Hierarchically porous polymer monoliths for size separation

38APS Auckland

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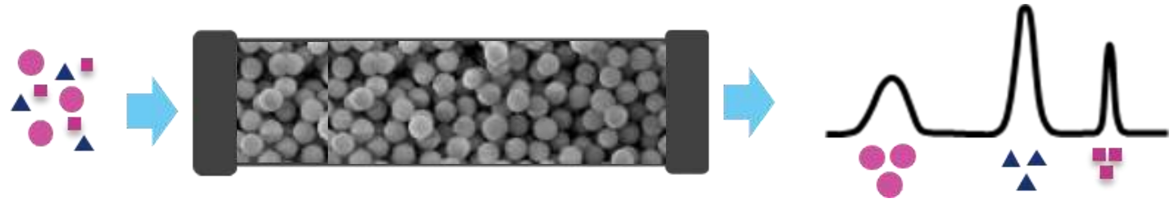
Hierarchically porous polymer monoliths for size separation

Size exclusion chromatography (SEC)

- ✓ Inert
- ✓ Adequate column dimensions
- ✓ Accessible pores

- ✓ High efficiency
- ✓ High selectivity
- ✓ Low back pressure
- ✓ Low analysis time



macropores: > 50 nm → permeability

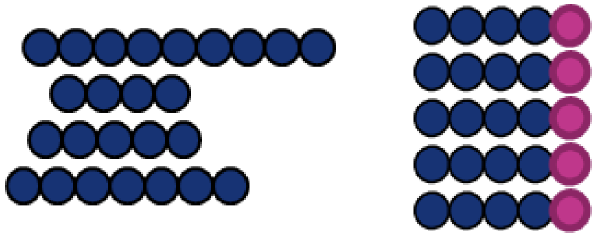
mesopores : 2 - 50 nm → selectivity

micropores : < 2 nm

Porous monoliths

- ✓ macropores: > 50 nm
- X mesopores : 2 - 50 nm

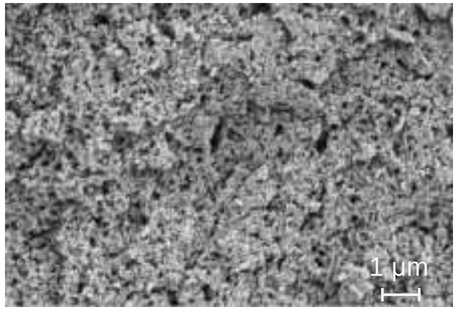
Free radical   RAFT polymerisation[1,2]



[1] *Aust. J. Chem.*, 2005, 58, 379-410.
[2] *Poly. Chem.*, 2014, 5, 722-732

Morphology with different CTA’s

A



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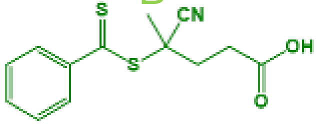

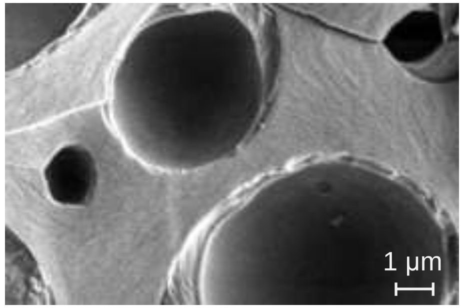

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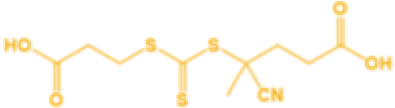

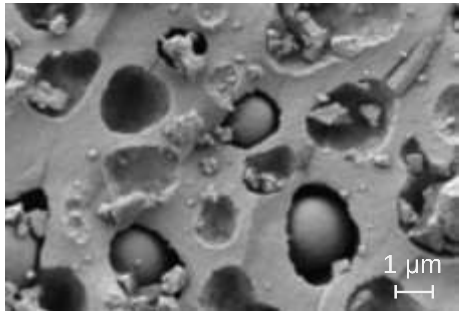

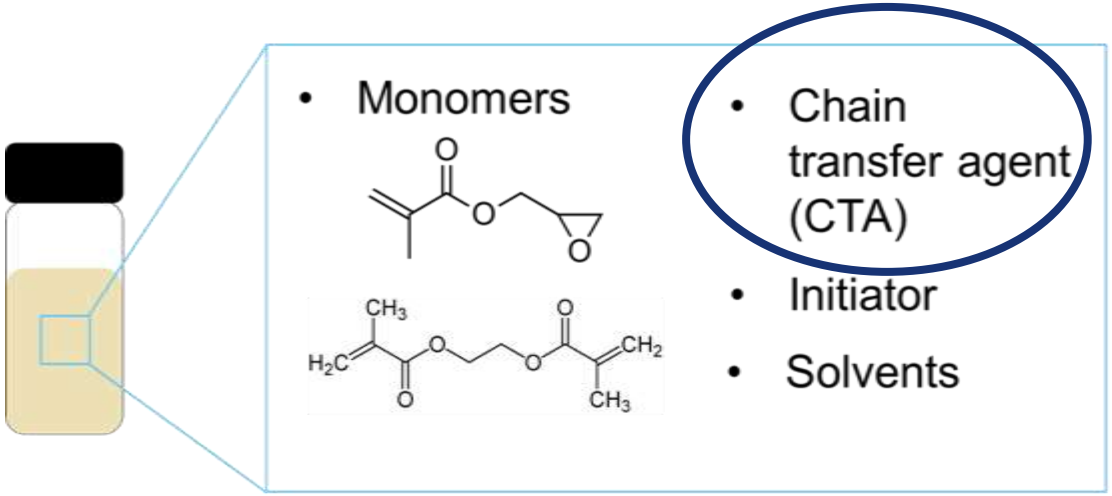

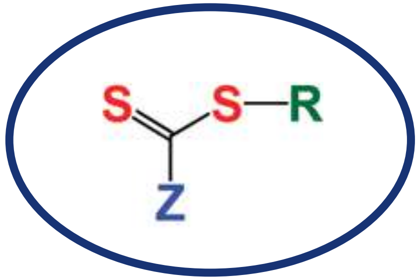

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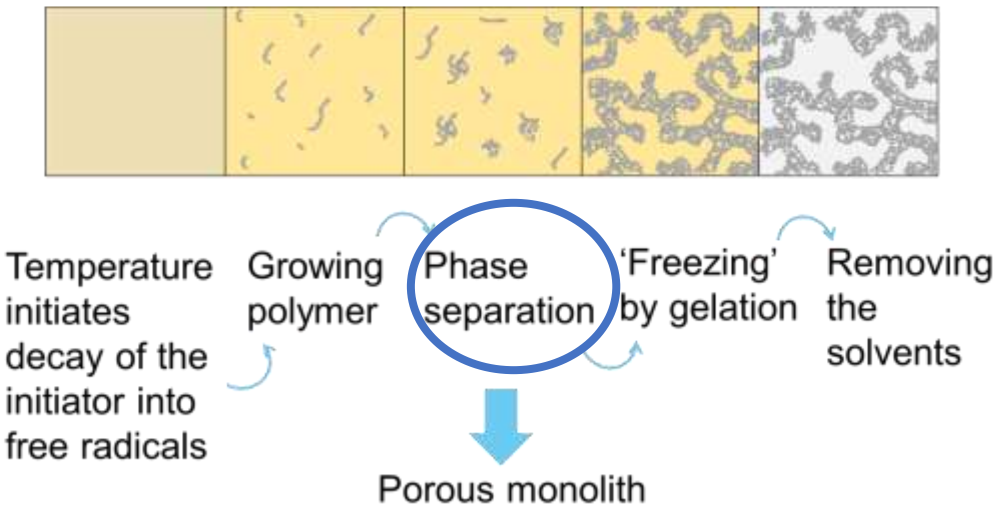
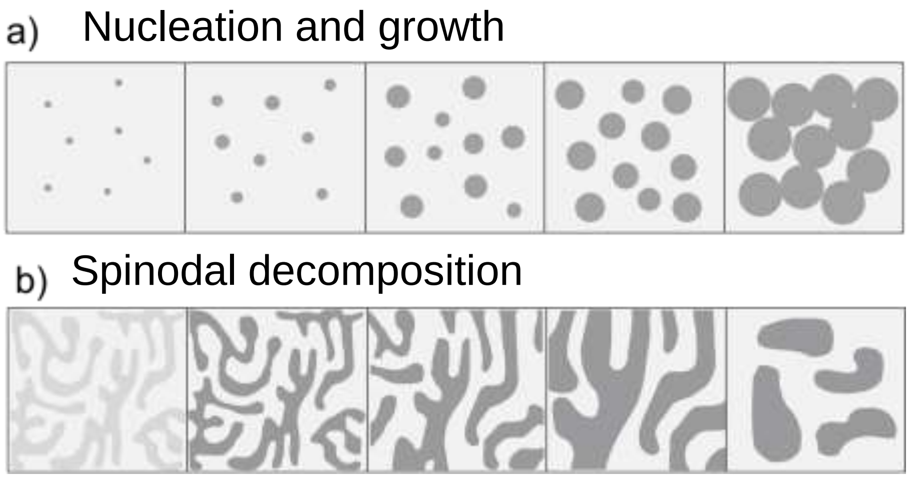
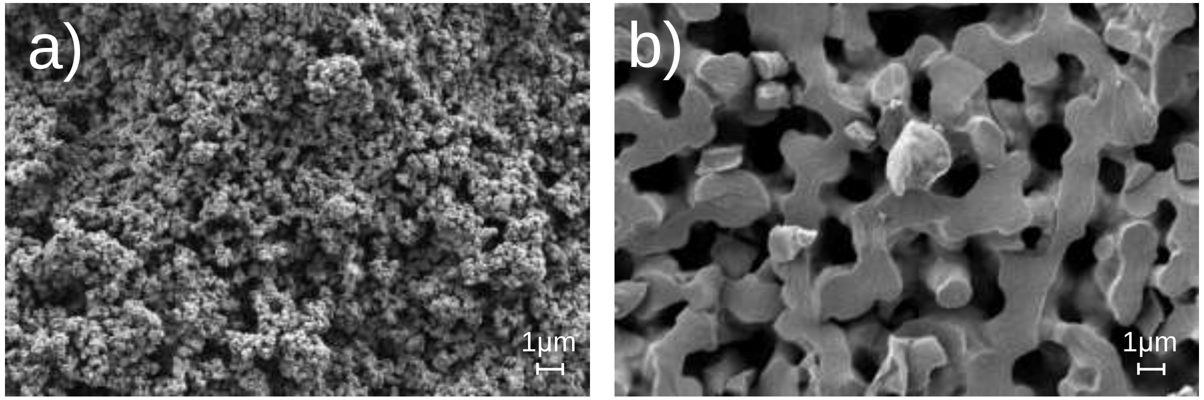
40% monomers, 60% porogens (15% poly(t-BMA)/ 85% dioxane), 1%wt AIBN with respect to monomers, [CTA]:[Initiator] = 2, 60°C, 24h

How can we explain this difference in morphology?[3]

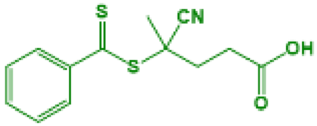


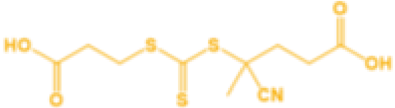




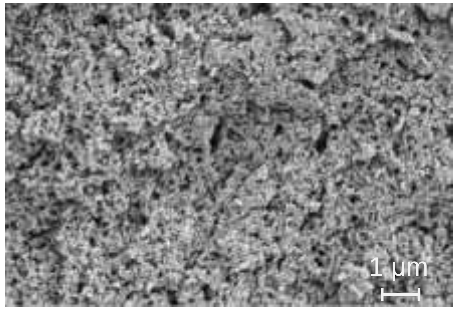
[3] *ACS Appl. Polym. Mater*. 2023, 5, 7, 5390–5401

How can we explain this difference in morphology?





A



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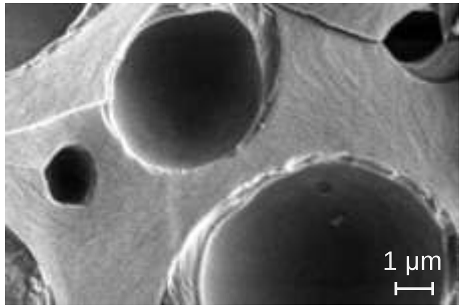

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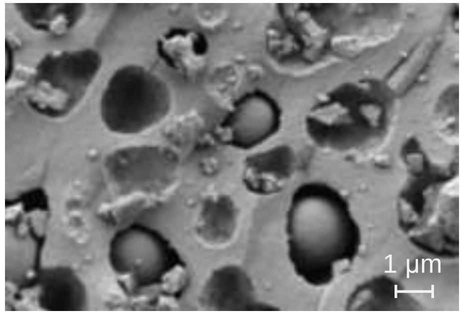
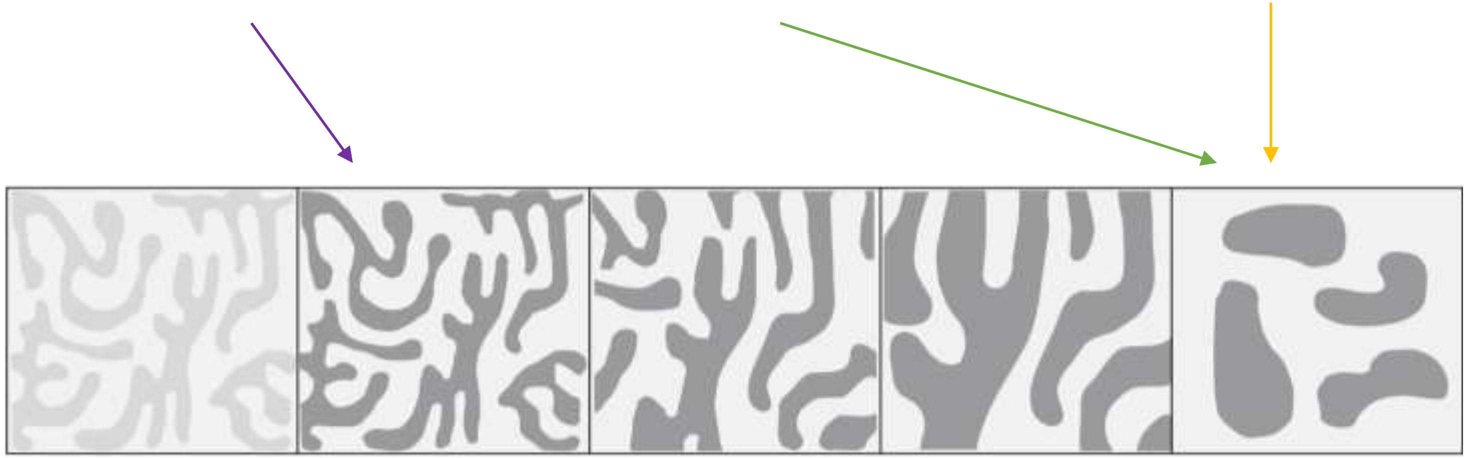




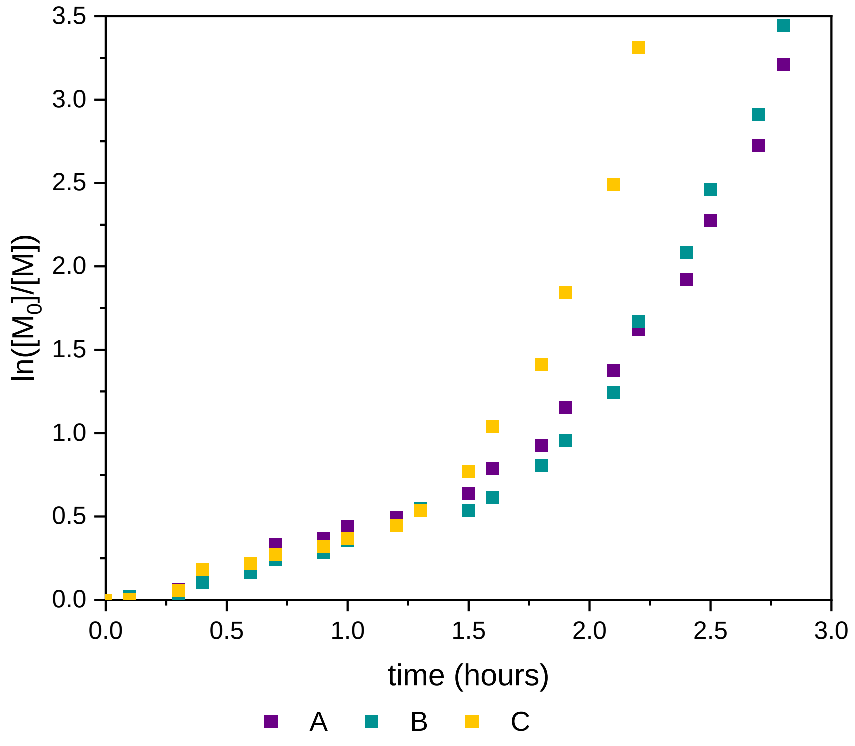
1) Kinetics

2) Phase separation

1. Kinetics

- Rate of polymerisation of crosslinked polymer

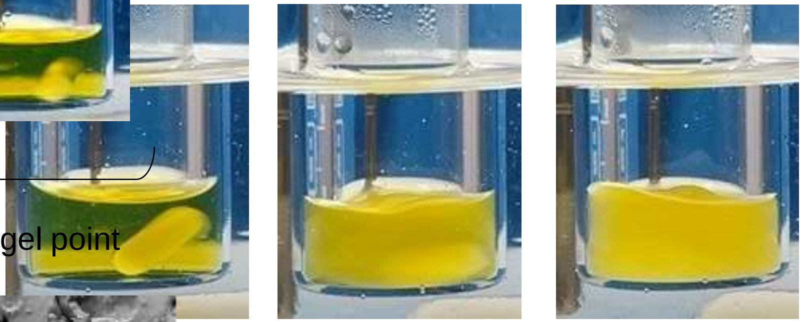
- No significant difference in kinetics between the polymers with different CTAs.



2. Phase separation[4]

Phase separation ≈ gel point

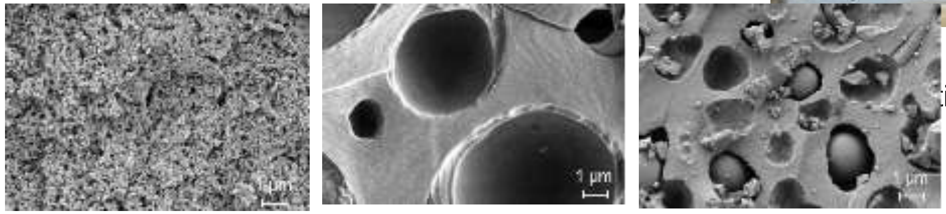
Phase separation before gel point



…ion

Onset of phase separation

Gel point



A B C

Condition	$\Delta_{gelpoint-phase\ separation}$ (min)	%S on surface (XPS)	% S on surface (with respect to theoretical amount)
A	3±2	0.18±0.02	48%
B	18±9	0.12±0.02	27%
C	19±2	0.19±0.07	28%
Control	4	0	-

[4] *Macromolecules* 2019, 52, 18, 7005–7015

Conclusion

- Kinetics are similar for all CTAs and do not contribute to the different morphologies
- The gelation study can help explain the phase separation for monoliths with different CTAs
- The morphology of the monolith can be tuned by choosing the type of CTA

Future work

- Investigating which monolith conditions give bicontinuous structures
- Introduction of mesopores in bicontinuous structures for stationary phase material for size separation

Acknowledgements

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  - Pratishtah Sobrun
  - Dr. Chris Desire

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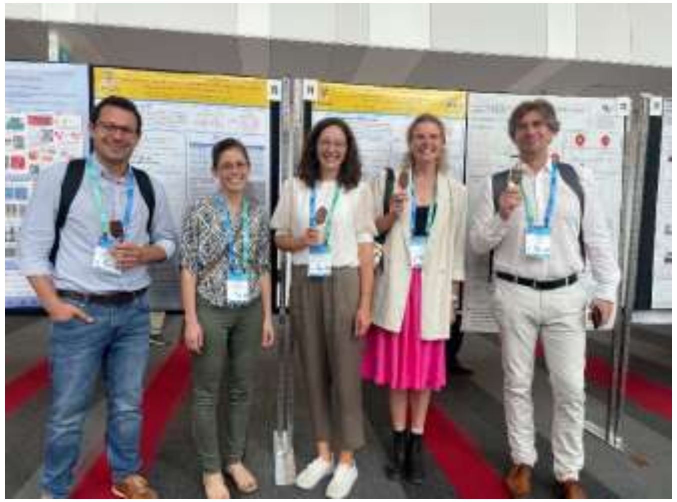

Thank you!

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