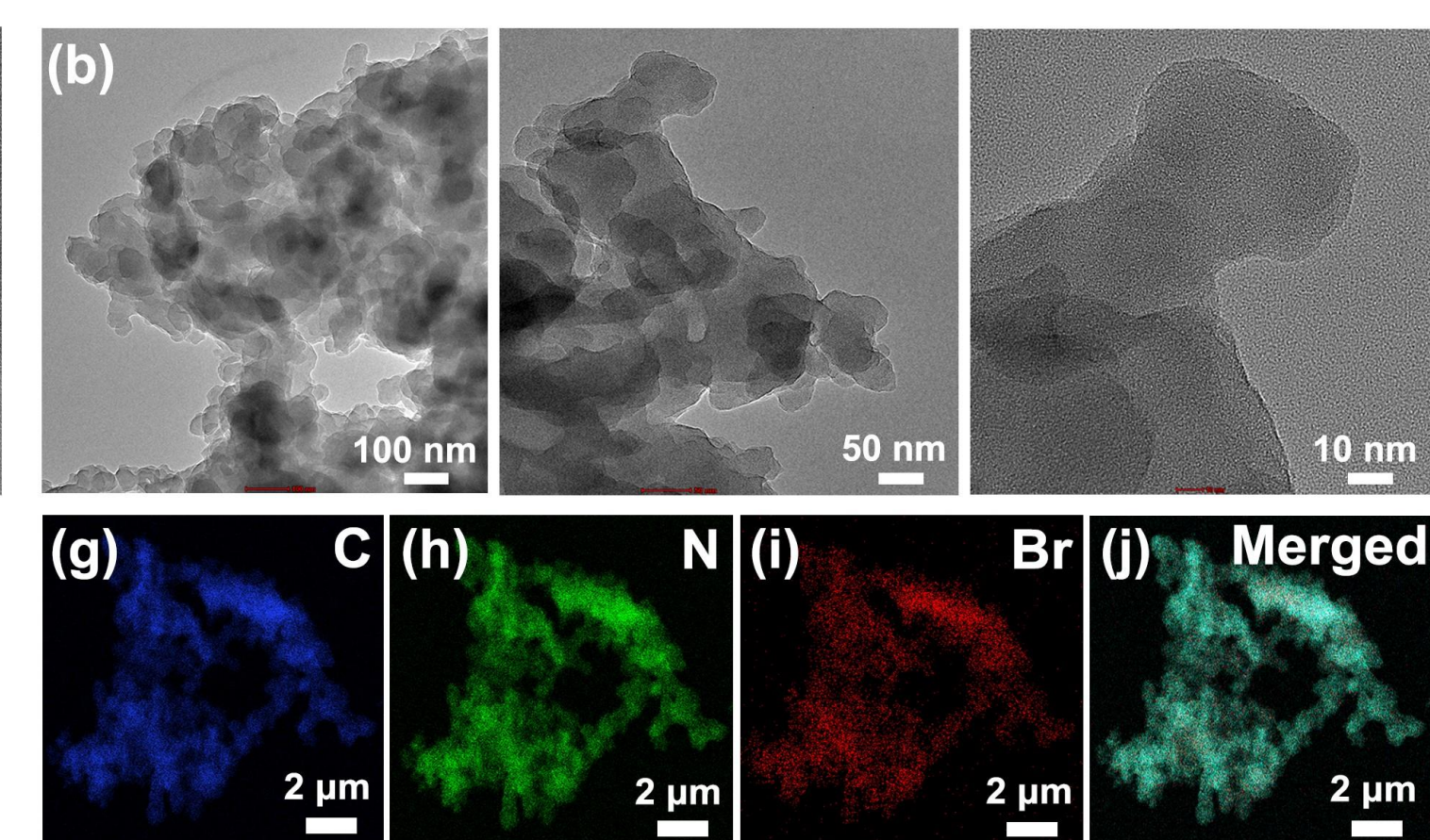
❖ Thermal stability up to 345 °C (SC-iPOP) and 260 °C (BHC-iPOP)

Morphological and Structural Analysis of iPOPs

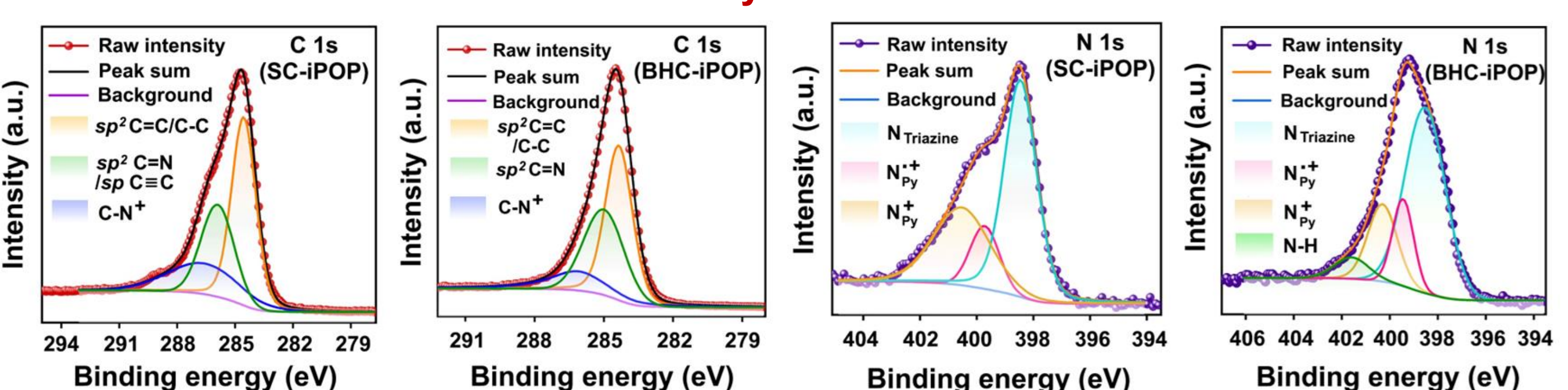
TEM Analysis of SC-iPOP



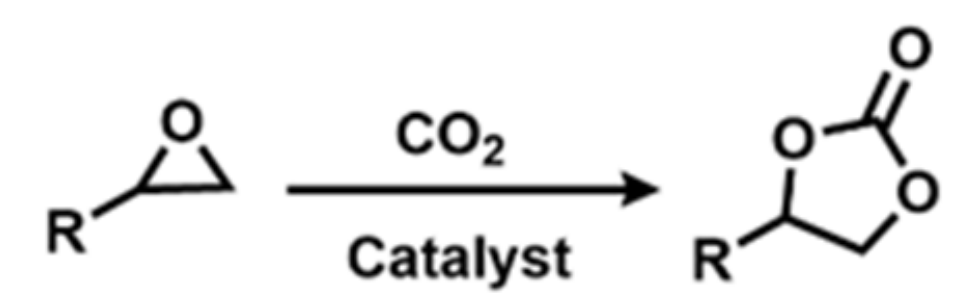
TEM Analysis of BHC-iPOP



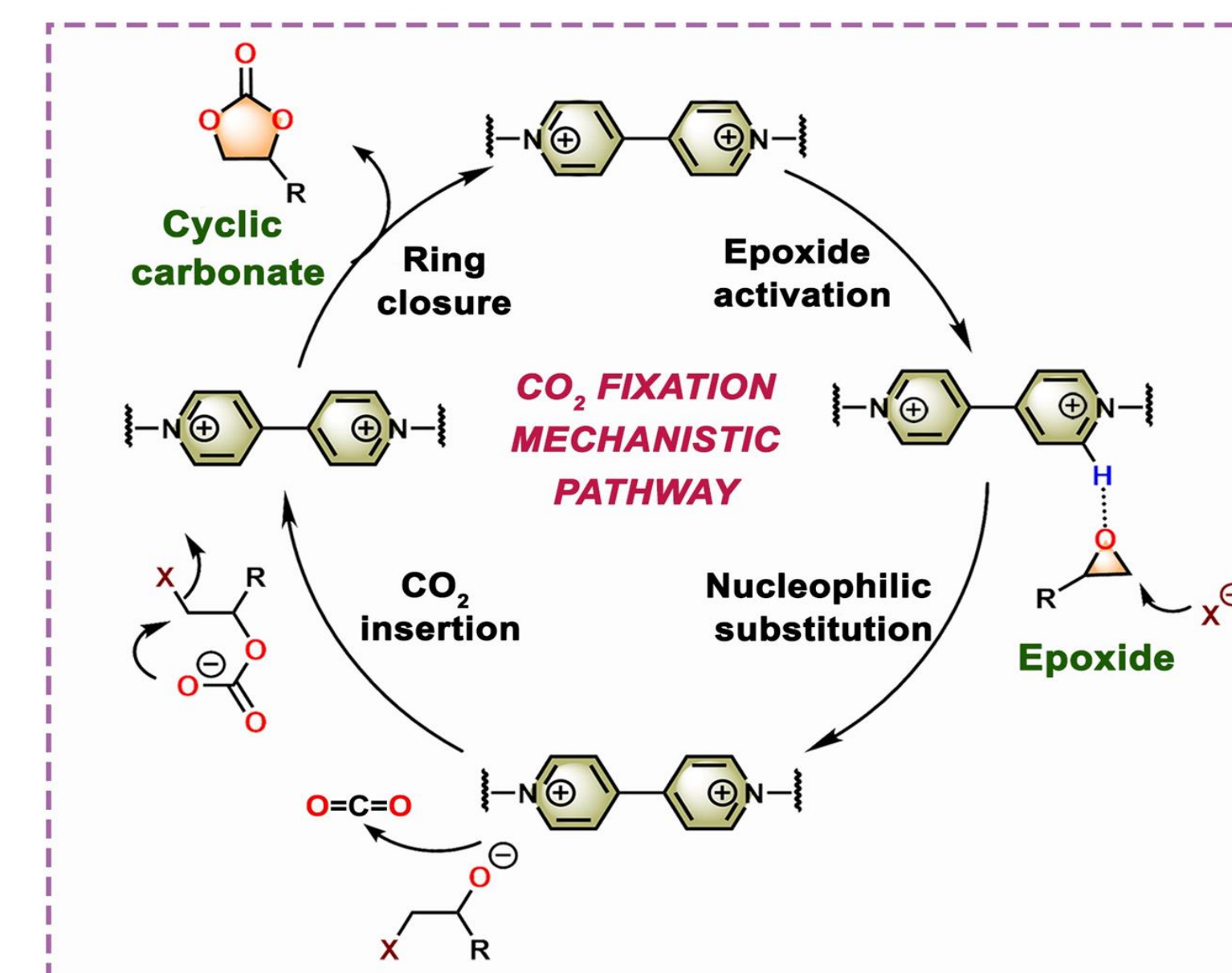
XPS Analysis of iPOPs



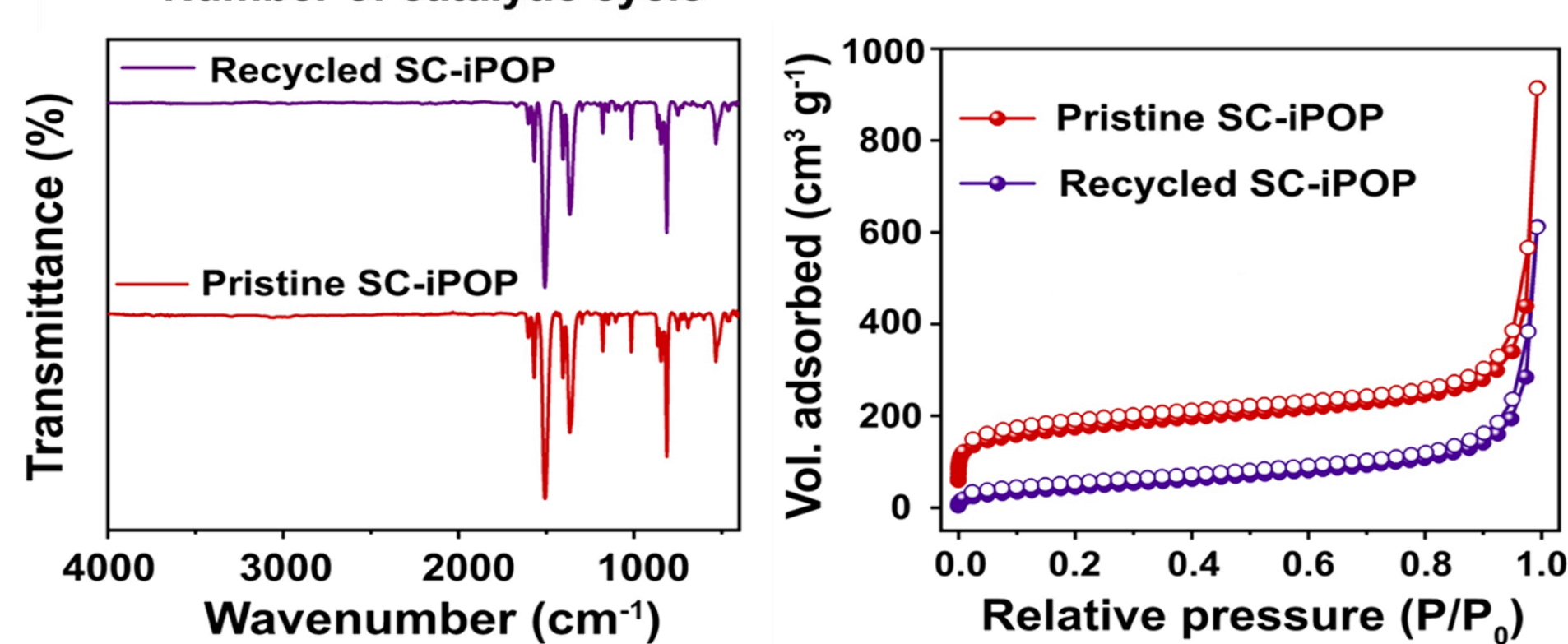
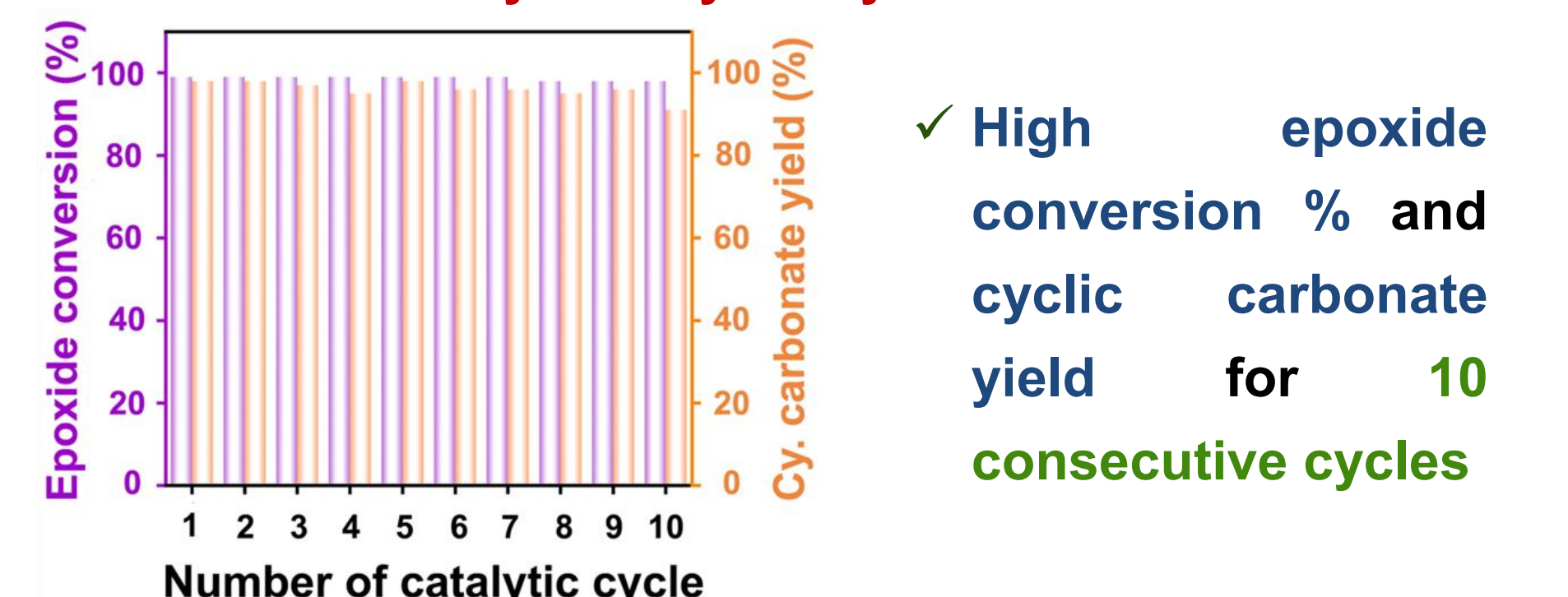
Catalytic CO₂ Fixation using Epoxides



Sl. No.	Catalyst	Epoxide	Time (h)	Conv. (%) ^a	TON ^b	TOF ^c (h ⁻¹)
1.	-	Epoxide	24	58	-	-
2.	SC-iPOP	Epoxide	24	87	104.8	4.4
3.	SC-iPOP	Epoxide	12	98	118.1	9.8
4.	SC-iPOP	Epoxide	12	94	113.2	9.4
5.	SC-iPOP	Epoxide	24	99	119.3	5.0
6.	SC-iPOP	Epoxide	24	75	90.4	3.8
7.	SC-iPOP	Epoxide	24	65	78.3	3.3
8.	SC-iPOP	Epoxide	24	40	48.2	2.0
9.	SC-iPOP	Epoxide	48	90 [#]	108.4	2.2
10.	BHC-iPOP	Epoxide	24	67	78.8	3.3



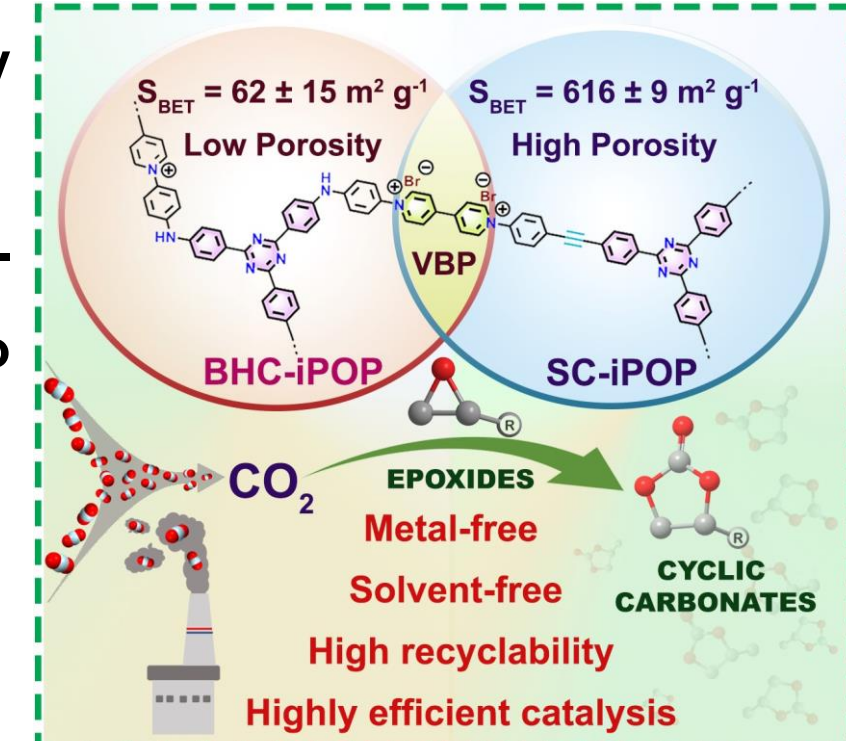
Recyclability Study of SC-iPOP



Reaction conditions: 10 mmol epoxide, 30 mg iPOP catalyst, 0.2 mmol TBAB, 1 bar CO₂, and 90 °C; a: % of conversion was determined by ¹H NMR spectroscopic analysis; b: TON = mmol. of product / mmol. of active catalyst (determined from the smallest idealized model structure of iPOPs containing all the plausible CO₂-philic functionalities); c: TOF (h⁻¹) = TON / Time (h); #: Catalysis was done at 50 °C.

Conclusion

- ❖ Design and fabrication of two structurally distinct viologen-based iPOPs
- ❖ Structure-activity correlation towards non-redox CO₂ fixation using epoxides to cyclic carbonates
- ❖ Highly efficient metal-free CO₂ conversion under atmospheric pressure and solvent-free conditions, with excellent recyclability



Acknowledgements

- ❖ Financial support from SERB-STARs (now ANRF)

References

1. Lodh, T., Shreeraj, G., Patra, A., Macromol. Chem. Phys. 2025, 2400373.

For more details of the work, scan here

Thank you...

