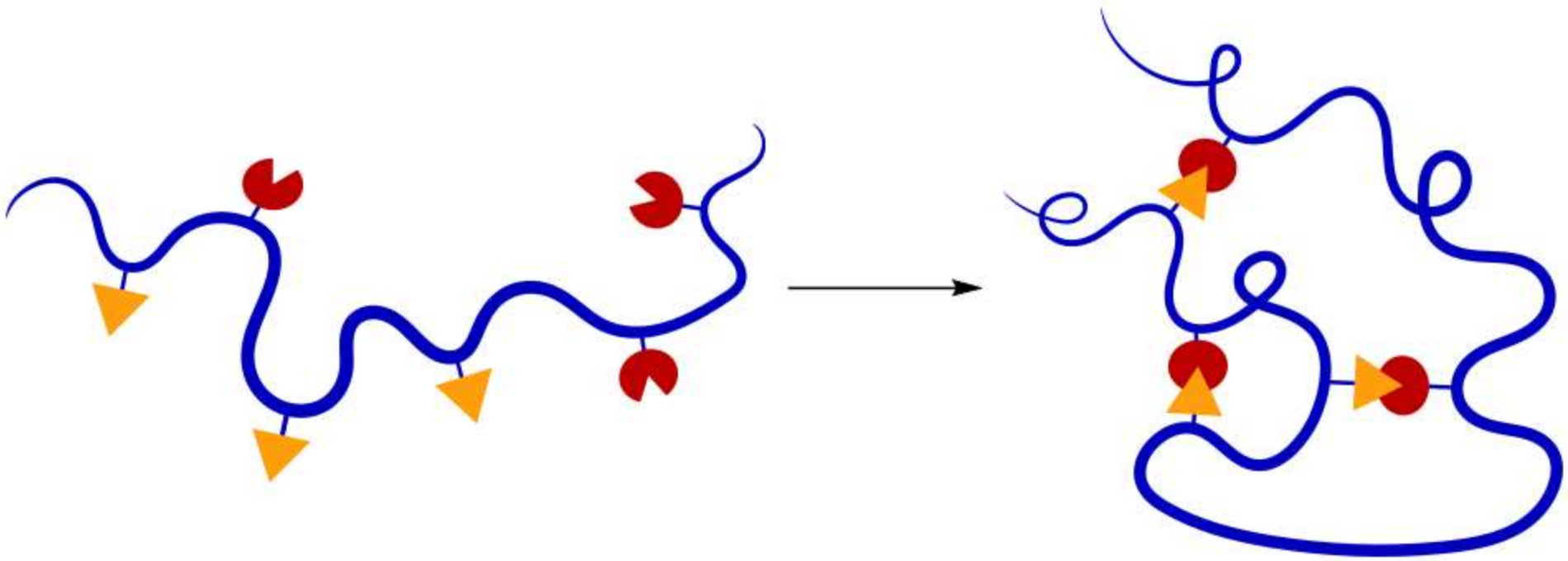

Visible Light Photoflow Synthesis of a Cu(II) Single-Chain Nanoparticle Catalyst

Sebastian Gillhuber
sebastian.gillhuber@hdr.qut.edu.au
38th APS | 20th February 2024

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soft matter materials group
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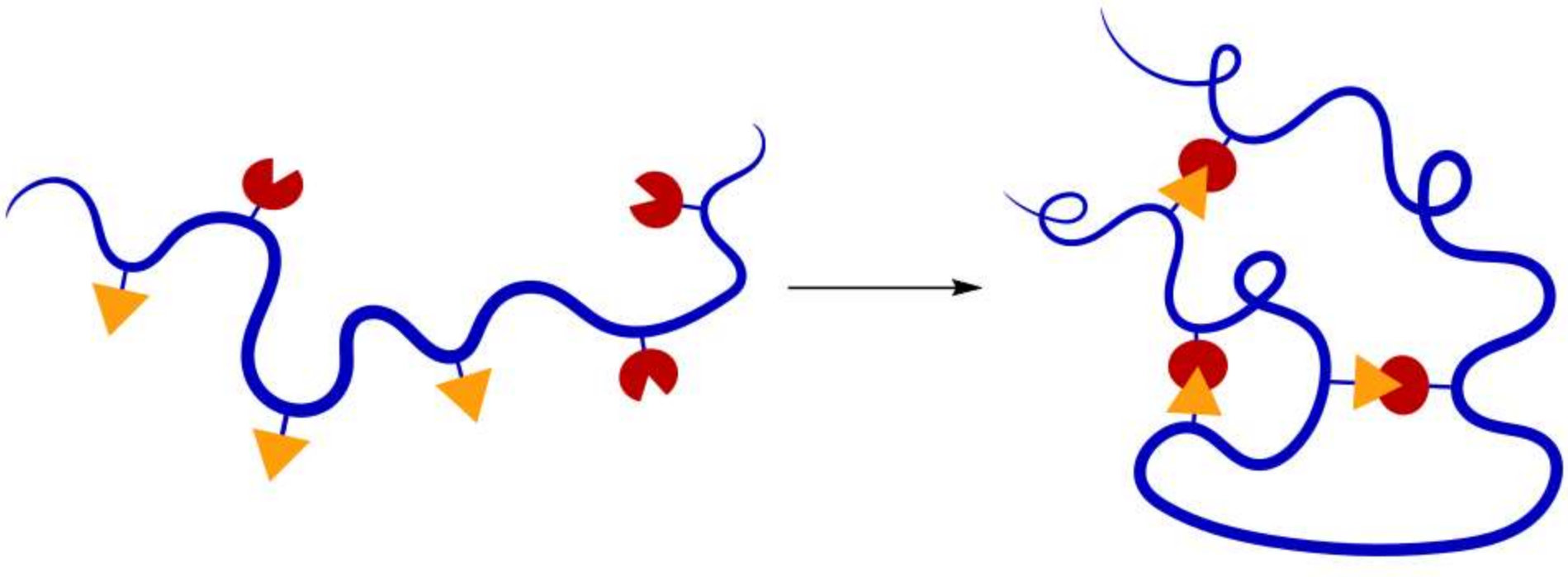
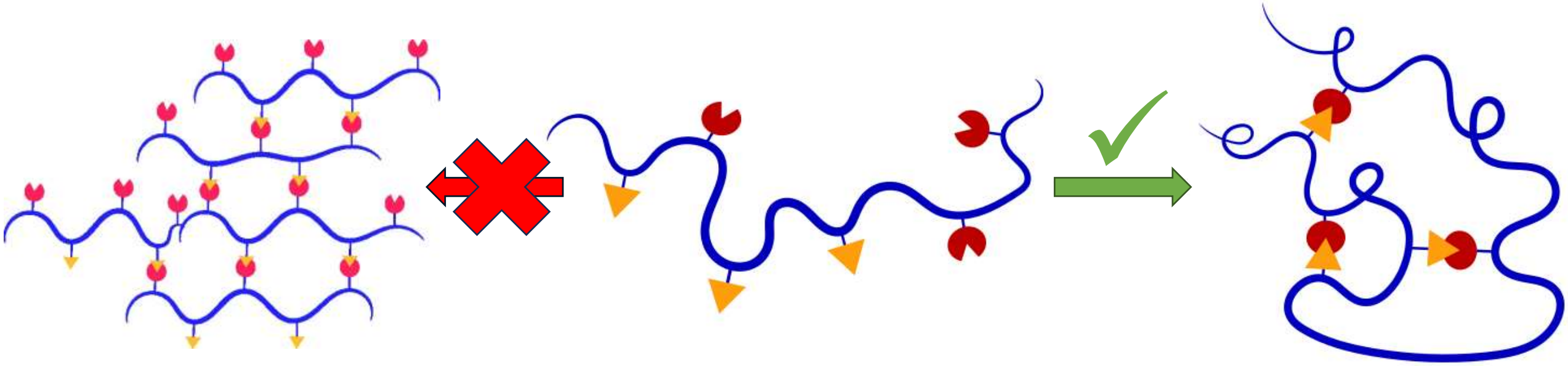
What Are Single-Chain Nanoparticles (SCNPs)?

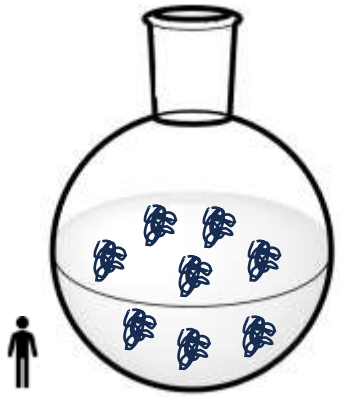


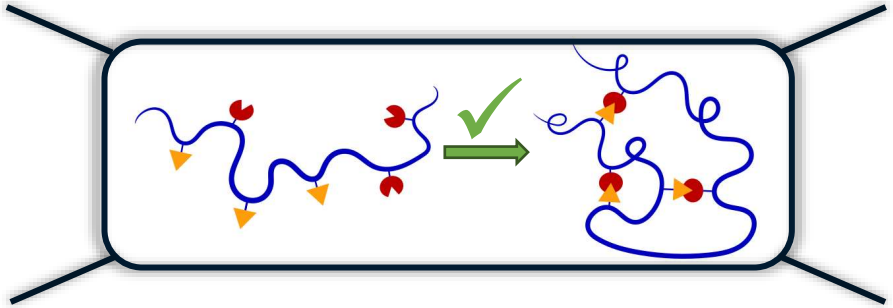
Synthesis of SCNPs



Synthesis of SCNPs

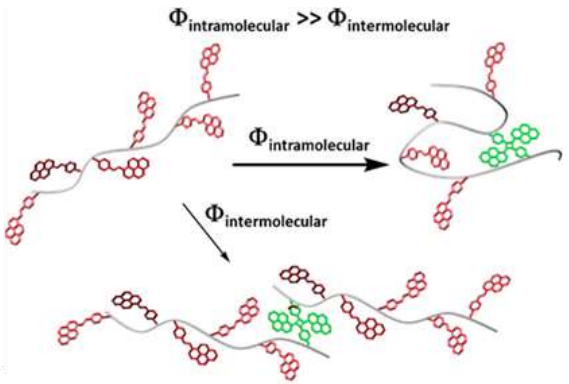
High dilution



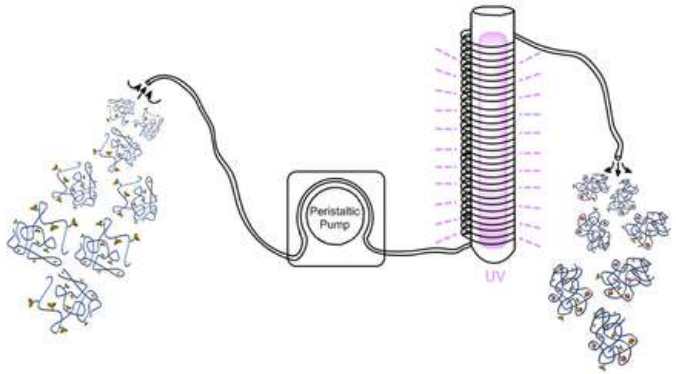


Continous addition

Finetuning reaction conditions



Flow synthesis

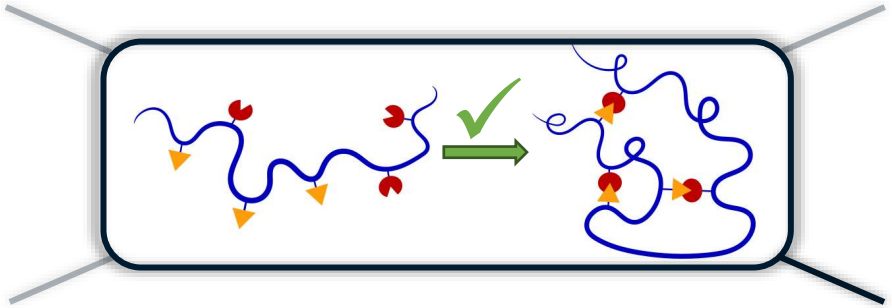


H. Frisch, J. P. Menzel, F. R. Bloesser, D. E. Marschner, K. Mundsinger, C. Barner-Kowollik *J. Am. Chem. Soc.* **2018**, *140*, 9551-9557.
O. Galant, H. B. Donmez, C. Barner-Kowollik, C. E. Diesendruck *Angew. Chem. Int. Ed.* **2021**, *60*, 2042-2046.

Synthesis of SCNPs

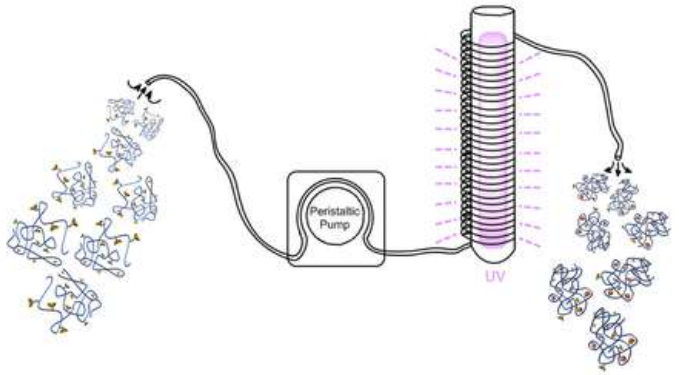
High dilution

Continous addition



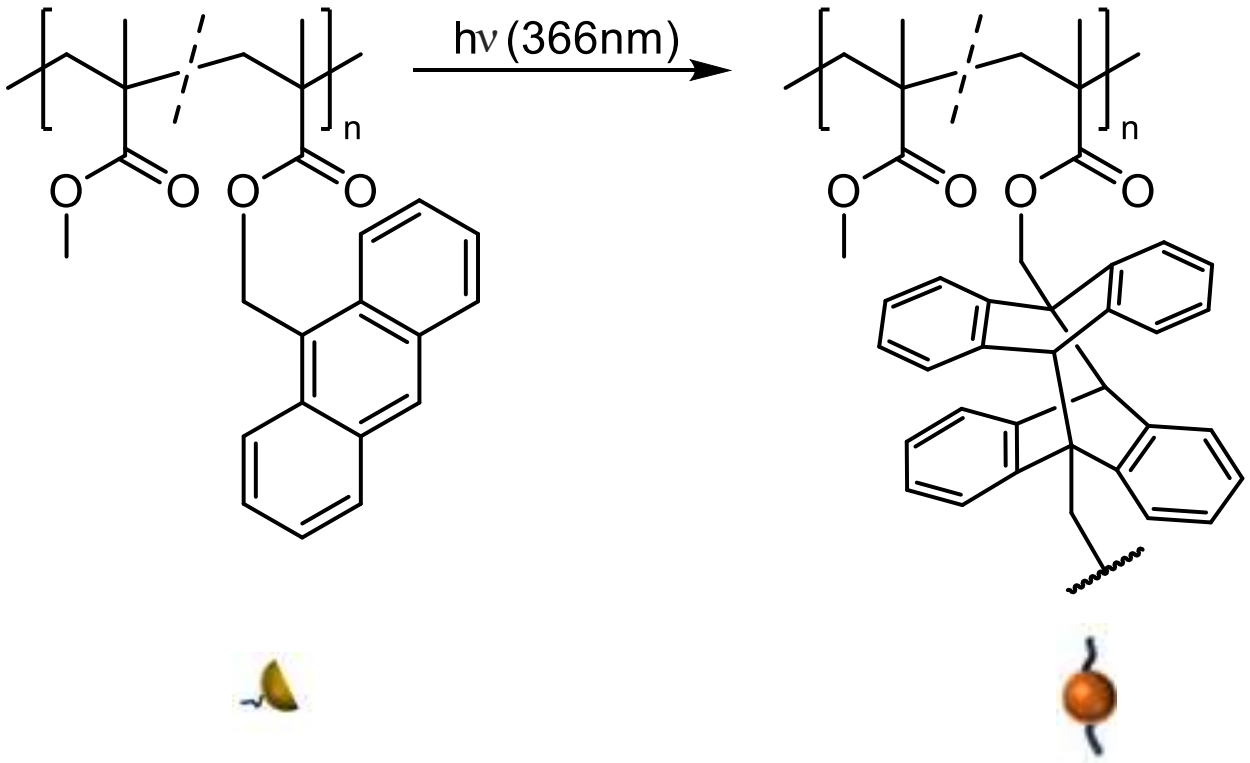
Finetuning reaction conditions

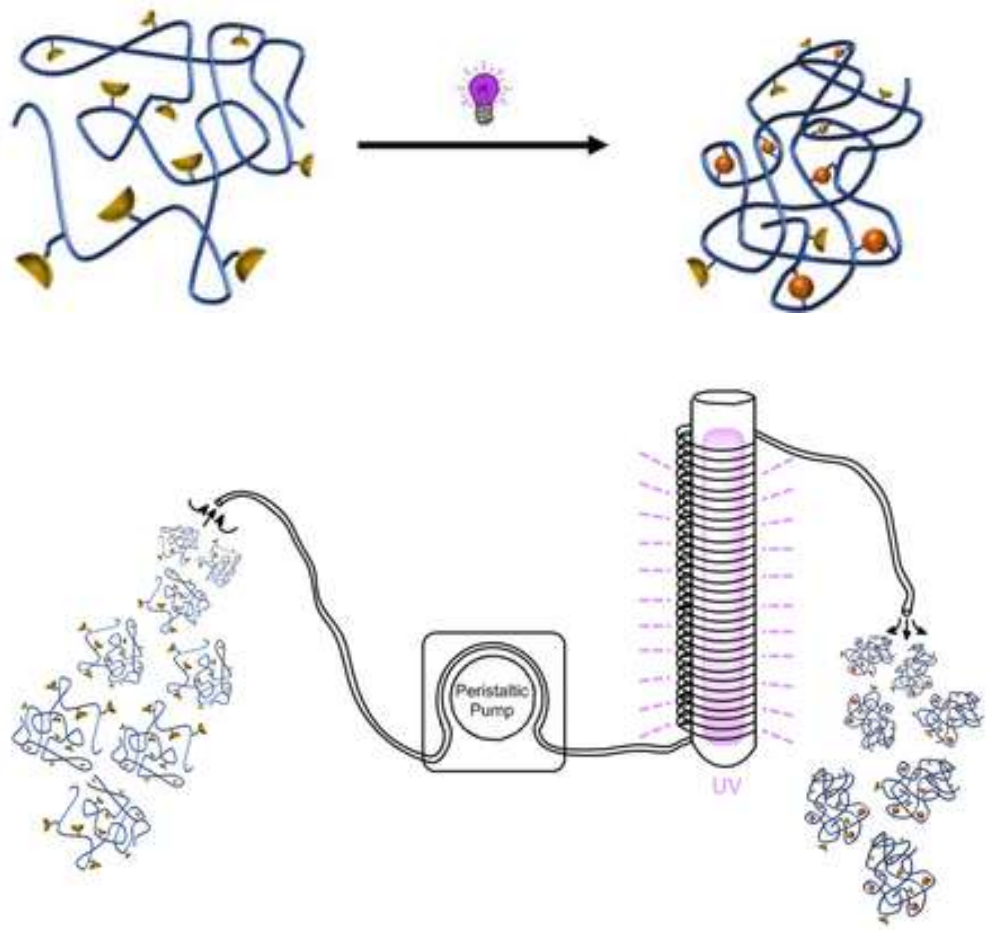
Flow synthesis



H. Frisch, J. P. Menzel, F. R. Bloesser, D. E. Marschner, K. Mundsinger, C. Barner-Kowollik *J. Am. Chem. Soc.* **2018**, *140*, 9551-9557.
O. Galant, H. B. Donmez, C. Barner-Kowollik, C. E. Diesendruck *Angew. Chem. Int. Ed.* **2021**, *60*, 2042-2046.

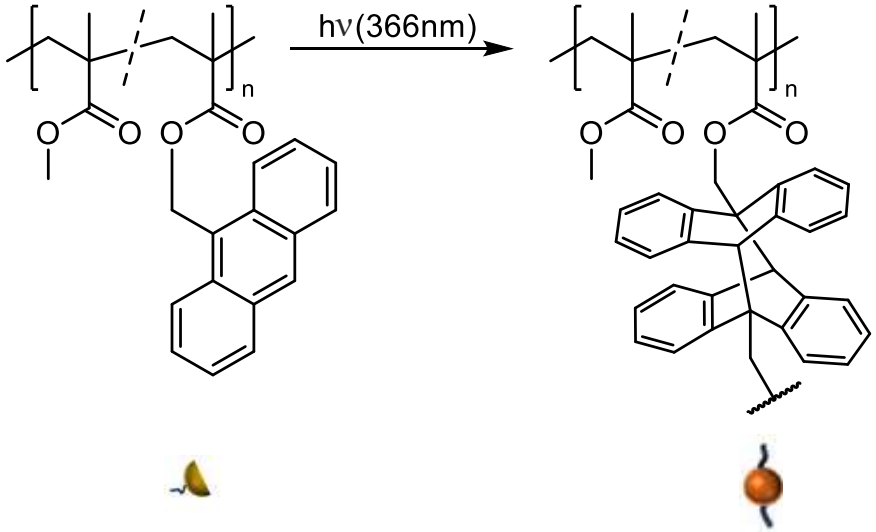
SCNP Flow Synthesis – Previous Work

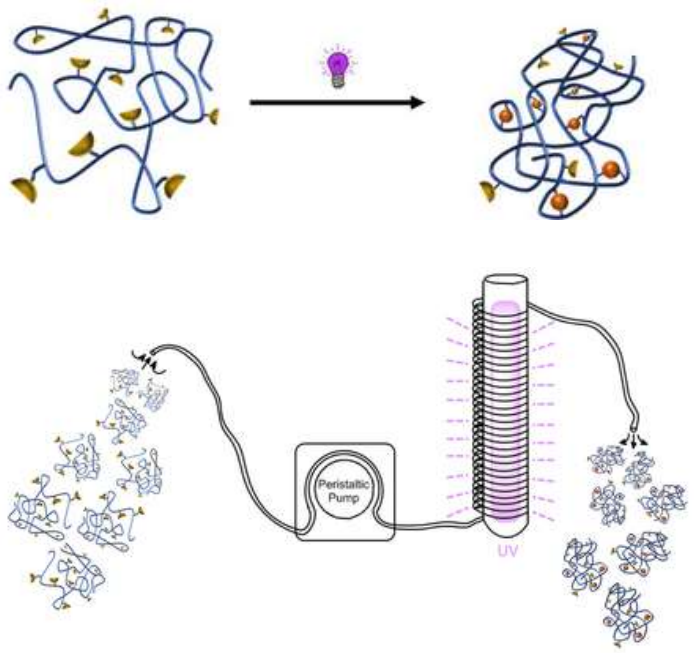




O. Galant, H. B. Donmez, C. Barner-Kowollik, C. E. Diesendruck *Angew. Chem. Int. Ed.* **2021**, *60*, 2042-2046.

SCNP Flow Synthesis – Previous Work





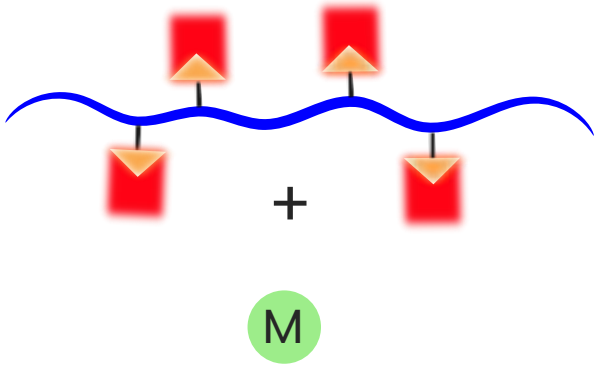
Successful SCNP flow synthesis

No application of synthesized SCNPs

O. Galant, H. B. Donmez, C. Barner-Kowollik, C. E. Diesendruck *Angew. Chem. Int. Ed.* **2021**, *60*, 2042-2046.

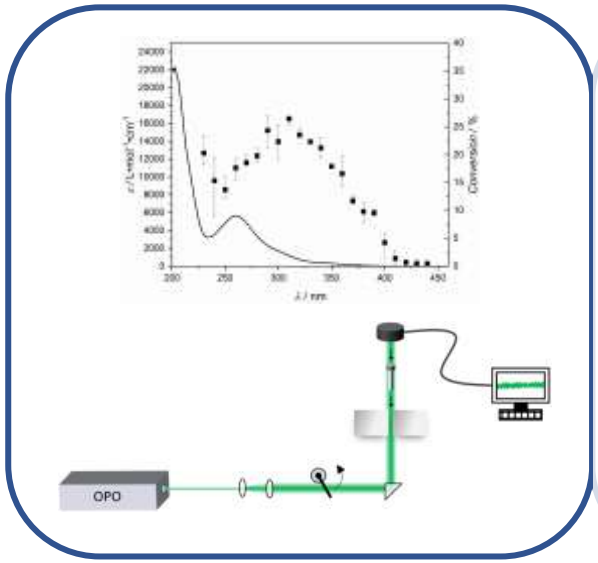
Can we synthesize
functional SCNPs in flow?

SCNP Flow Synthesis – Concept



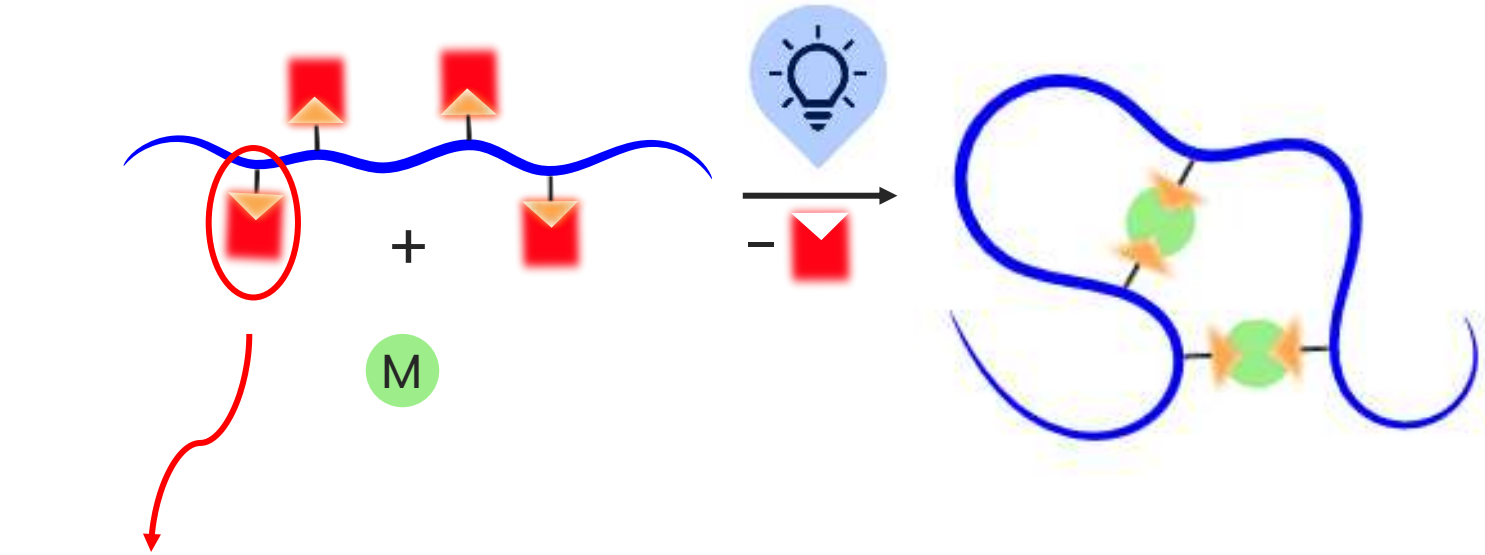
S. Gillhuber, J. O. Holloway, K. Mundsinger, J. A. Kammerer, H. Frisch, C. Barner-Kowollik, P. W. Roesky **2024**, submitted.

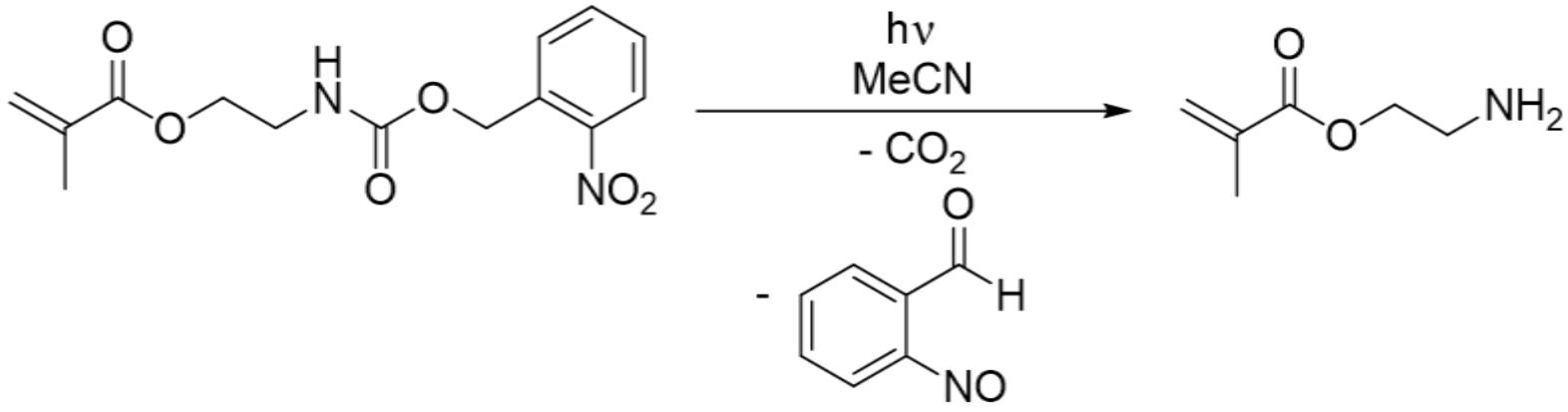
Research Plan – Step I



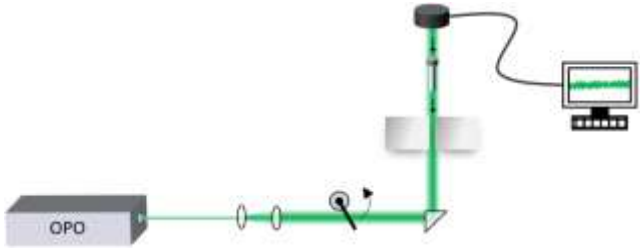
Monomer Action Plot → Proof-of-Concept → Flow Synthesis → Catalysis

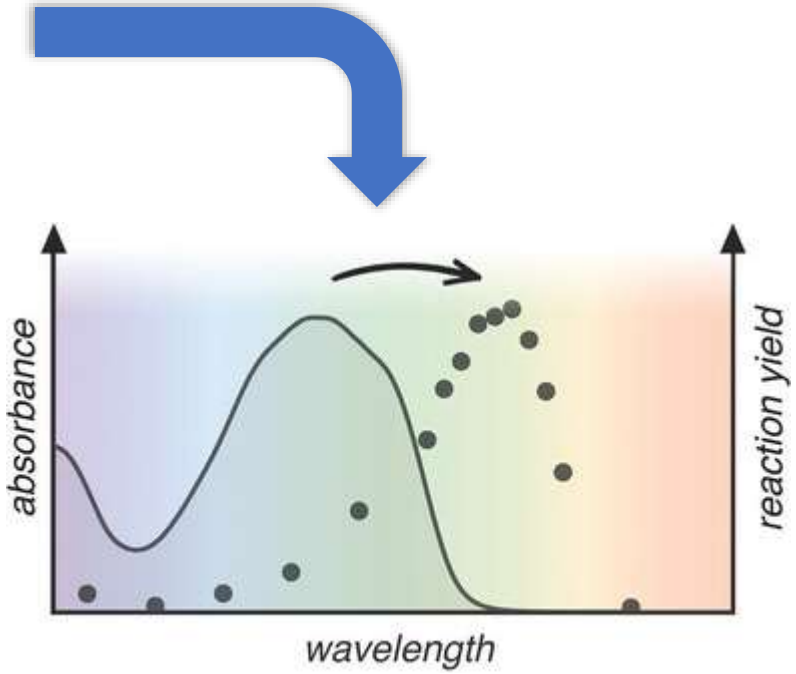
Monomer Choice

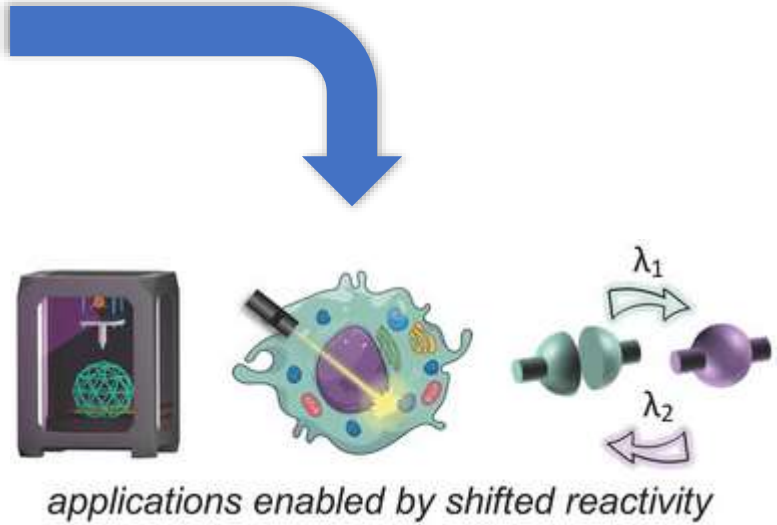




Action Plots

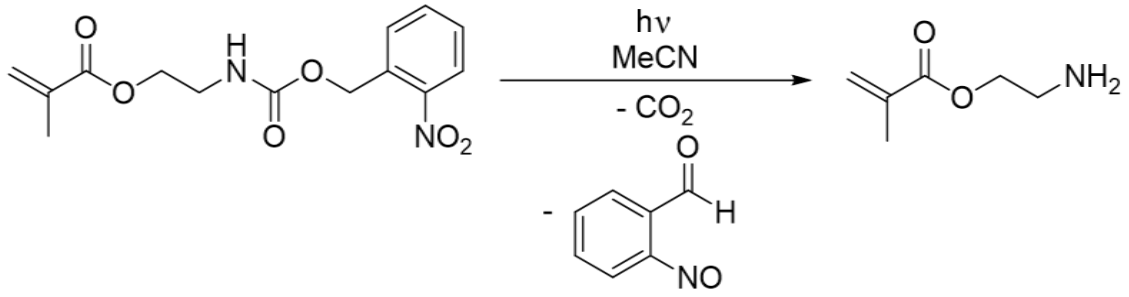


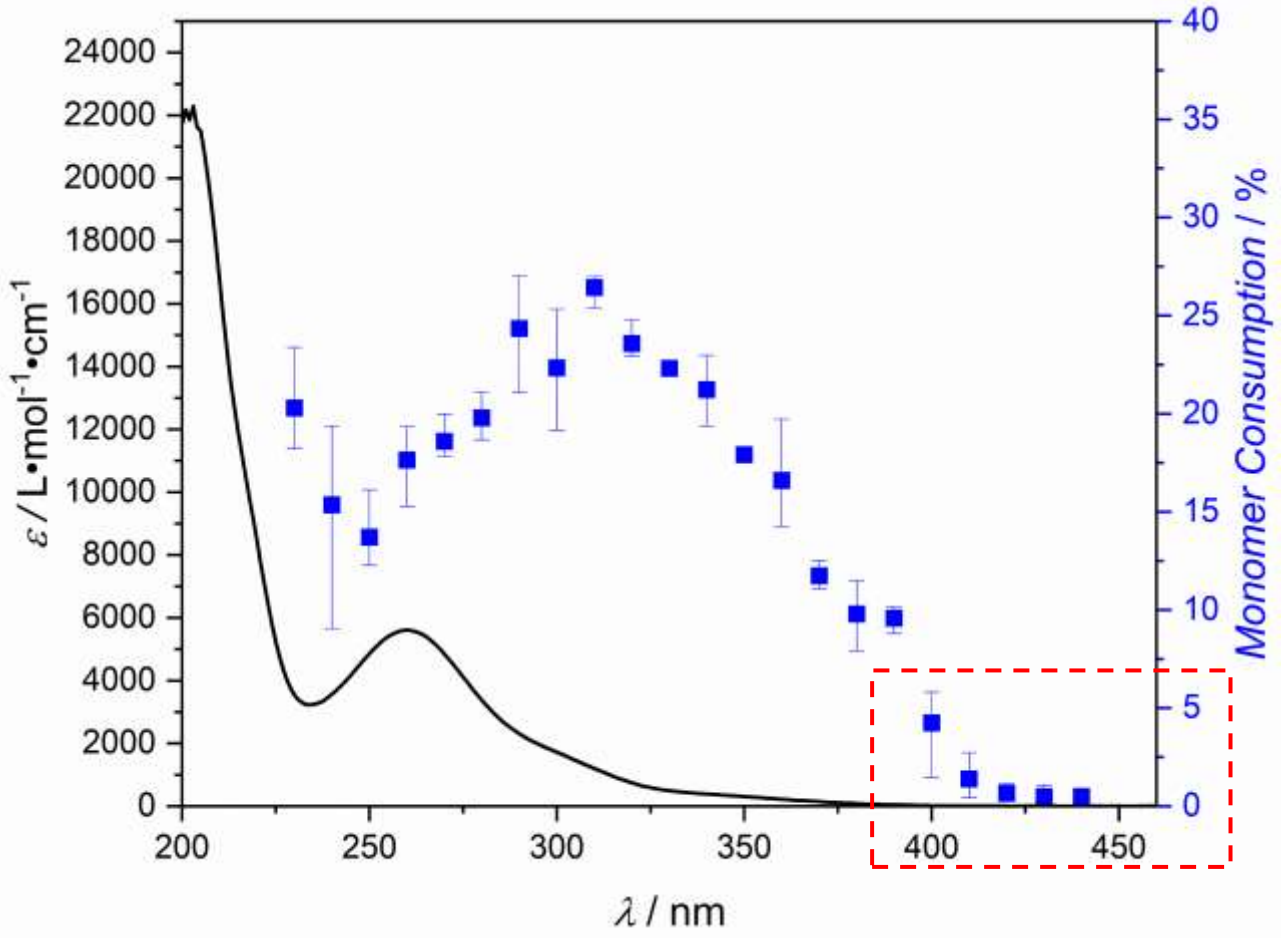




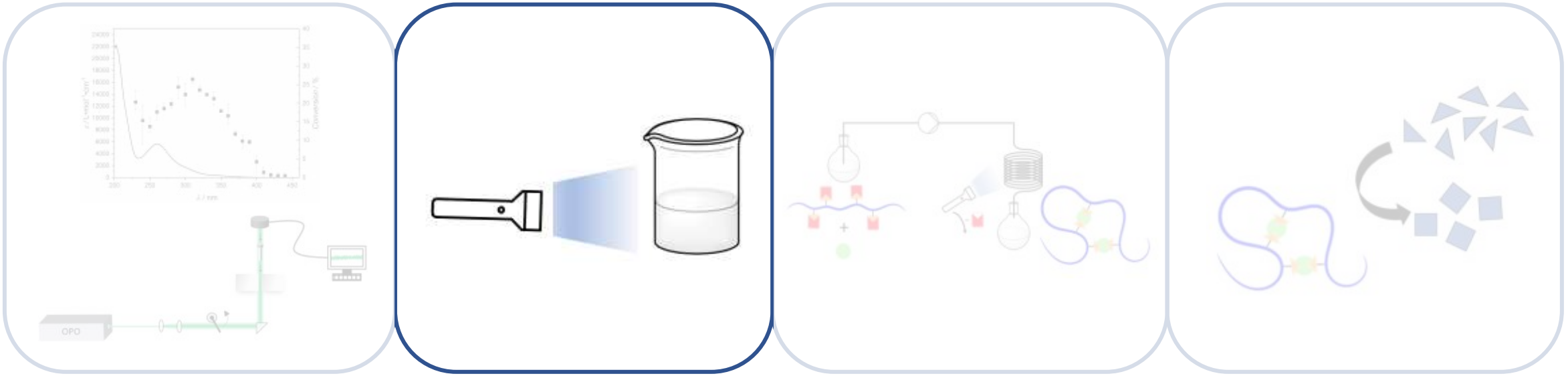
S. L. Walden, J. A. Carroll, A.-N. Unterreiner, C. Barner-Kowollik *Adv. Sci.* **2024**, *11*, 2306014.

Monomer Action Plot (CH_3CN)





Research Plan – Step II



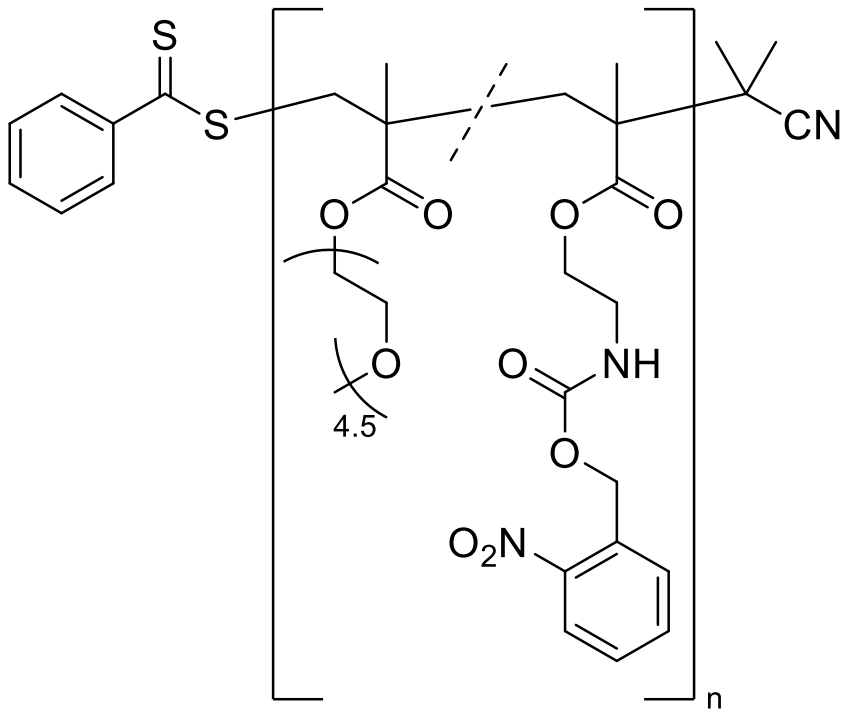
Monomer Action Plot

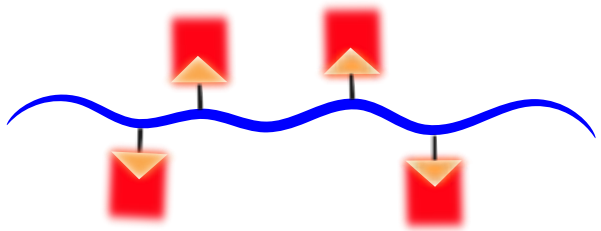
Proof-of-Concept

Flow Synthesis

Catalysis

Proof-Of-Concept – SCNP Batch Synthesis

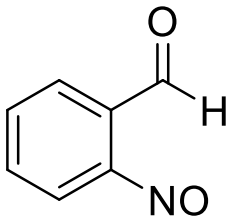


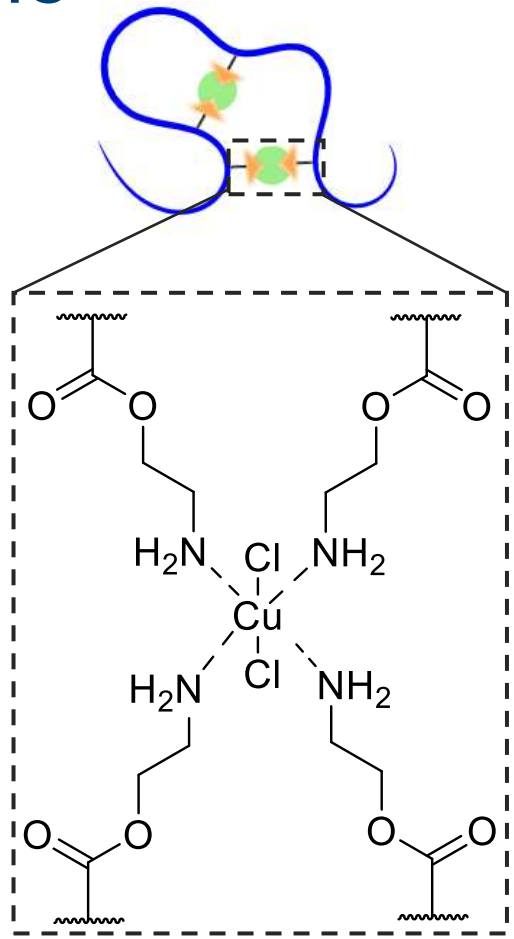


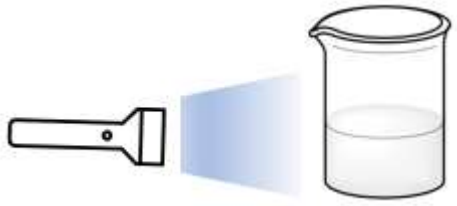
+ $CuCl_2 \cdot 2\ H_2O$

hν
MeCN

CO_2 +





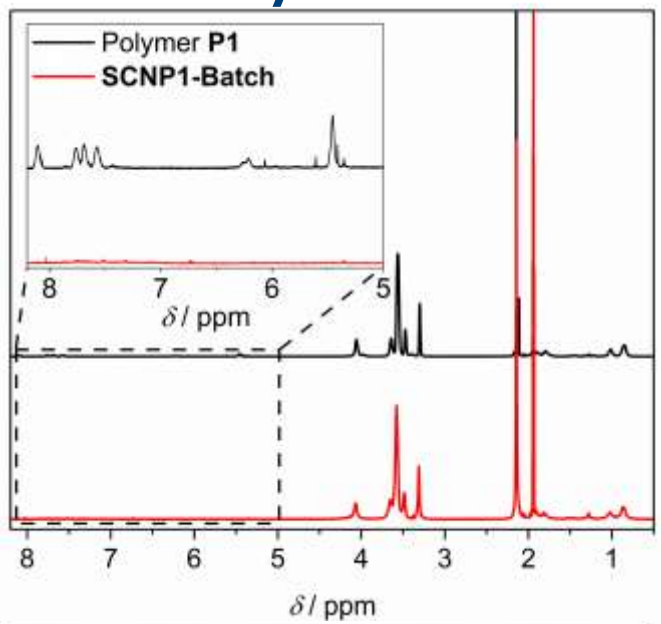


400 nm LED

macroarc soft matter materials group KIT QUT

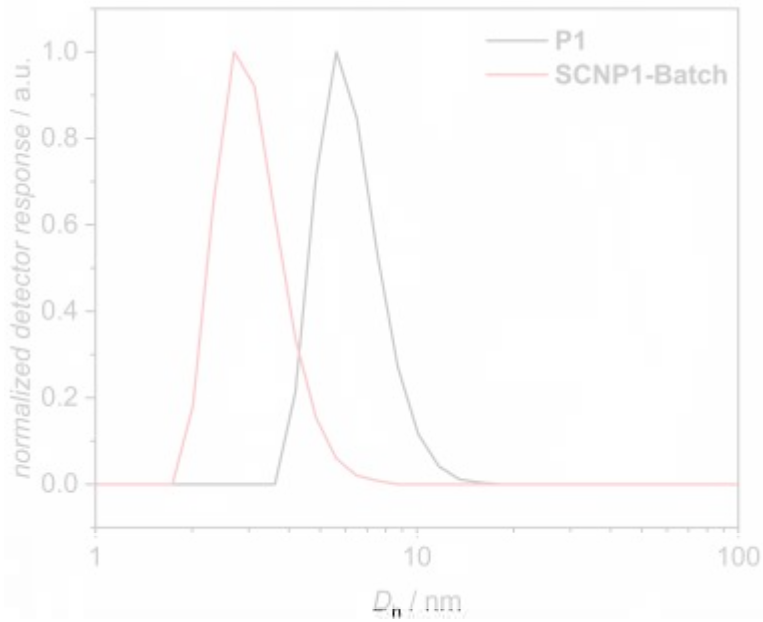
SCNP Batch Synthesis – Analytics

^{1}H NMR (CD_3CN)

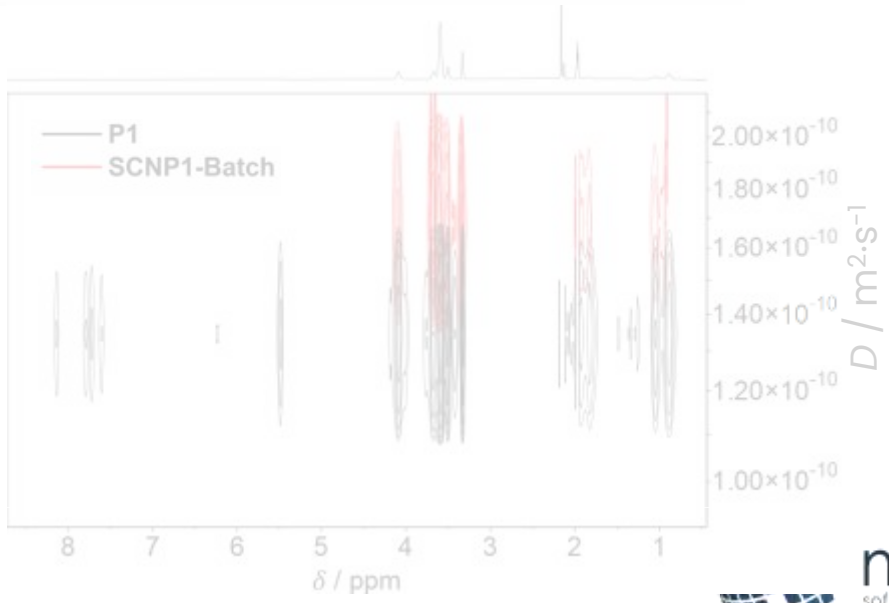


SEC (THF)

DLS (CH_3CN)



DOSY (CD_3CN)



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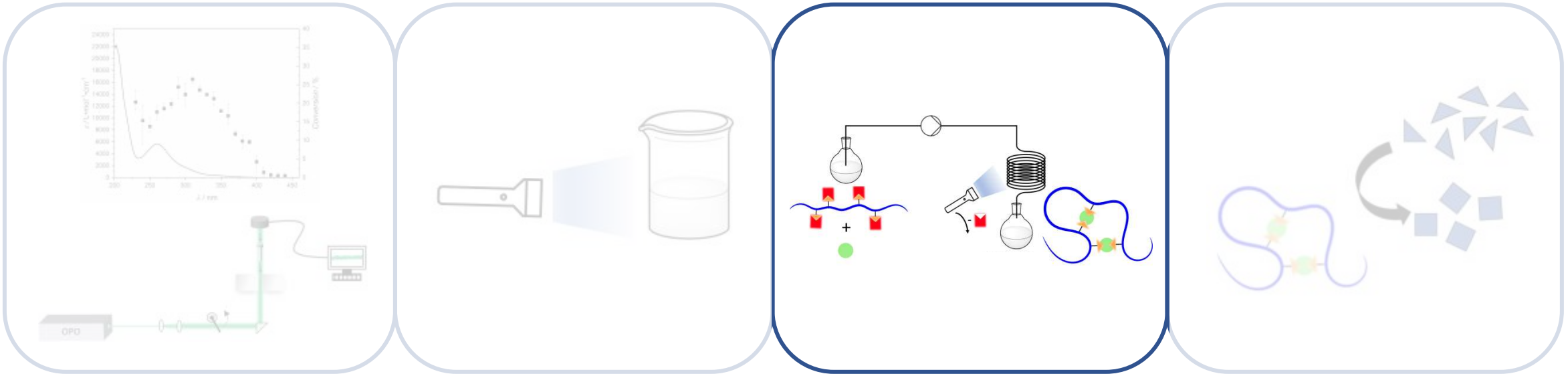
Research Plan – Step III



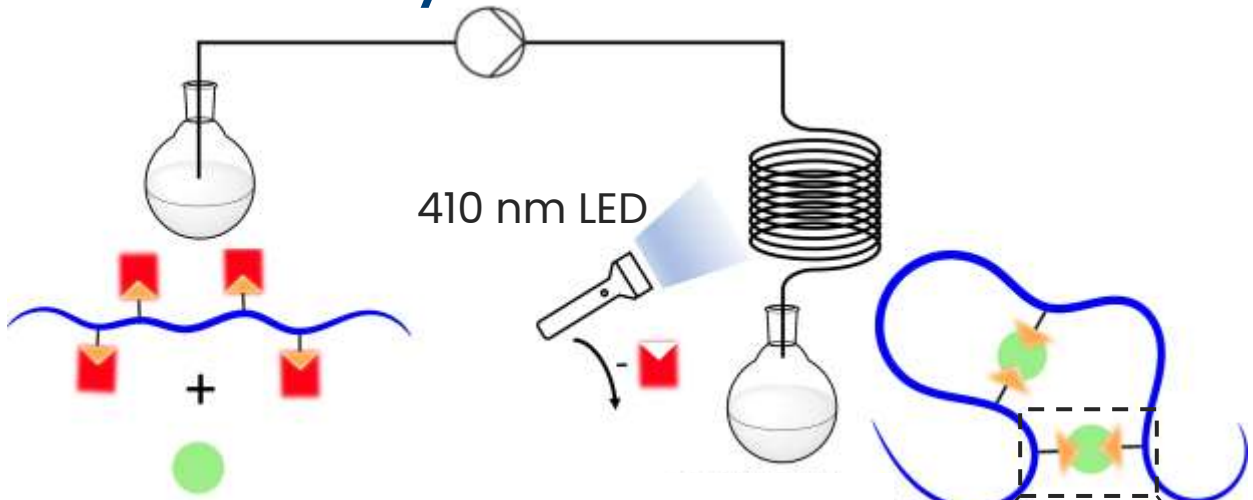
Monomer Action Plot

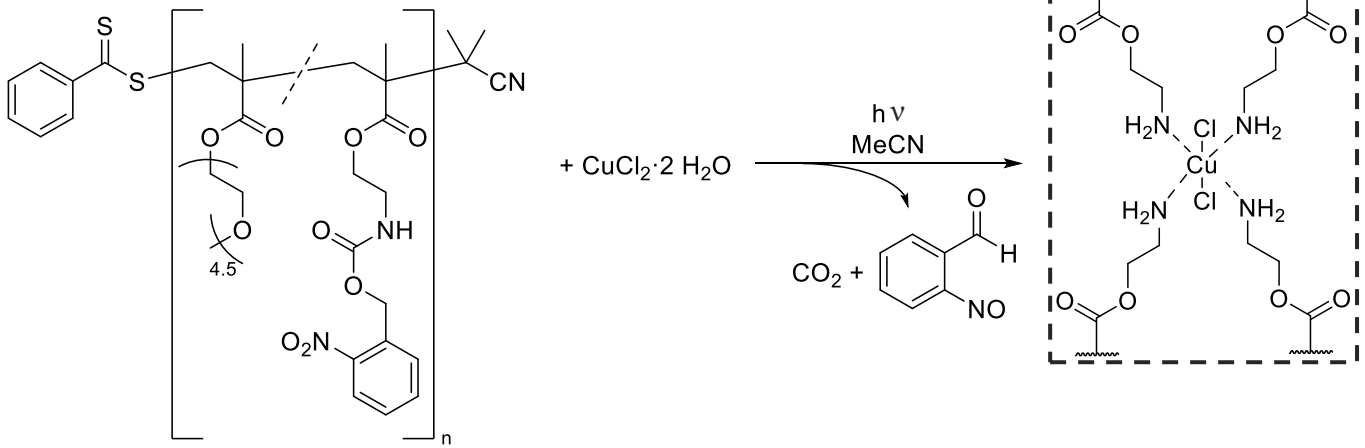
Proof-of-Concept

Flow Synthesis

Catalysis

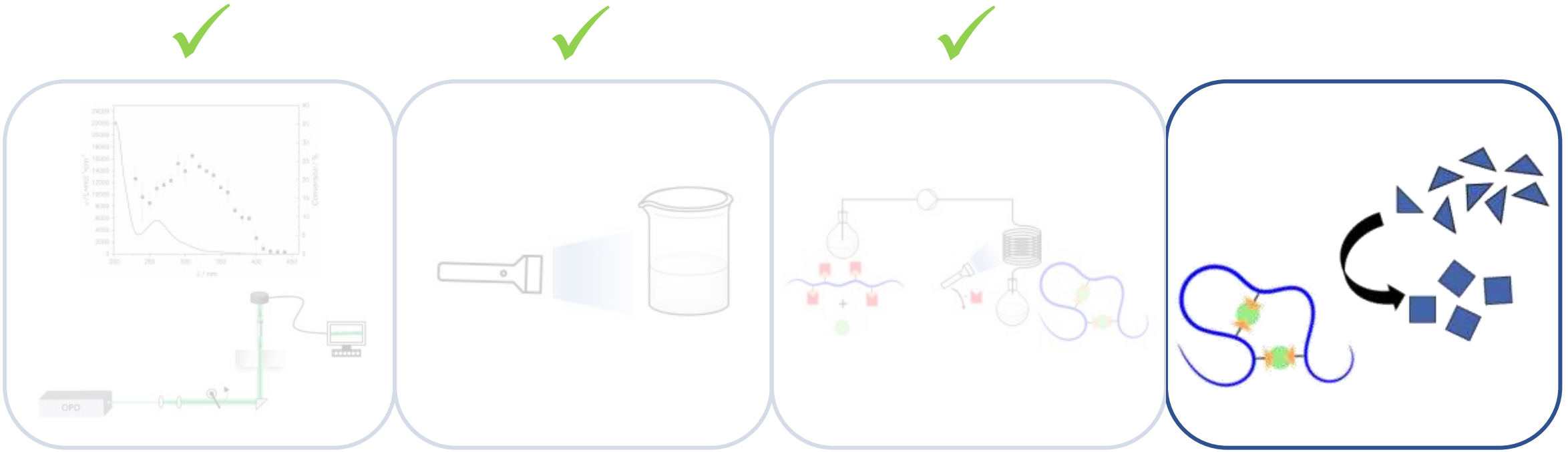
SCNP Flow Synthesis





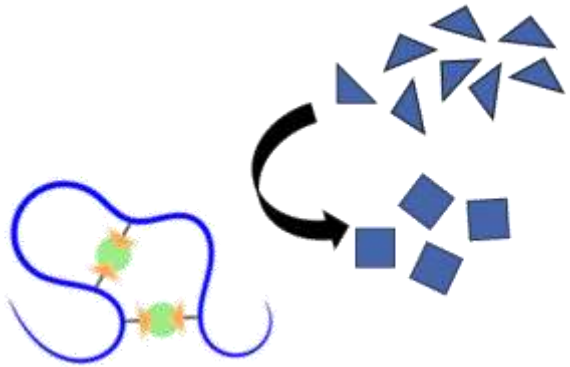
https://www.vapourtec.com/products/flow-reactors/photochemistry-uv-150-photochemical-reactor-features/ (15/02/24)

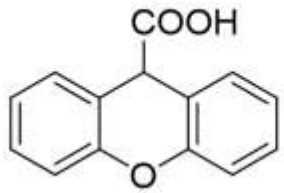
Research Plan – Step IV



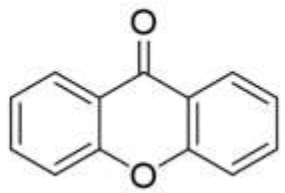
Monomer Action Plot → Proof-of-Concept → Flow Synthesis → Catalysis

Application – Catalysis

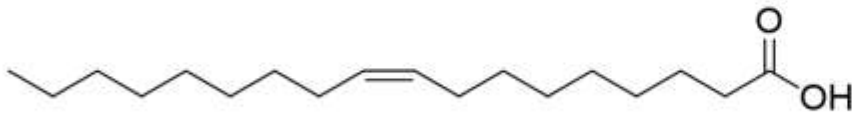




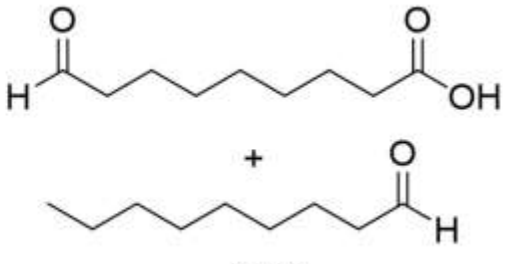
SCNP1-Flow (max. 10 mol% Cu(II))
400 nm LED (10 W), O_2
MeCN



Quantitative conversion after 90 minutes

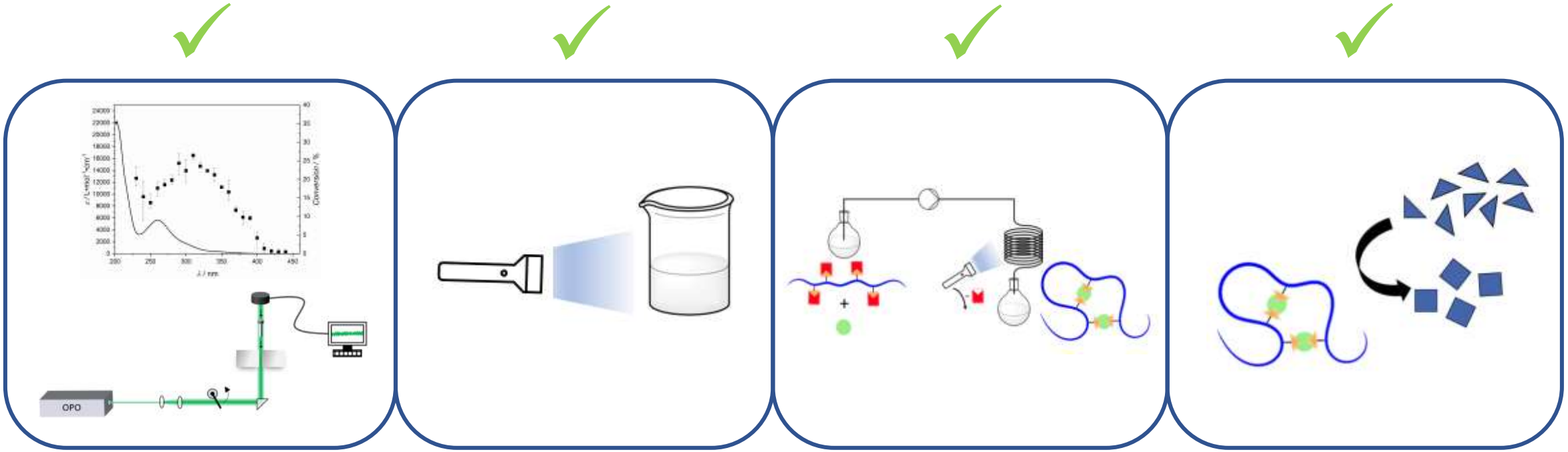


SCNP1-Flow (max. 10 mol% Cu(II))
400 nm LED (10 W), O_2
MeCN



40 % conversion after 24 h

Summary


OPO
Monomer Action Plot
Proof-of-Concept
Flow Synthesis
Catalysis

Macroarc @ 38APS

Tuesday 12.15 pm in Tasman 1

Investigating the impact of olefinic structure in polystyrene-polyisoprene-polystyrene (SIS) triblock copolymers on their performance as flexible electrothermal composite heaters - Hiruni Dedduwakumara

Tuesday 12.45 pm in Tasman 1

Visible-Light-Induced Control over Folding and Unfolding of Fluorescent and Catalytically Active Single-Chain Nanoparticles - Patrick Maag

Tuesday 4 pm in Tasman 1

Dynamic Chalcogen Squares for Material and Topological Control over Macromolecules - Dr Bryan Tuten