UV-Responsive Bottlebrush Block Copolymers: Transition from Nanodiscs to Micelles through Triggered Self-Immolation Process

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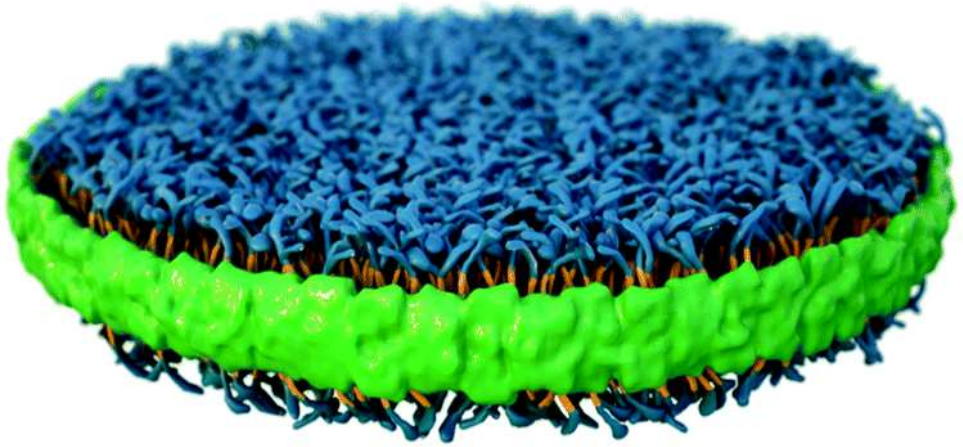
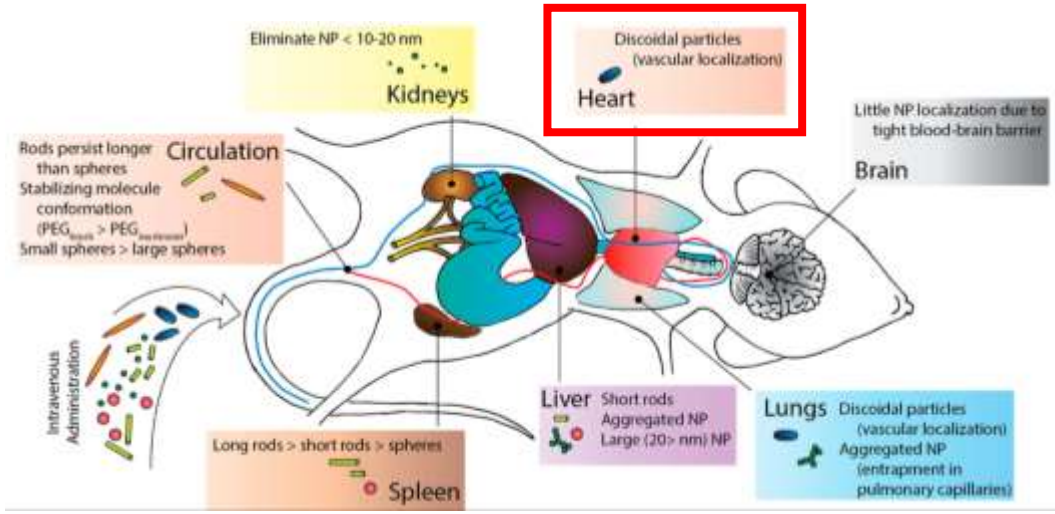
Polymer Nanodiscs

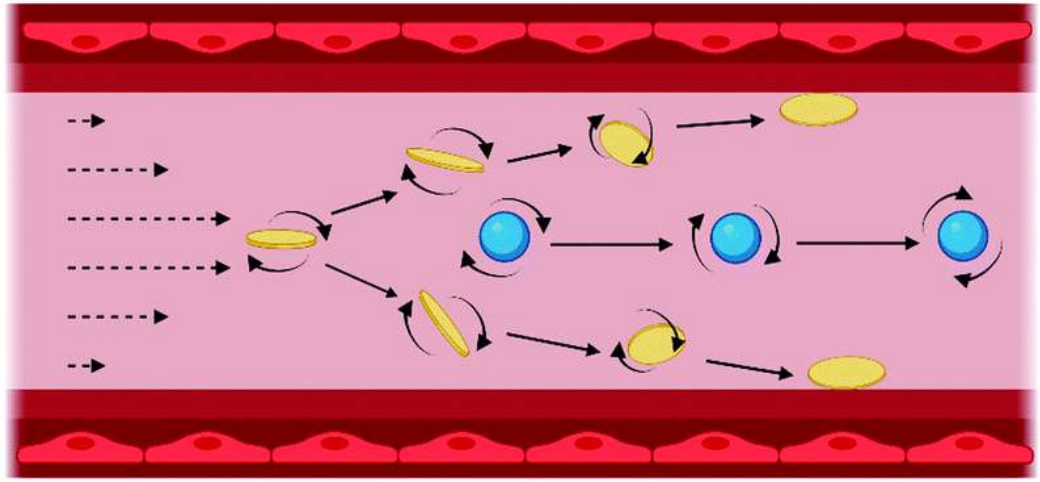
Chem. Soc. Rev., 2022, 51, 1702-1728



- Unique 2D-like structure
- Large specific surface area
- Vascular localization
- Challenging to make



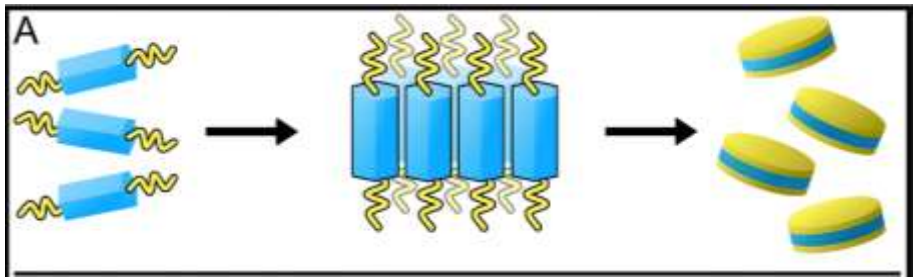
Chem. Rev., 2017, 117, 17, 11476–11521



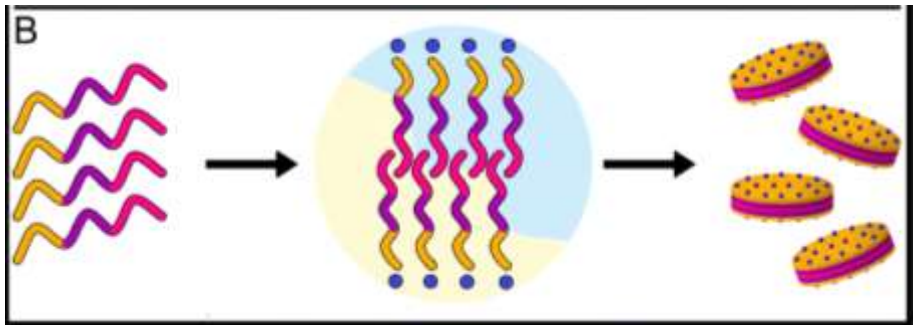
Chem. Soc. Rev., 2022, 51, 1702-1728

Preparation of Polymer Nanodiscs

Direct Self-Assembly

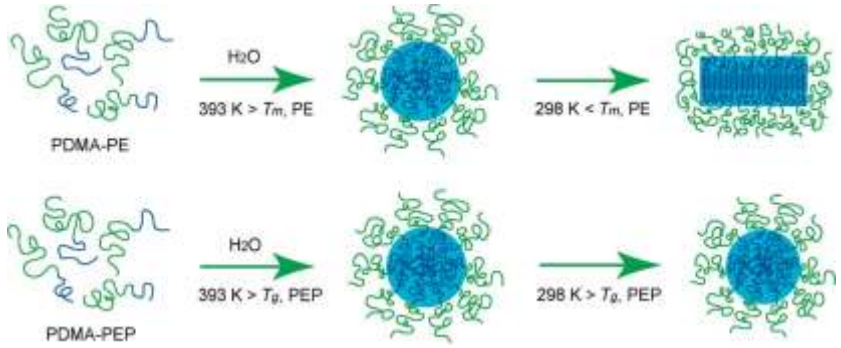


Directed Self-Assembly

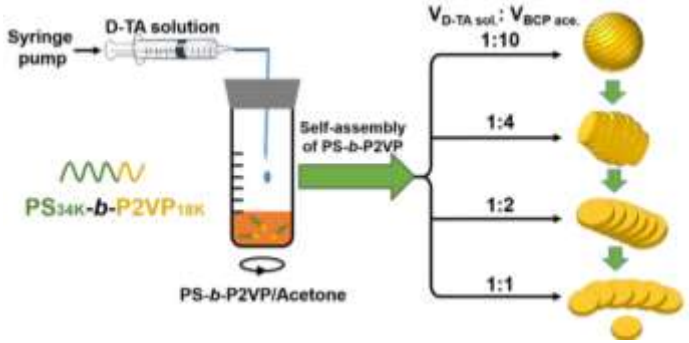


Disassembly of Superstructures

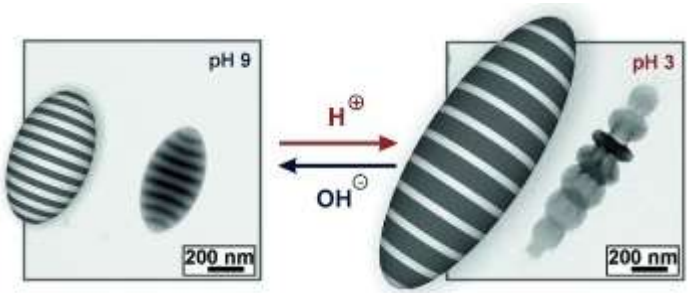
Chem. Soc. Rev., **2024**, DOI: 10.1039/D1CS01114F



Macromolecules 44.8 (2011): 3021-3028.



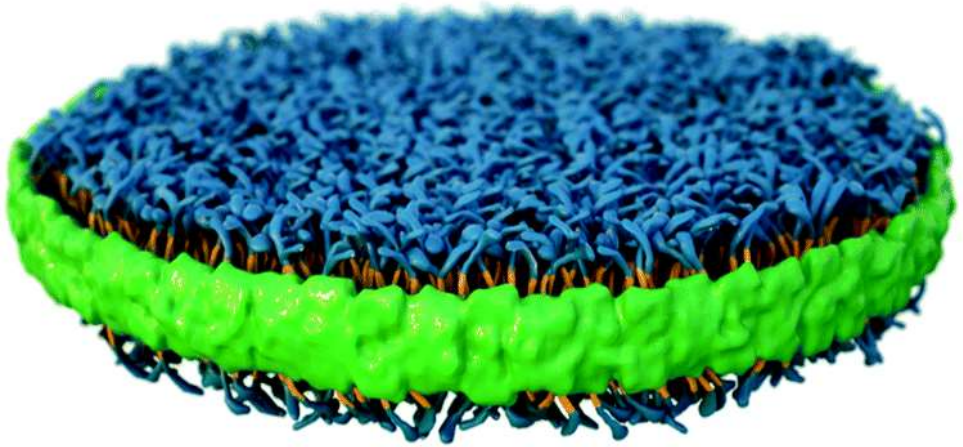
Macromolecules 53.16 (2020): 7025-7033.



Angewandte Chemie International Edition 53.27 (2014): 6829-6829.

Research Objective

Pure polymer nanodiscs are challenging to make



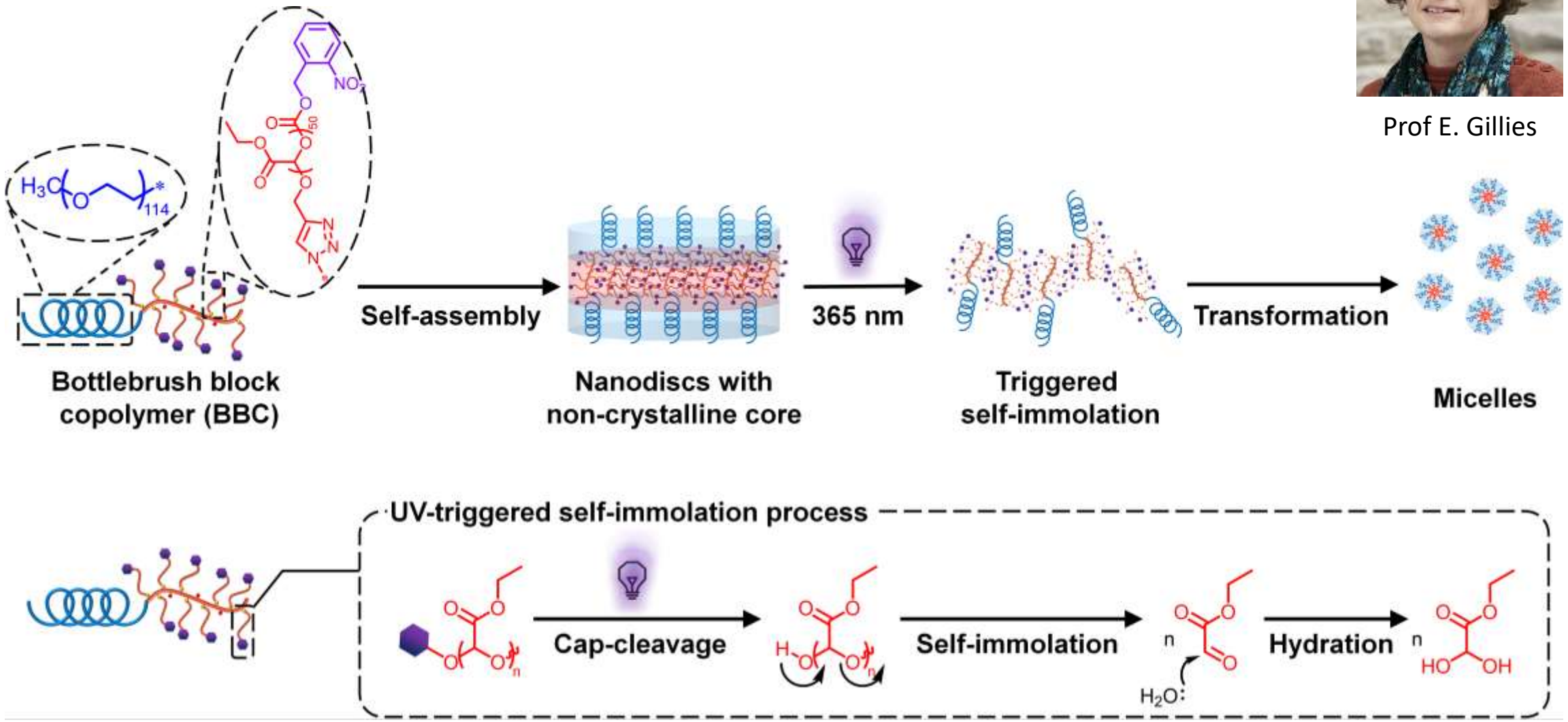
Chem. Soc. Rev., 2022, 51, 1702-1728

- 😐 Preparation process rather complicated
- 😐 Limited applications

- 🎯 Easy and safe preparation method
- 🎯 Amorphous cores
- 🎯 Stimuli-responsive properties

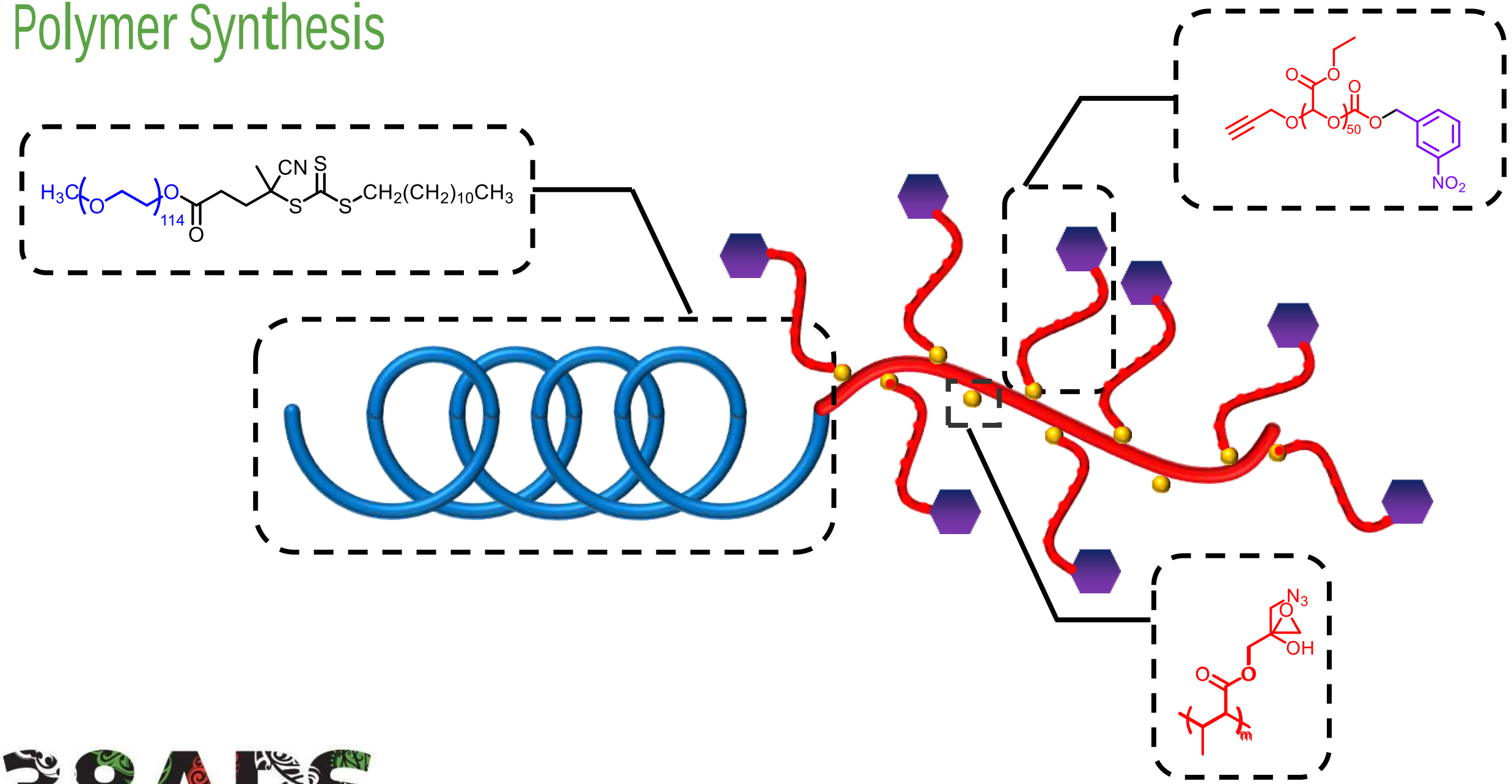
Project Overview

Prof E. Gillies

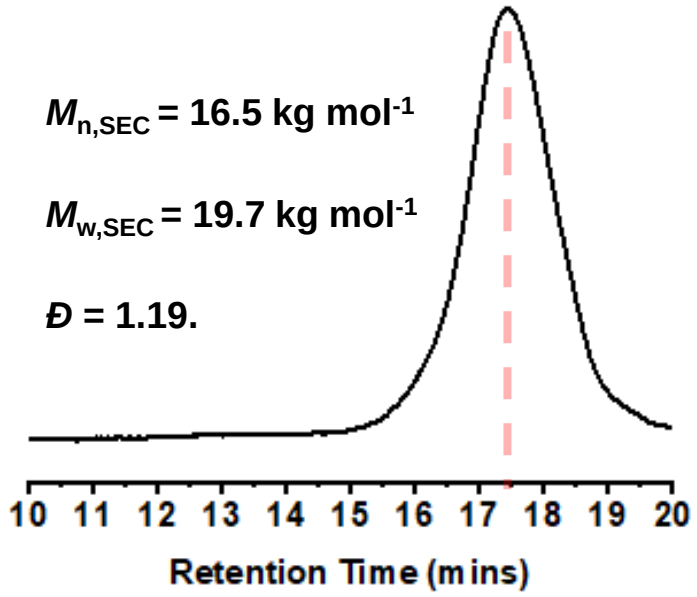


Zeng, Liang, Roberts, Gillies, Müllner *Angew. Chem. Int. Ed.* **2024**, *63*, e202317063.

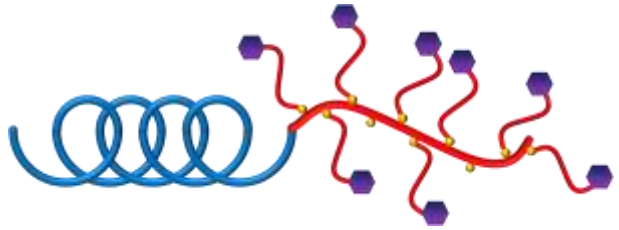
Polymer Synthesis



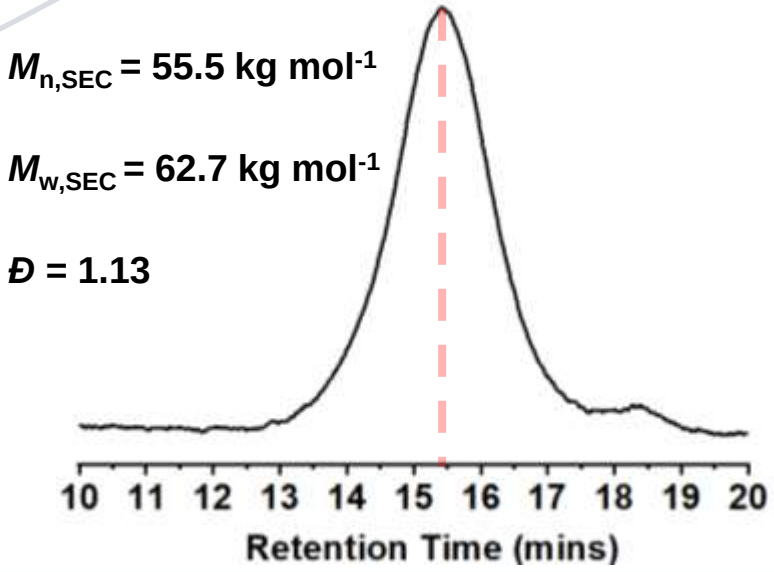
Polymer Synthesis

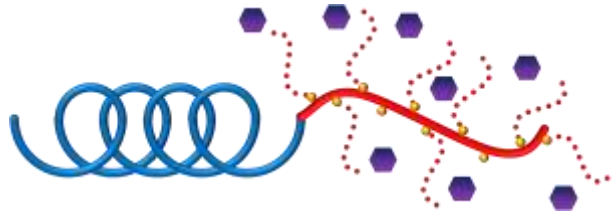


Polymer backbone

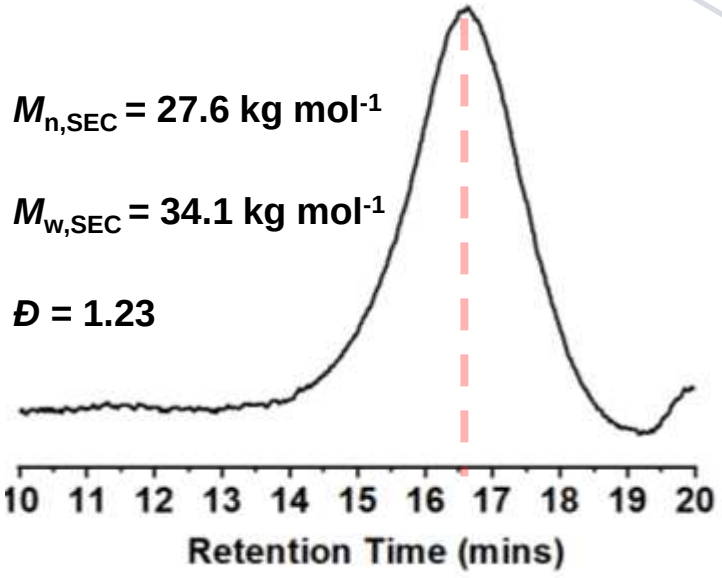


Polymer brush

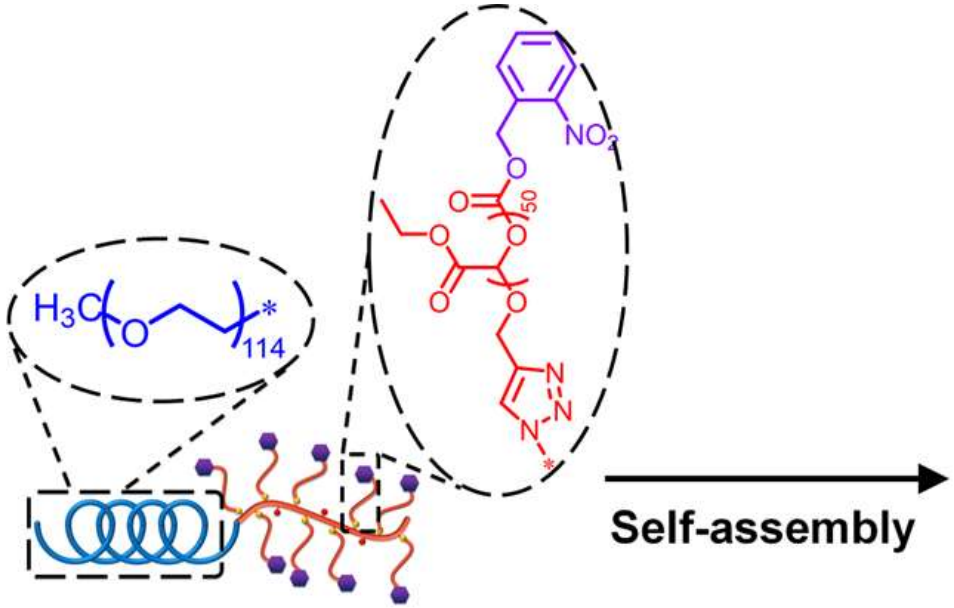




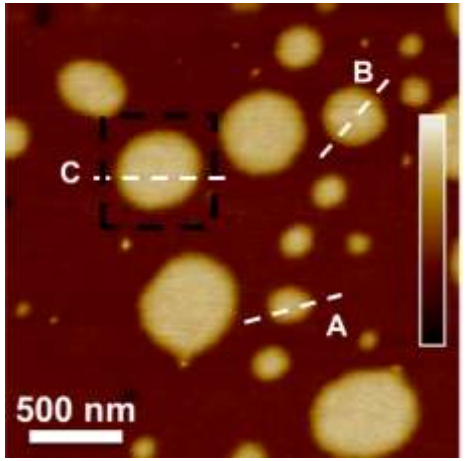
Self-immolated product



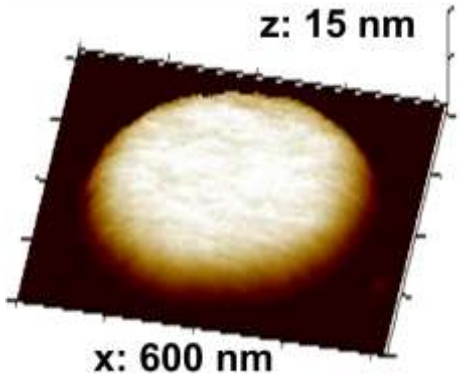
Preparation through Direct Self-Assembly

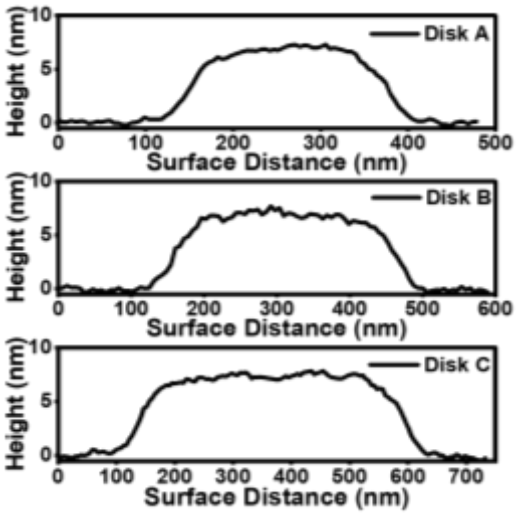


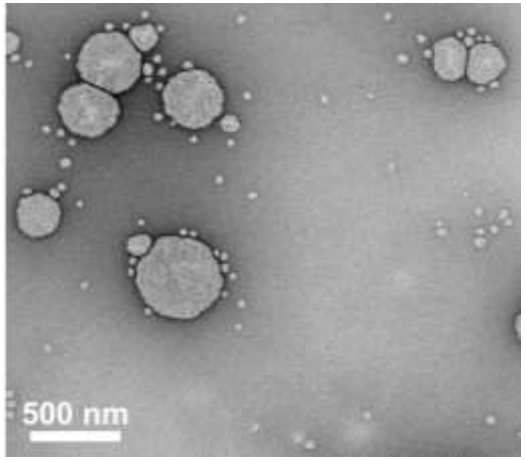
Self-assembly



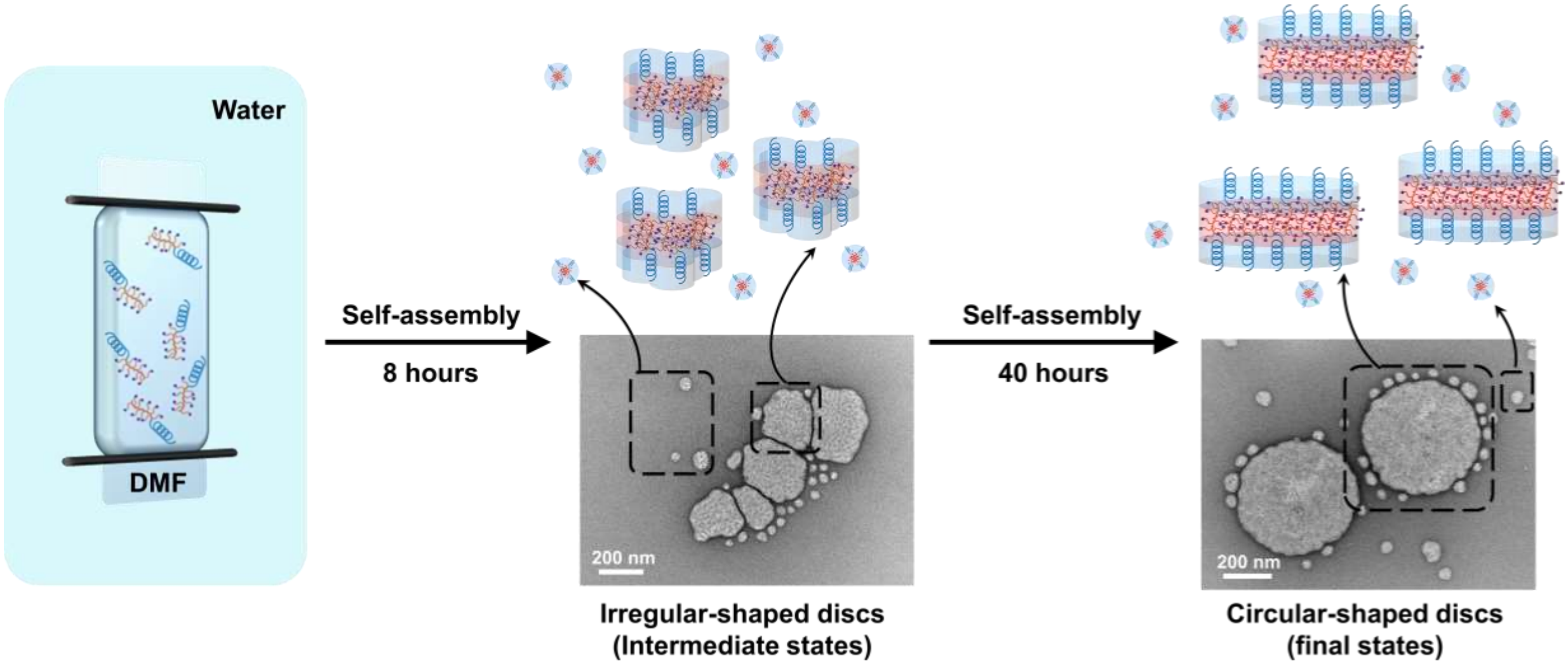
Particle C



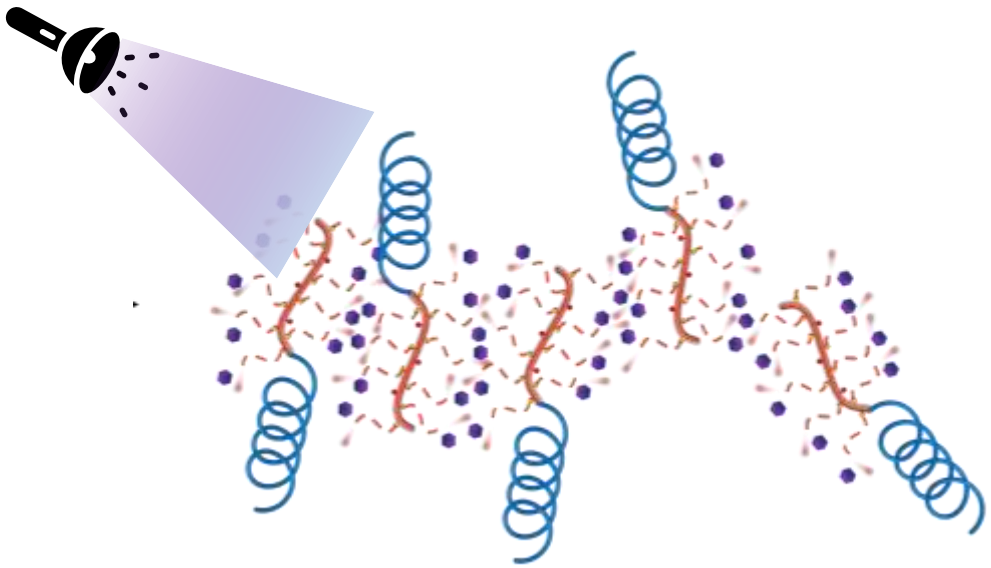


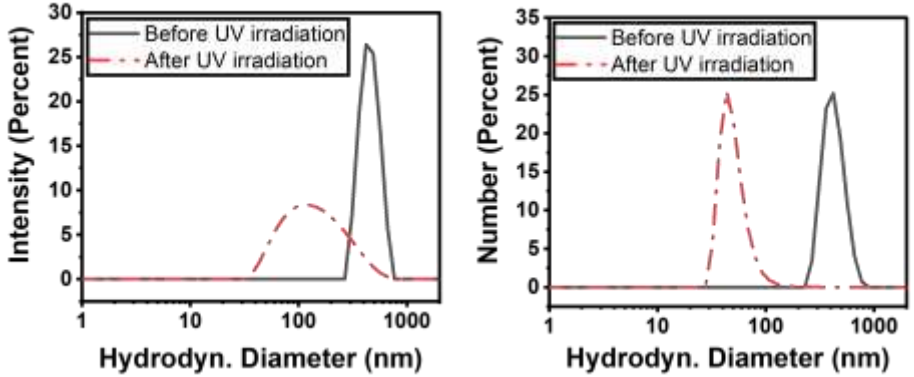


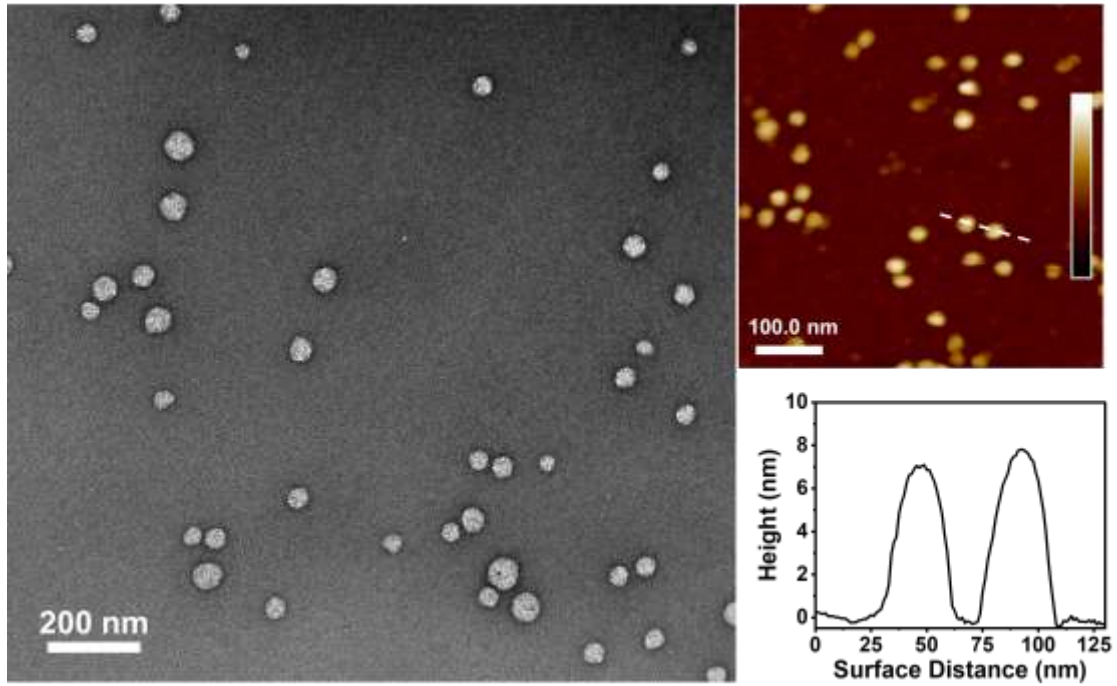
Nanodisc Formation



UV-Triggered Self-Immolation



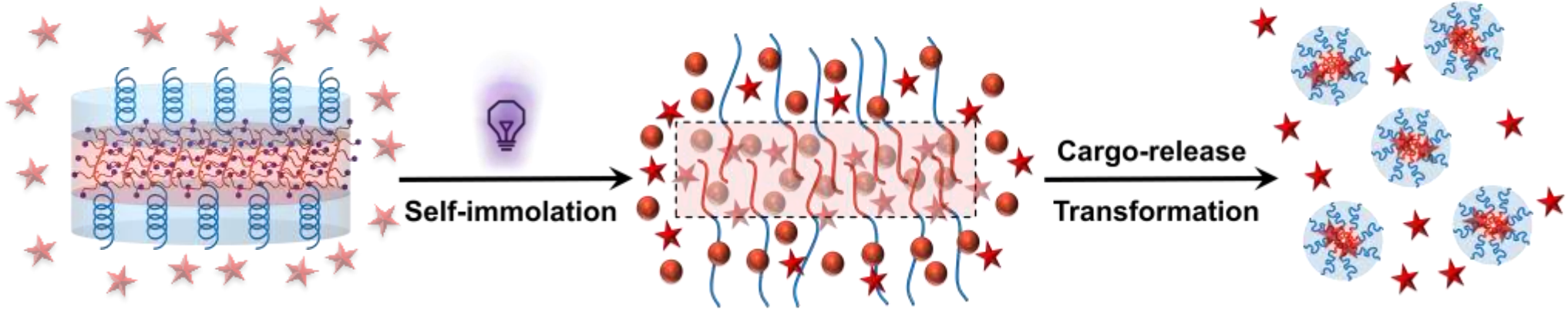


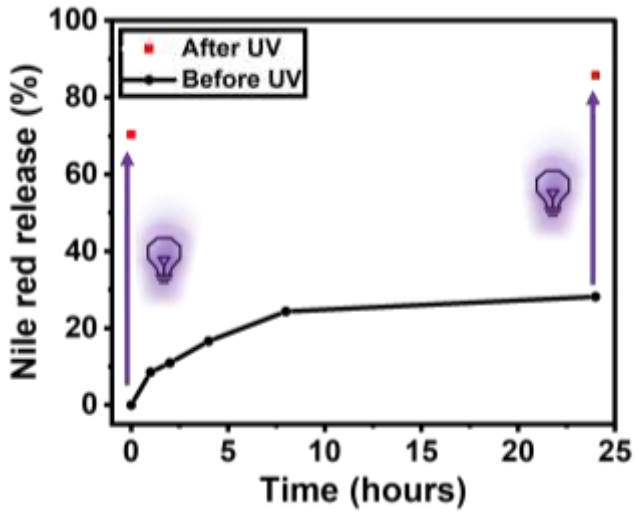


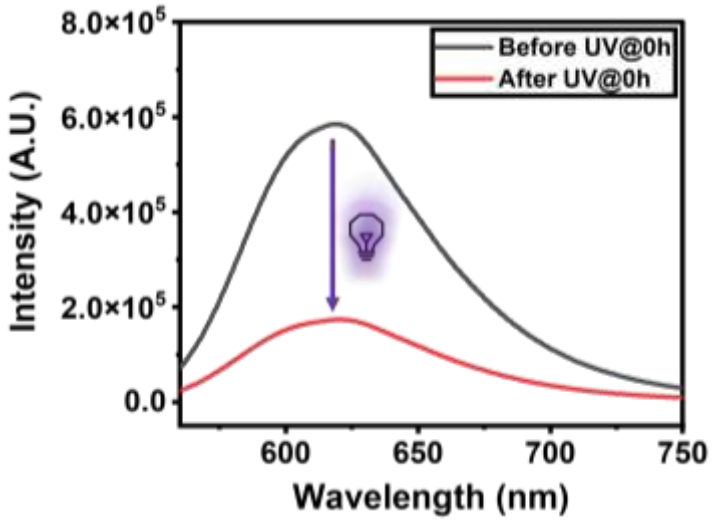
~400 nm

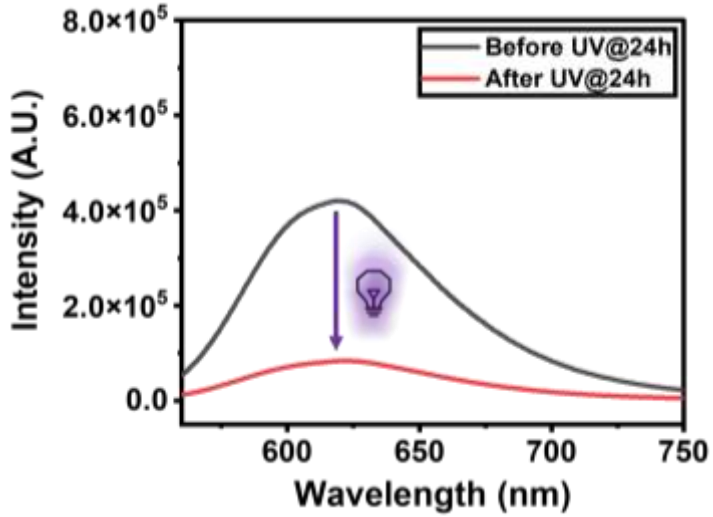
~50 nm

Encapsulation and Release of Hydrophobic Molecules









Summary

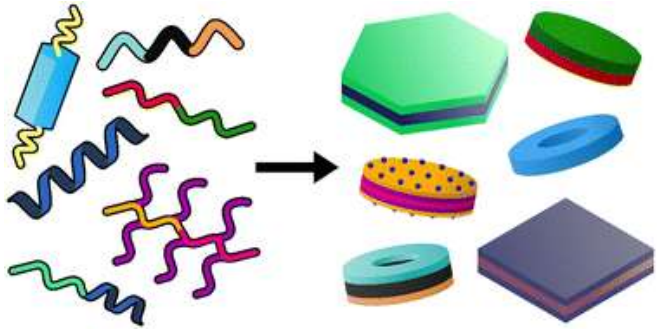
- Tad-pole, amphiphilic bottlebrush copolymers can assemble directly into nanodiscs in water.
- The amorphous cores have allowed to encapsulate small molecules, like Nile red and DOX.
- Hydrophobic self-immolative polymers enable a UV-triggered disassembly process, which reconfigures discs into smaller spherical micelles and facilitates drug release.
- The design is universal and can be used to feature different functionality in the disc core, such as pH responsive polymers (manuscript in preparation).

Read our paper:

Zeng, Liang, Roberts, Gillies, Müllner *Angew. Chem. Int. Ed.* **2024**, *63*, e202317063.

More context on nanodisc (and toroids, platelets):

Brisson, Worthington, Kerai, Müllner *Chem. Soc. Rev.*, **2024**, DOI: 10.1039/D1CS01114F



Acknowledgement

- A/Prof Markus Müllner
- Dr Derrick Roberts
- PNG group
- Gillies group
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- KCPC
- Sydney Nano
- Sydney Analytical
- ACMM

Australian Government
Australian Research Council

Future Fellowship
‘Polymer Nanodiscs’

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