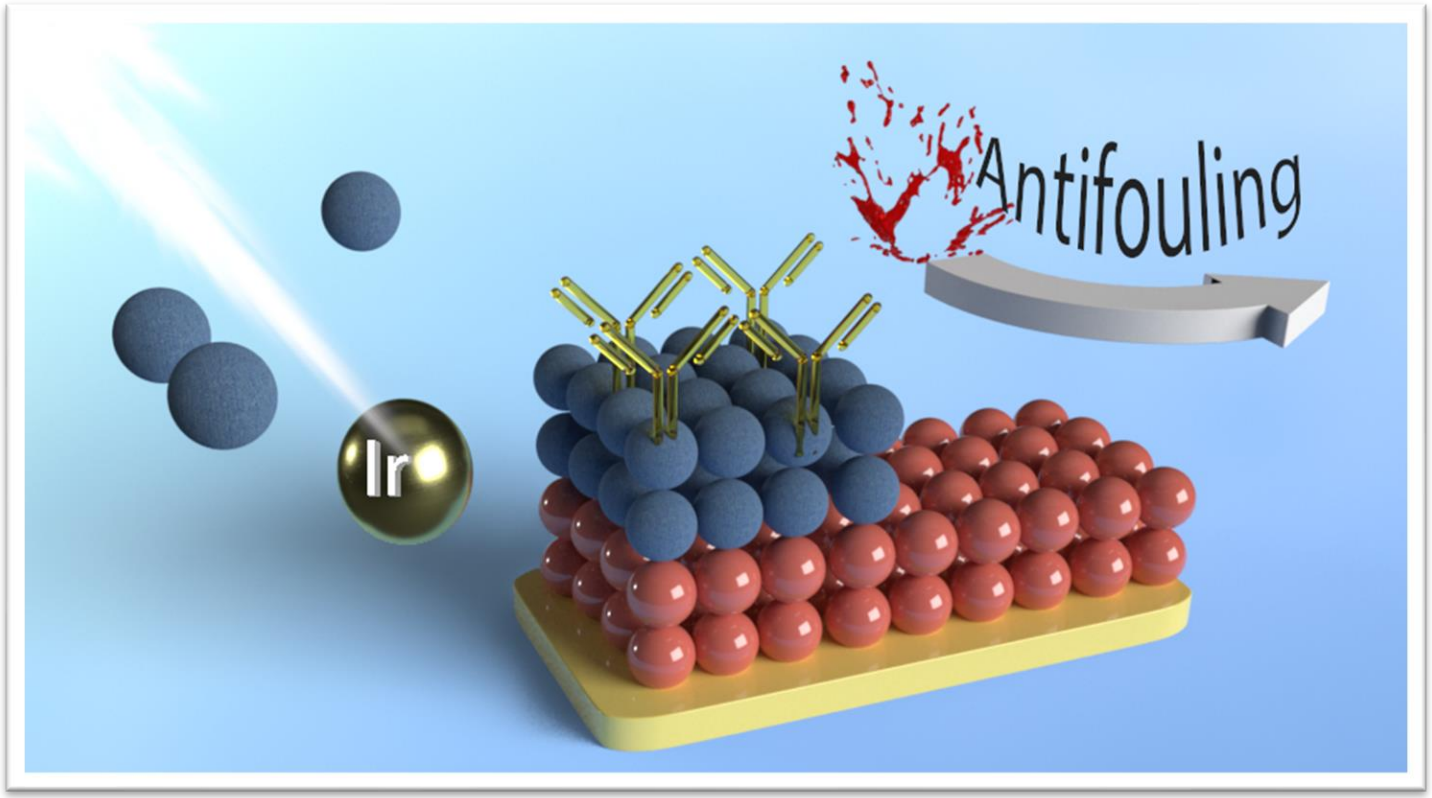
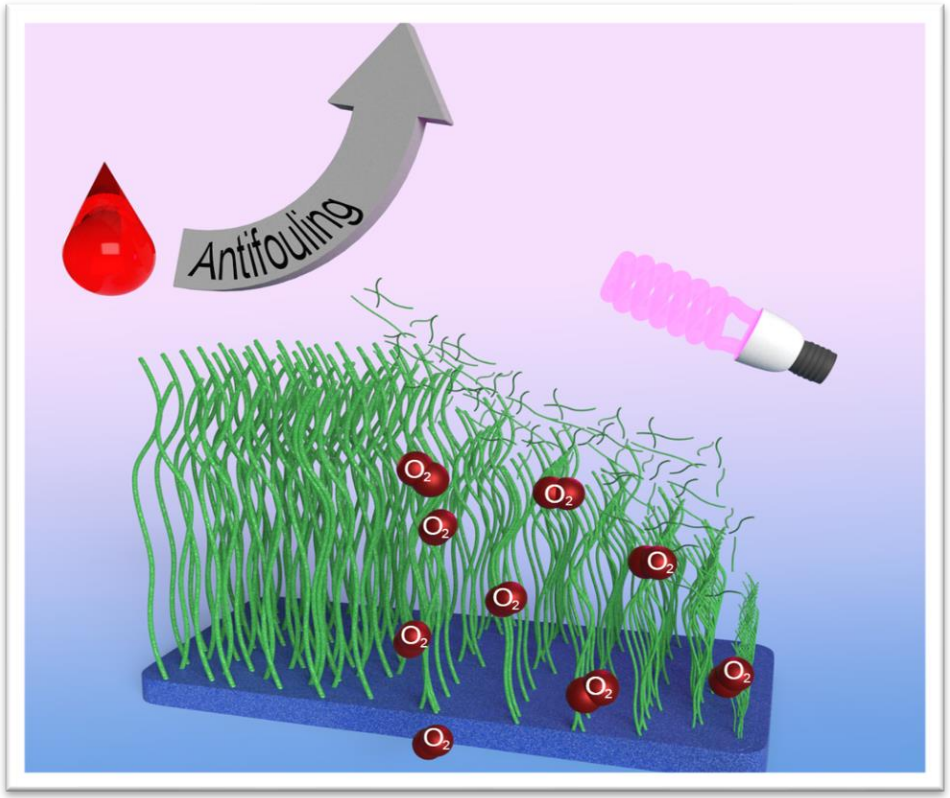
Visible Light-triggered Living Polymerization for Creating Antifouling and Bioactive Surfaces





Andriy Kuzmyn

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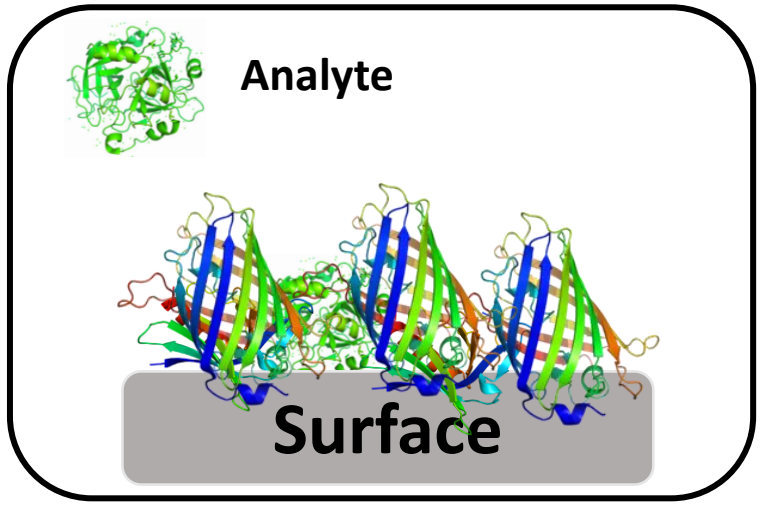
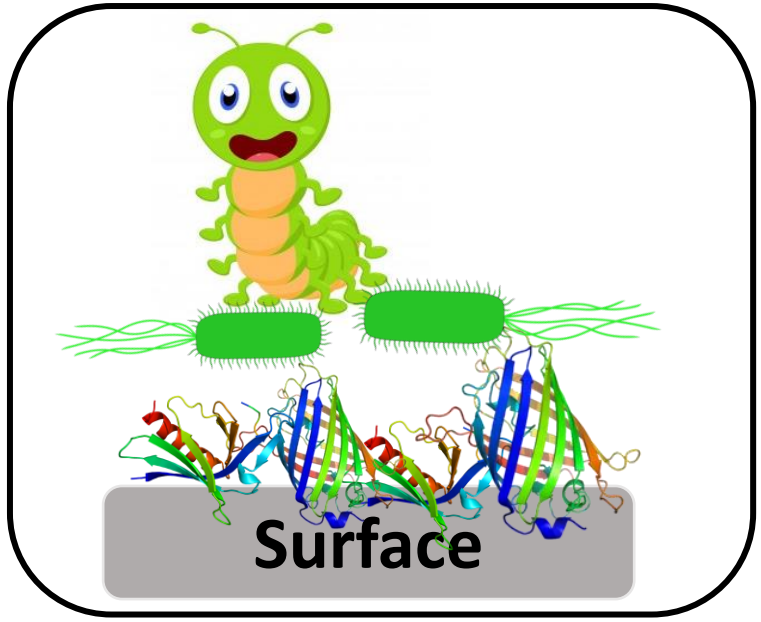
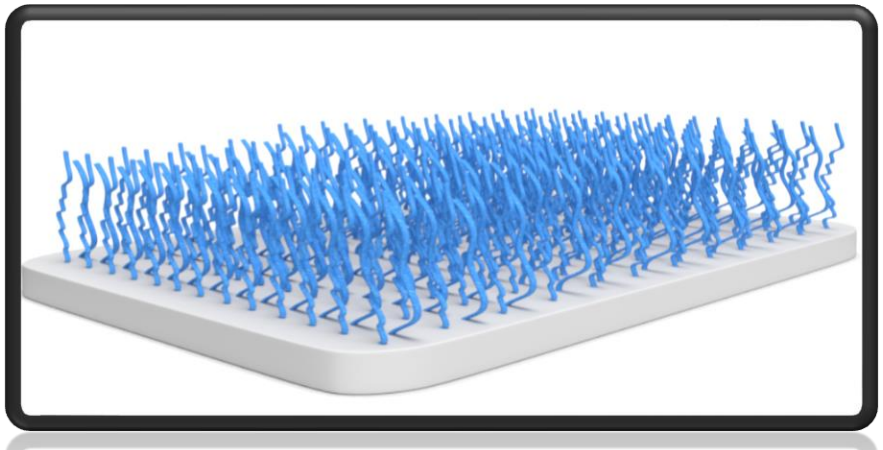
Fouling, and How to Deal with It ?



Biosensors

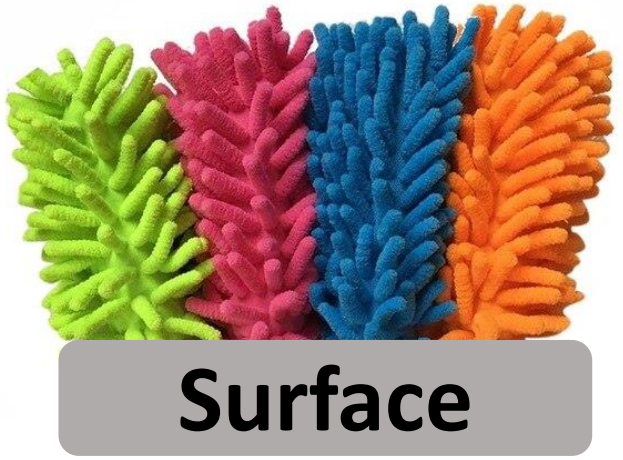


Tissue engineering
Membranes
Implants
Ships

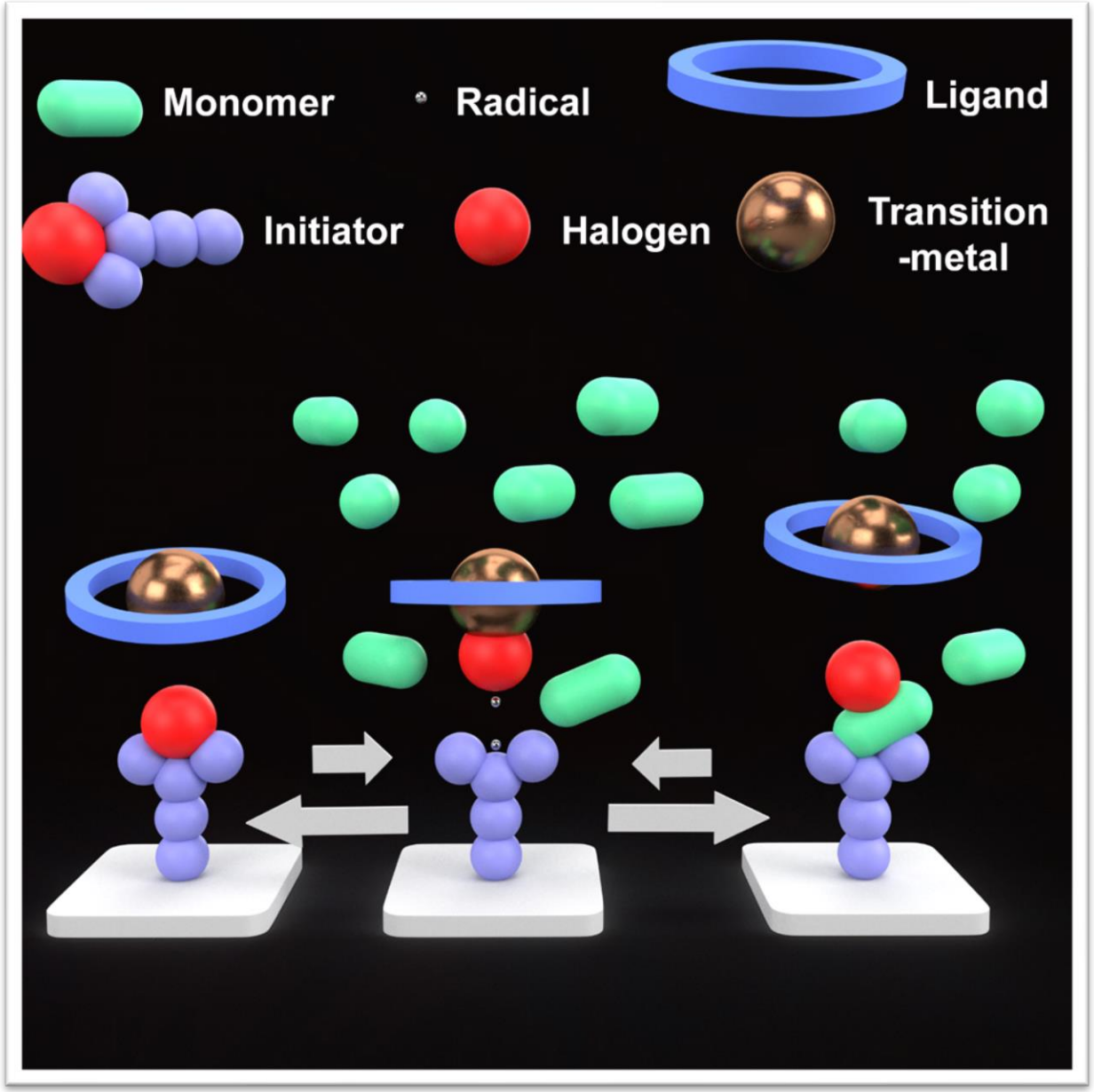


Best solution

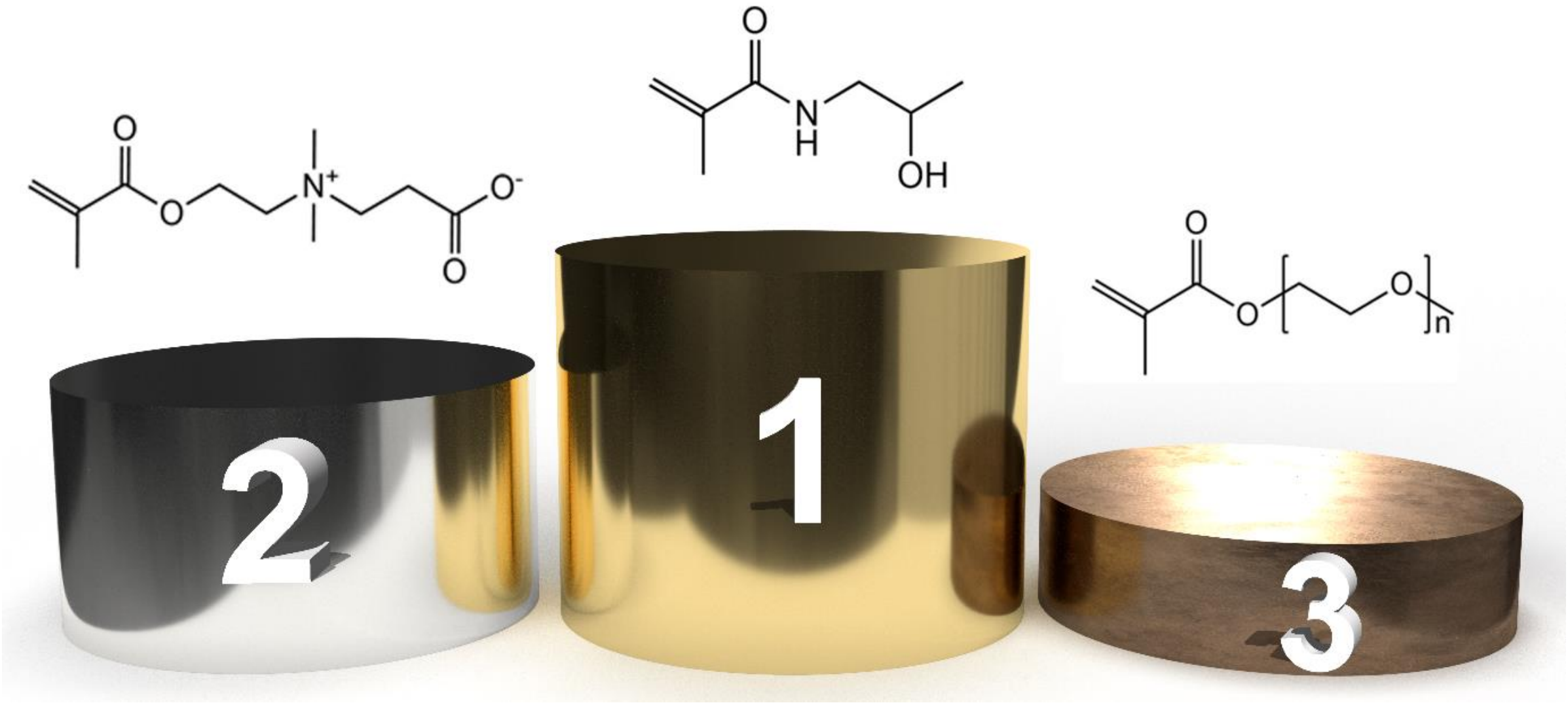
Polymer brushes



Atom Transfer Radical Polymerization (ATRP)

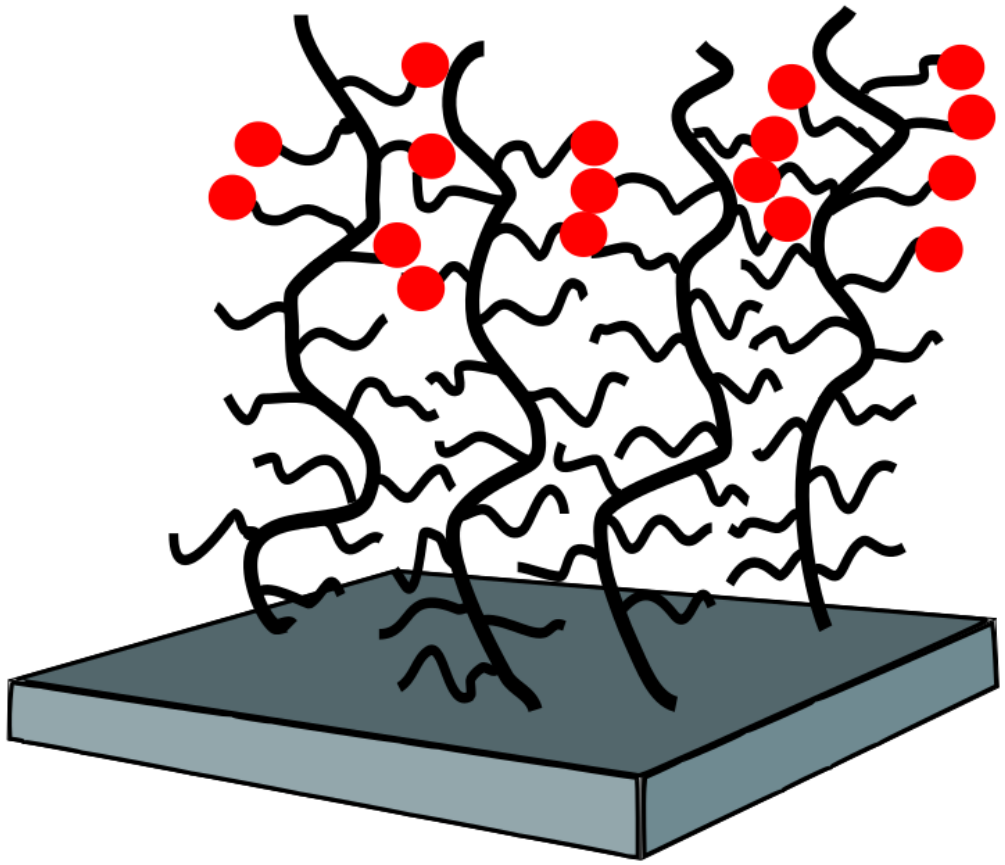


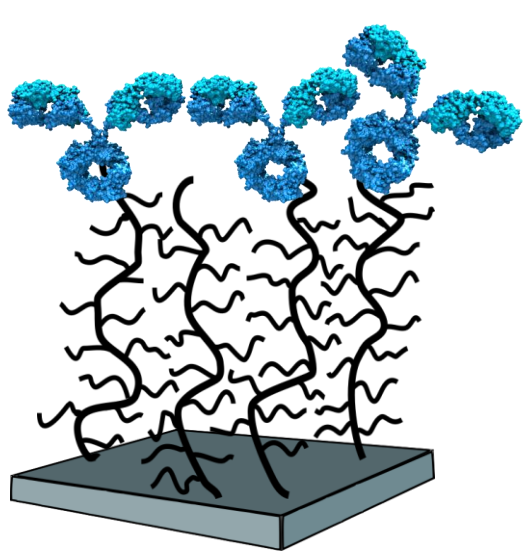
Best Performing Antifouling Polymer Brush Surfaces



van Andel, E., Lange, S. C., Pujari, S. P., Tijhaar, E. J., Smulders, M. M. J., Savelkoul, H. F. J., & Zuilhof, H.
Systematic Comparison of Zwitterionic and Non-Zwitterionic Antifouling Polymer Brushes on a Bead-Based Platform.
Langmuir (2019) 35, 5, 1181

Biofunctionalization of Antifouling Polymer Brushes





Biorecognition element

Antifouling layer

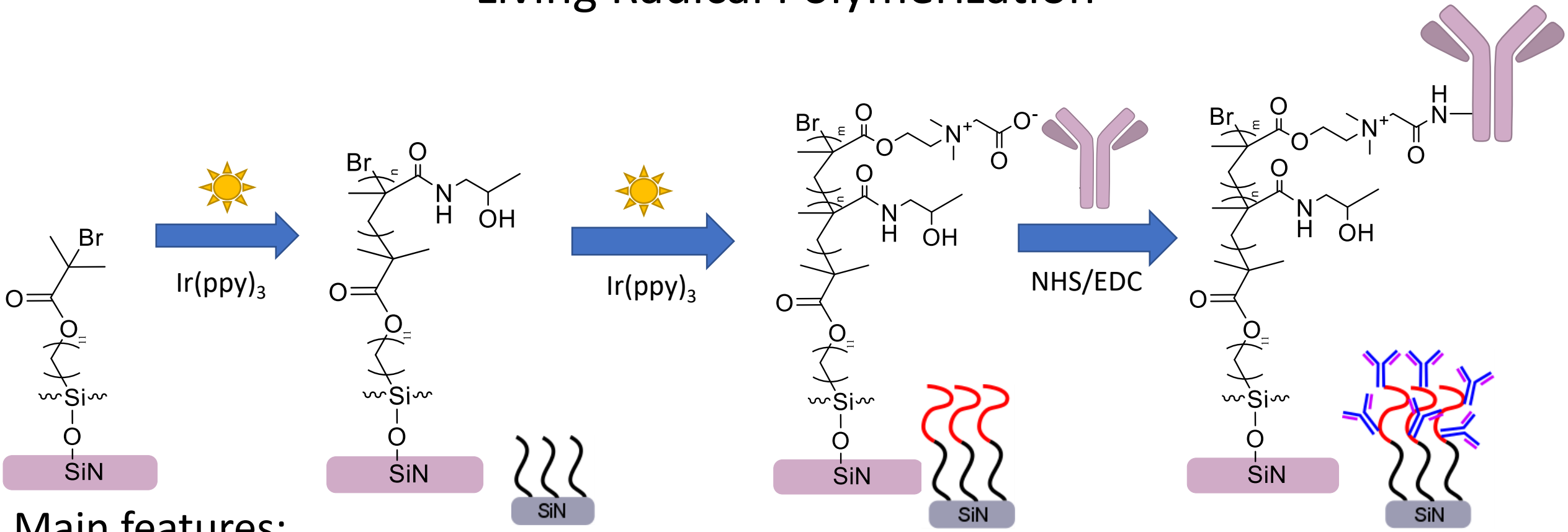
Surface

Chain-end modification

Side-chain functionalization

Block copolymer functionalization

Surface-Initiated Visible Light-triggered Living Radical Polymerization

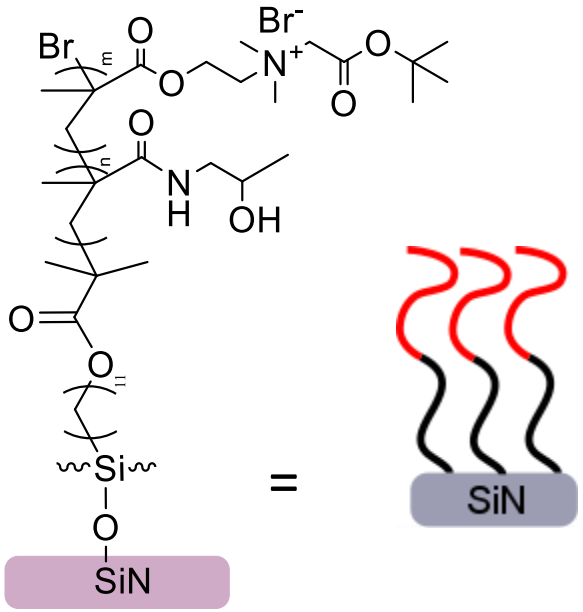


Main features:

- Well- controlled polymerization
- Pattering

Kuzmyn, A. R., Nguyen, A. T., Zuilhof, H., & Baggerman, J.
Bioactive Antifouling Surfaces by Visible-Light-Triggered Polymerization.
Advanced Materials Interfaces, (2019). 2196

XPS Characterization of Synthetized Polymer Brushes



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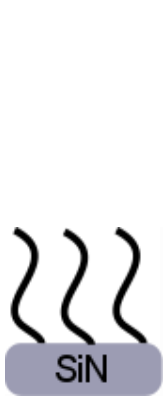

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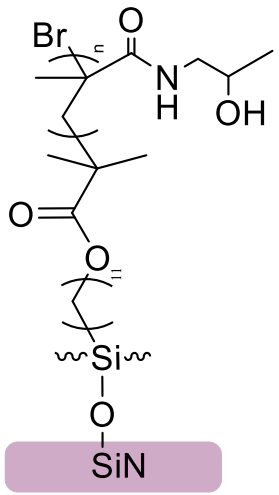
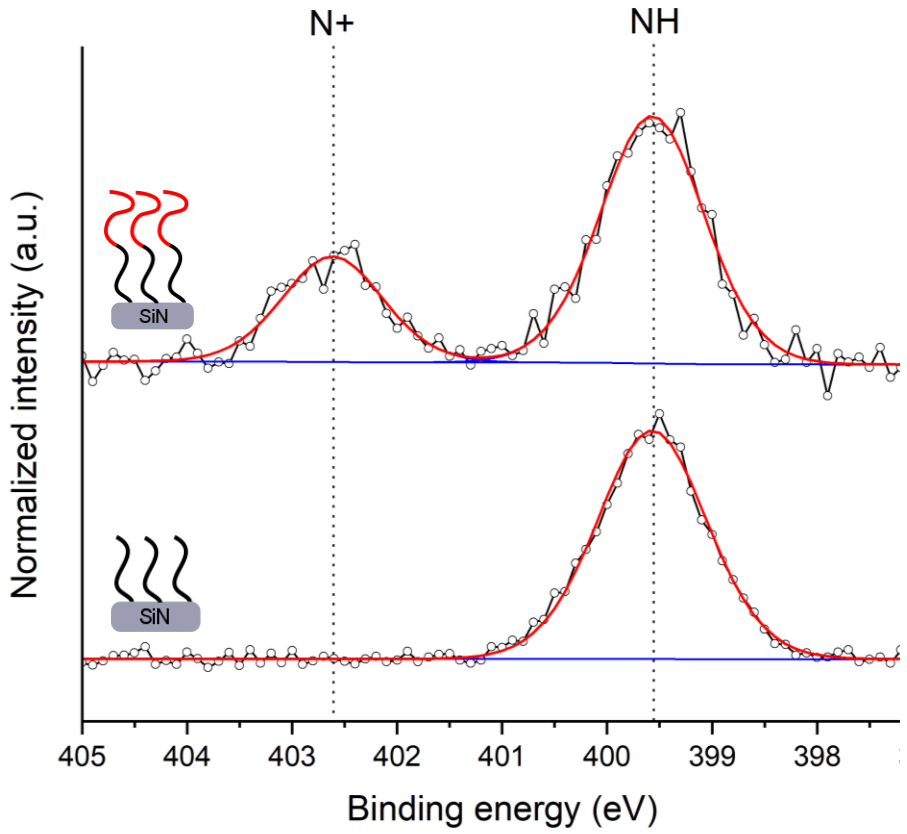
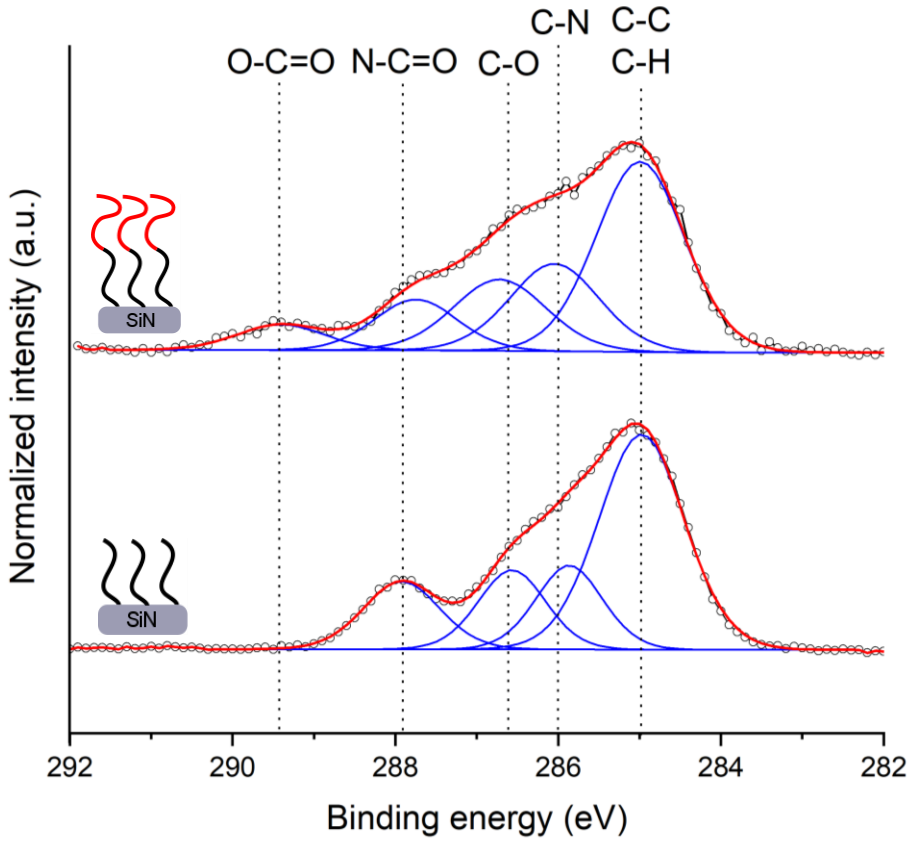




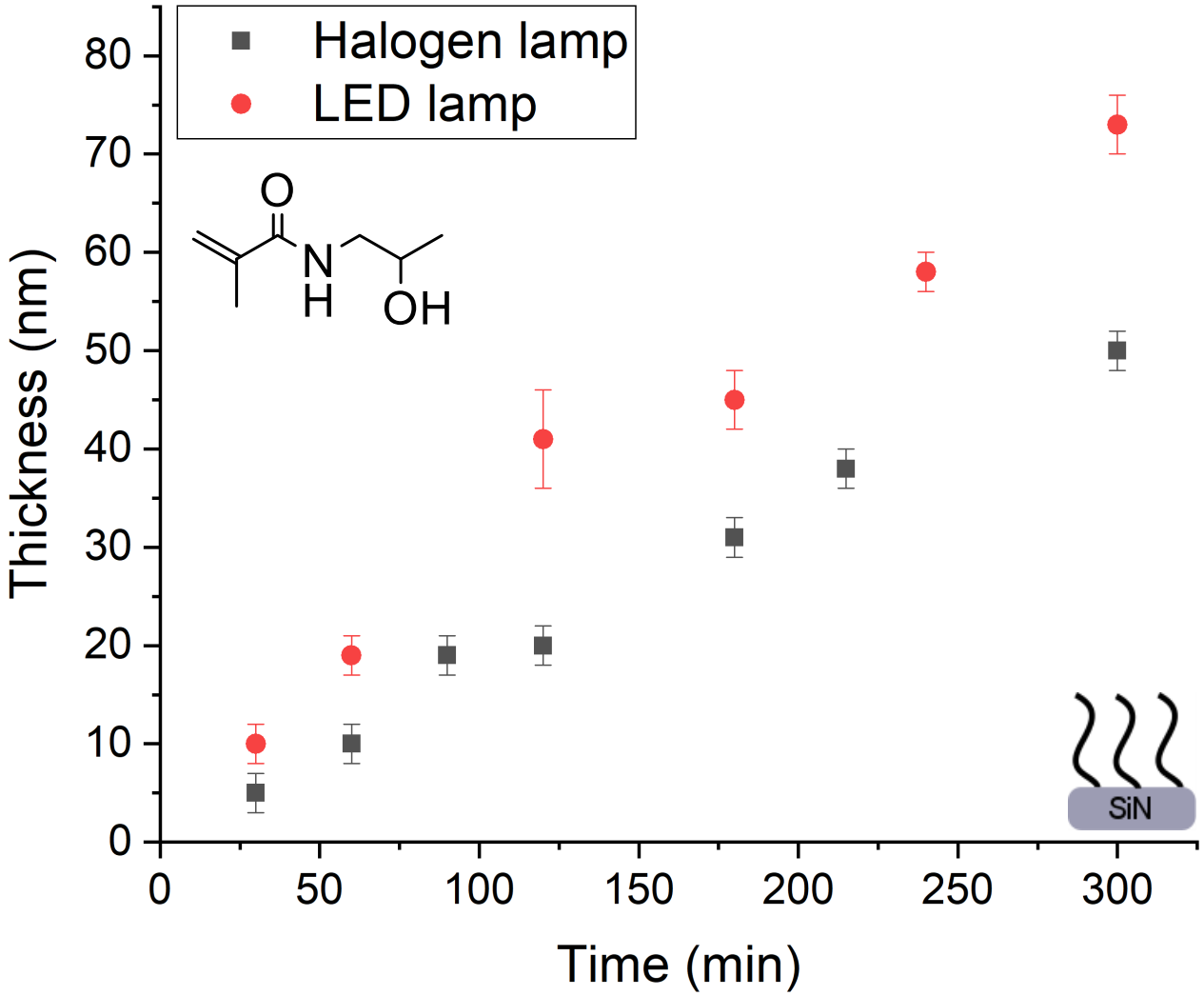
Narrow C1s XPS spectra



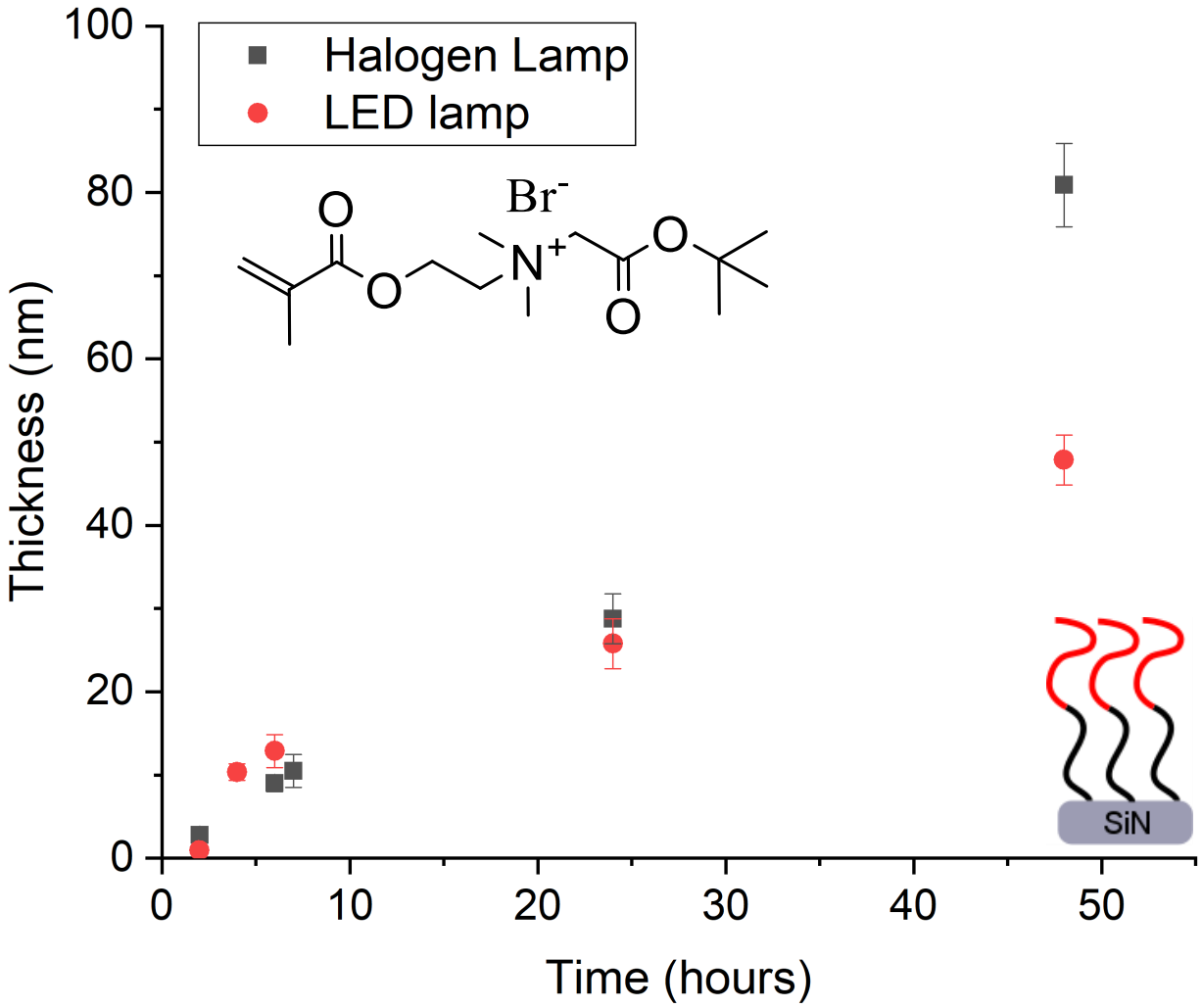
Narrow N1s XPS spectra

Kuzmyn, A. R., Nguyen, A. T., Zuilhof, H., & Baggerman, J.
Bioactive Antifouling Surfaces by Visible-Light-Triggered Polymerization.
Advanced Materials Interfaces, (2019), 6(12), 1900351.

Kinetics of Polymerization

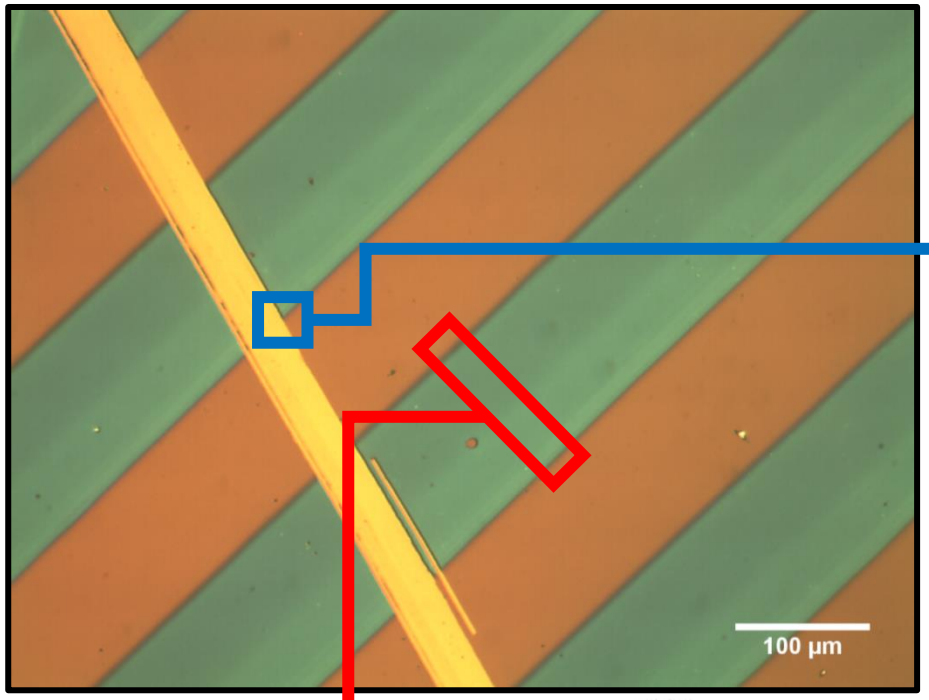


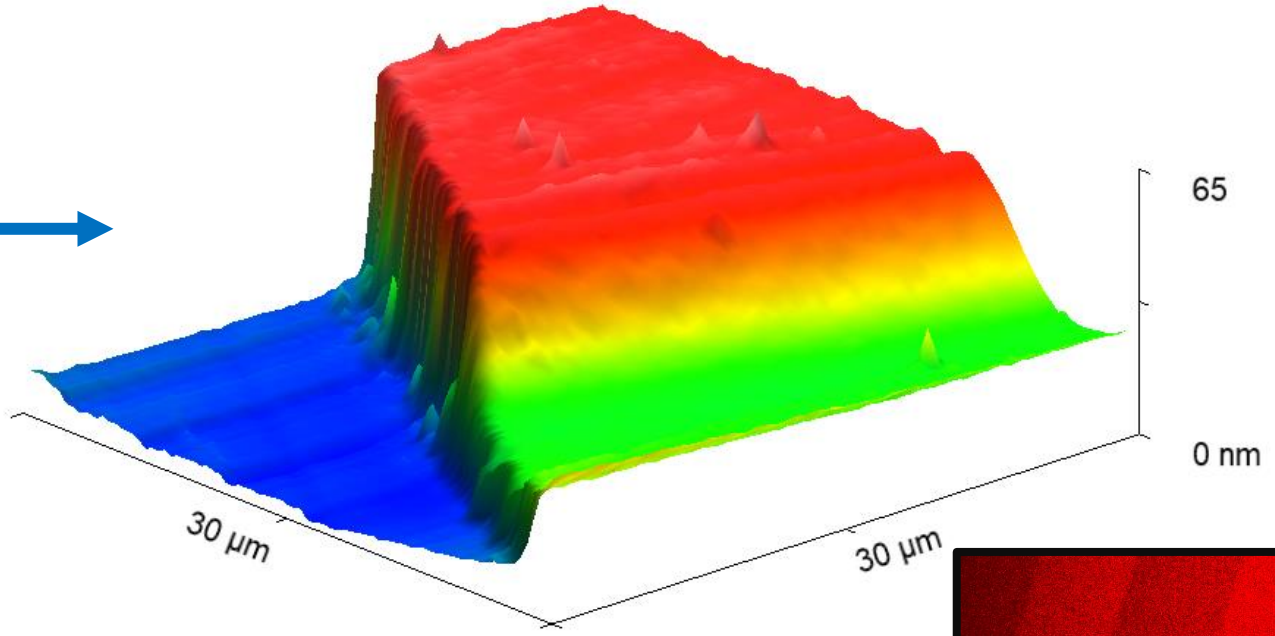
Growth of poly(HPMA) brushes vs polymerization time

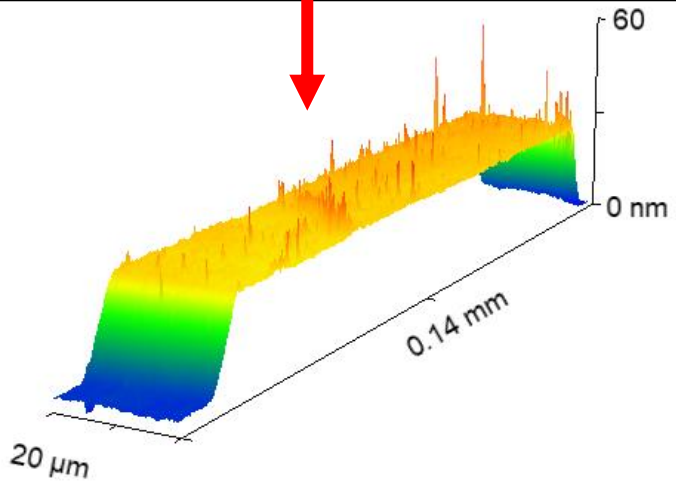


Growth of poly(CBMA-tBu) brush from poly(HPMA) brush of 20 nm

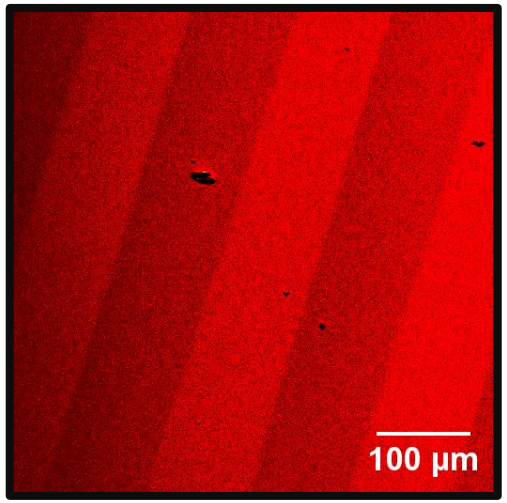
Patterned Antifouling Polymer Brush Surfaces





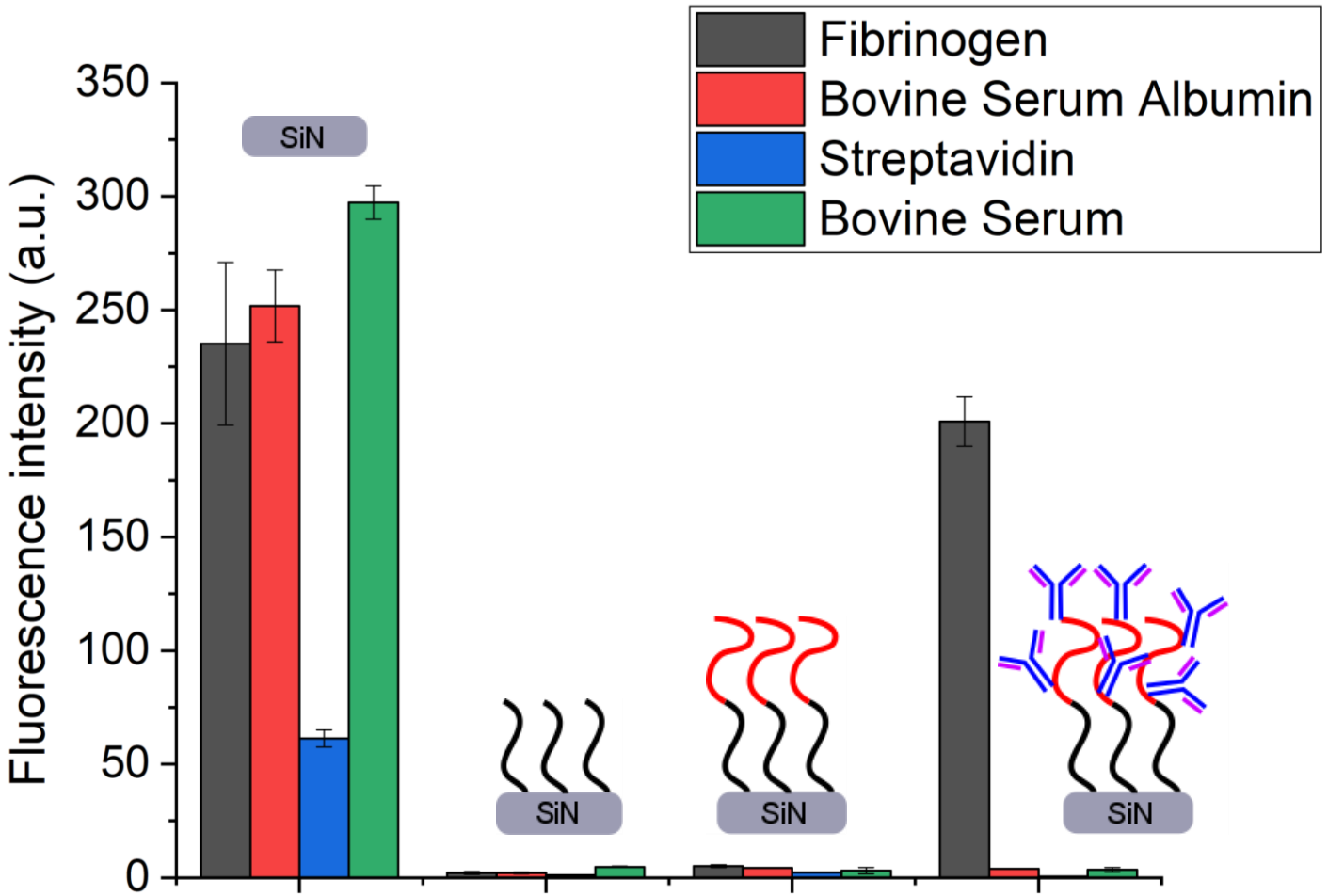


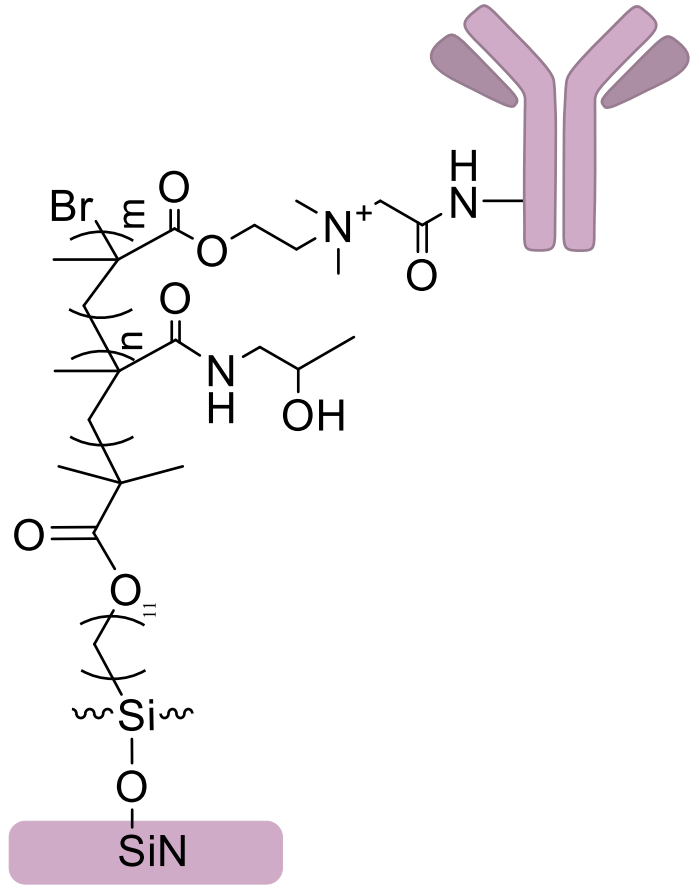
⇒ Potential for multiplex biosensors



Auger mapping of Nitrogen(NH)

Antifouling & Bioactive Properties of Hierarchical Brushes





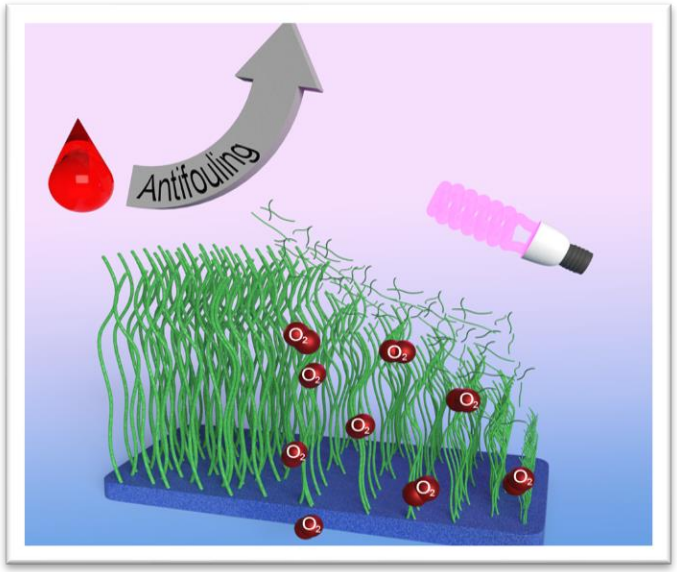
⇒ Efficient & selective antifouling

Kuzmyn, A. R., Nguyen, A. T., Zuilhof, H., & Baggerman, J.
Bioactive Antifouling Surfaces by Visible-Light-Triggered Polymerization.
Advanced Materials Interfaces, (2019), 6(12), 1900351.

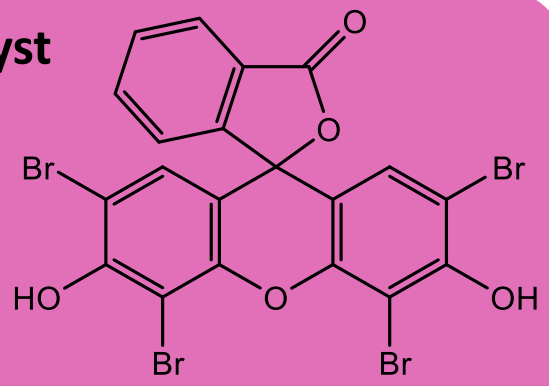
Drawbacks of Traditional Synthesis of Polymer Brushes

Heavy metals

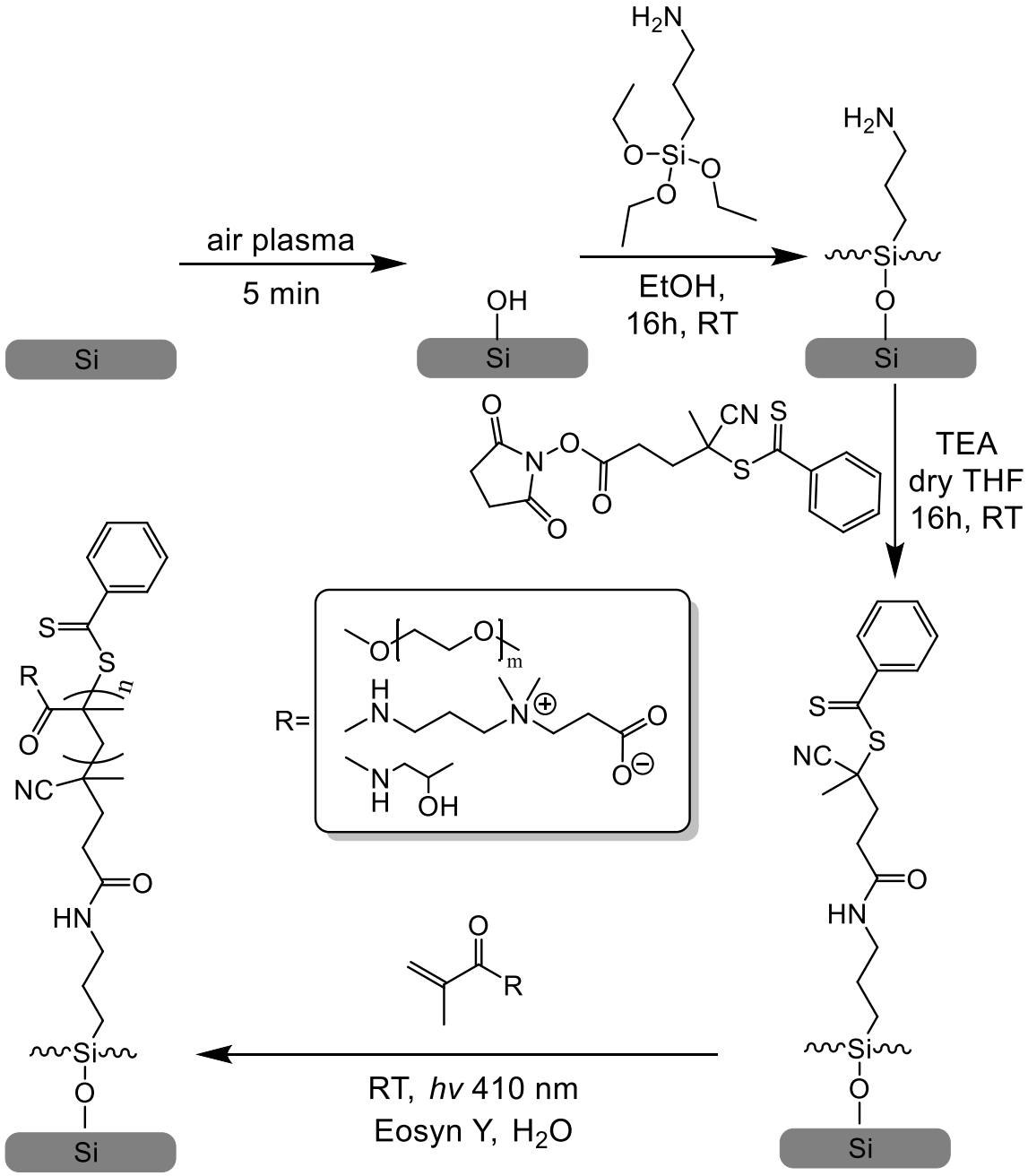
PET-RAFT



Catalyst

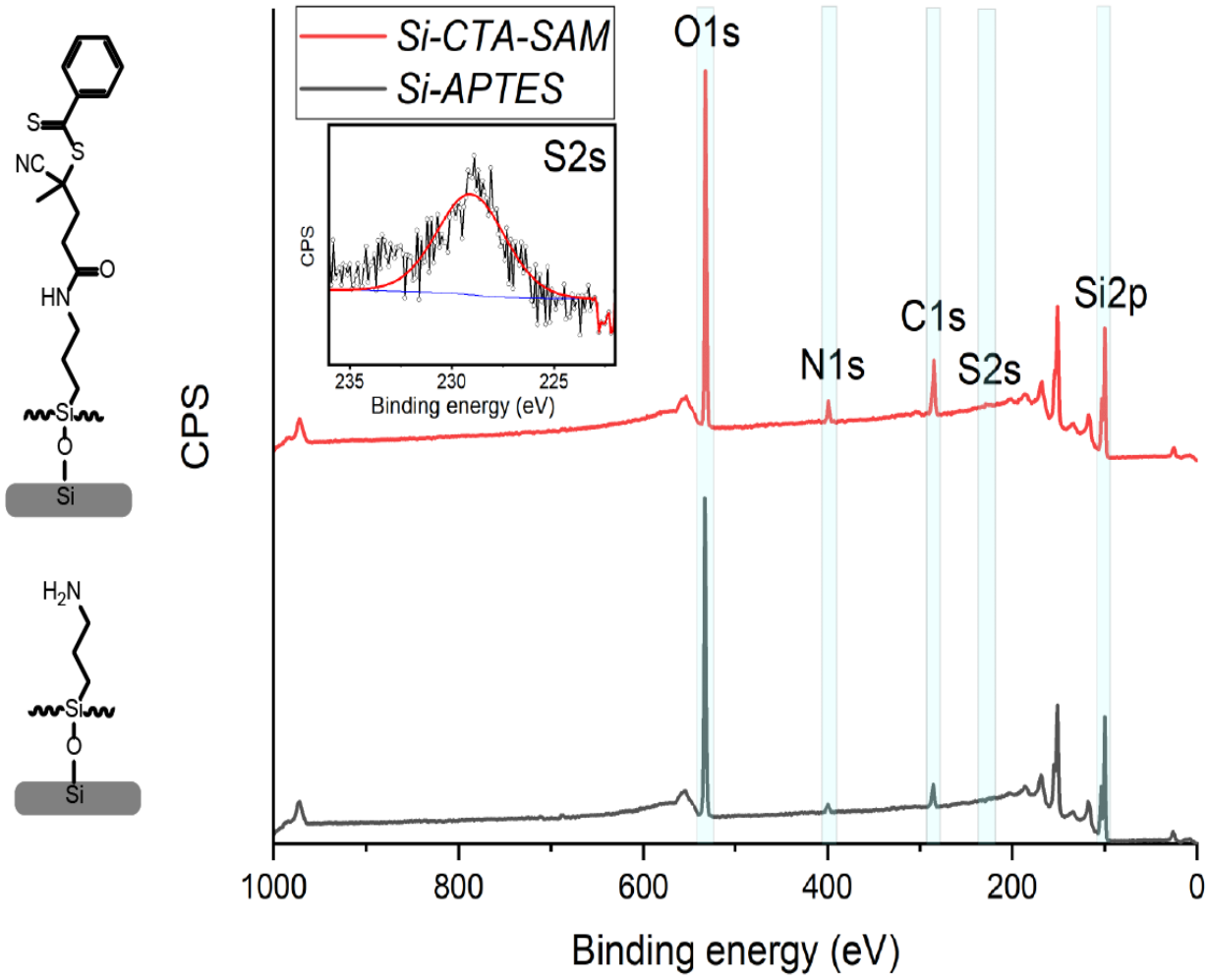


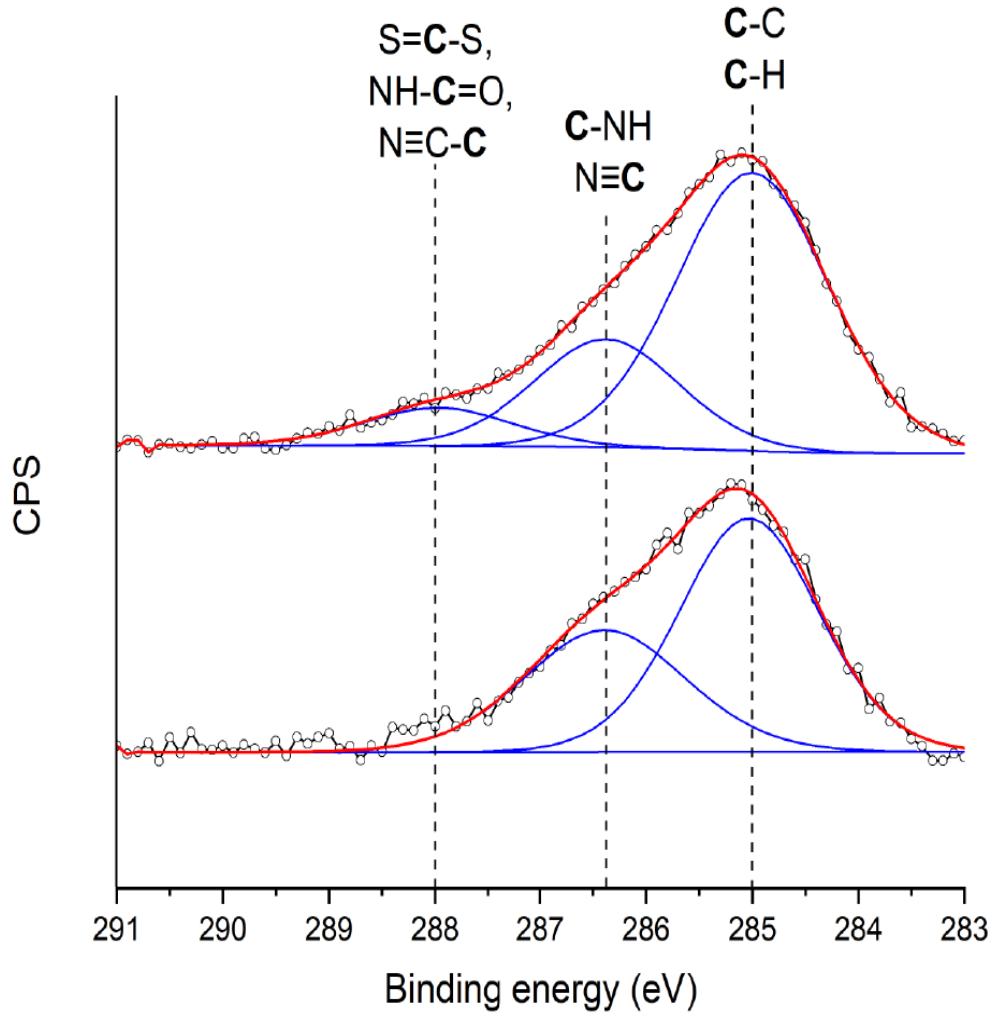
Eosyn Y



Kuzmyn, A. R., Nguyen, A. T., Teunissen, L. W., Zuilhof, H., & Baggerman, J. Antifouling Polymer Brushes via Oxygen-Tolerant Surface-Initiated PET-RAFT. Langmuir, (2020), 36(16), 4439

Immobilization of RAFT-agent





Thickness by XPS

1.1 nm

0.5 nm

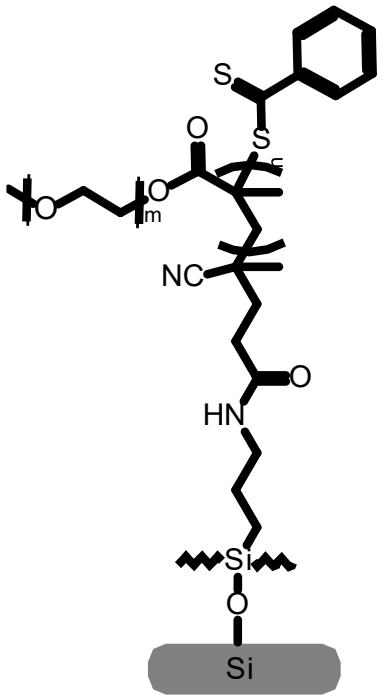
Conversion 29%

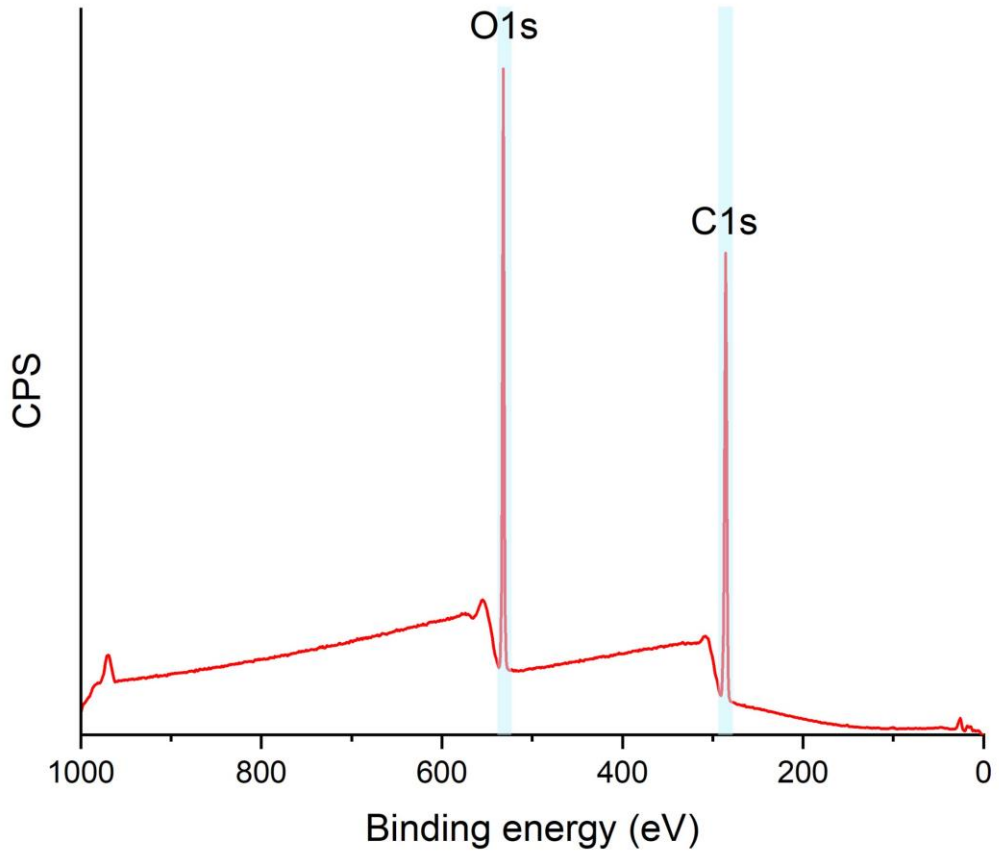
Wide XPS spectra

Narrow C1s region XPS spectra

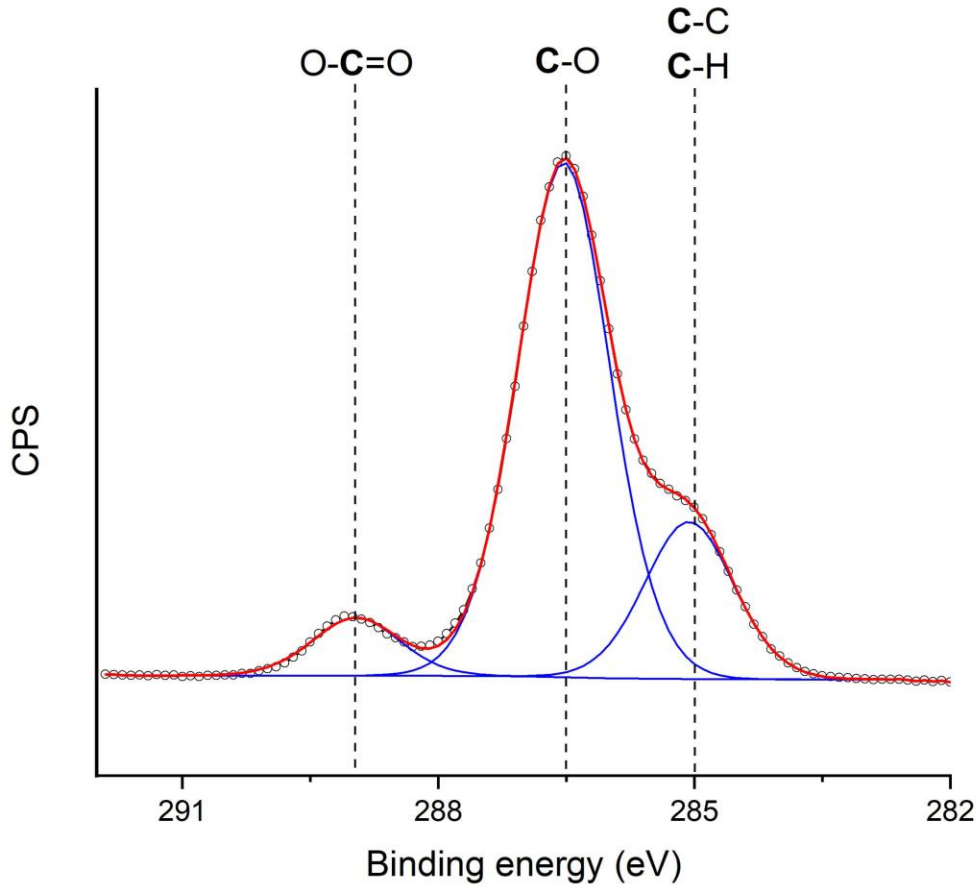
Kuzmyn, A. R., Nguyen, A. T., Teunissen, L. W., Zuilhof, H., & Baggerman, J. Antifouling Polymer Brushes via Oxygen-Tolerant Surface-Initiated PET-RAFT. Langmuir, (2020), 36(16), 4439

Chemical Characterization of Poly(MeOEGMA) Brushes





Wide XPS spectra

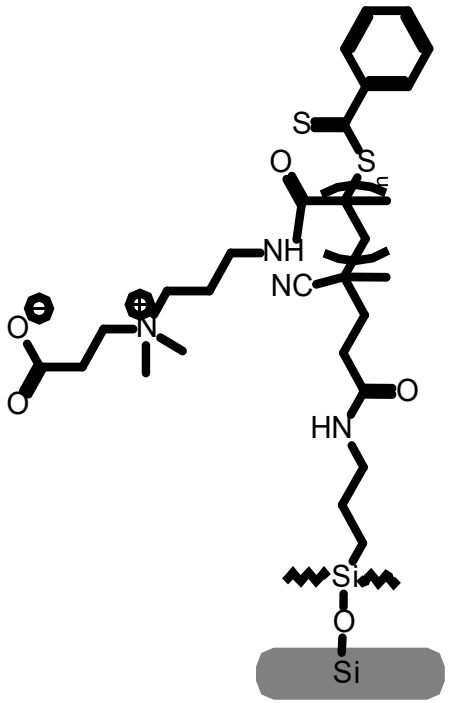


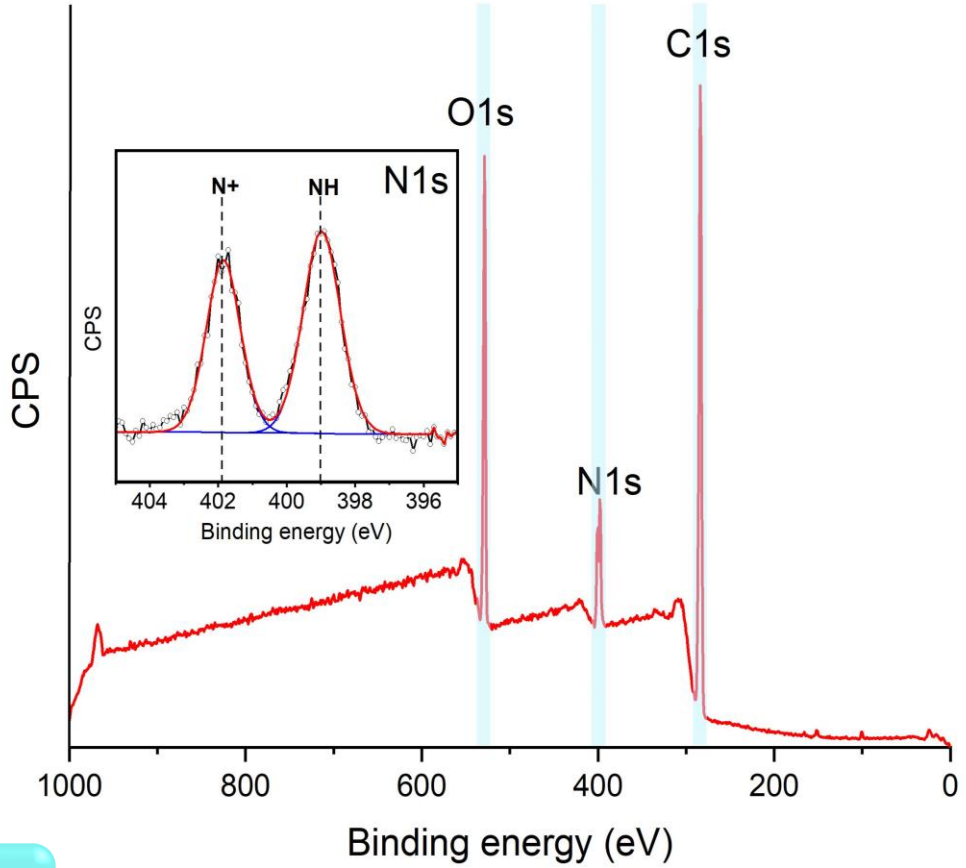
Narrow C1s region XPS spectra

Thickness by ellipsometry : 26 nm

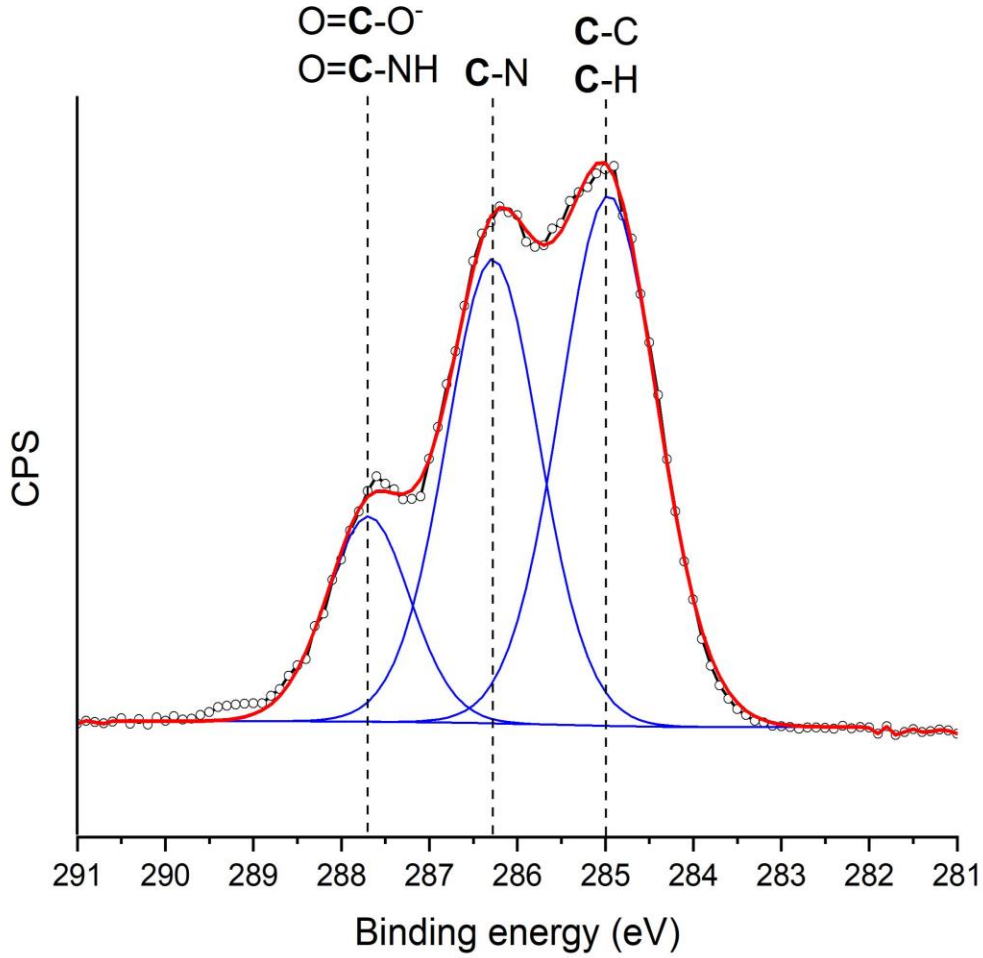
Kuzmyn, A. R., Nguyen, A. T., Teunissen, L. W., Zuilhof, H., & Baggerman, J. Antifouling Polymer Brushes via Oxygen-Tolerant Surface-Initiated PET-RAFT. Langmuir, (2020), 36(16), 4439

Chemical Characterization of Poly(CBMA) Brushes





Wide XPS spectra

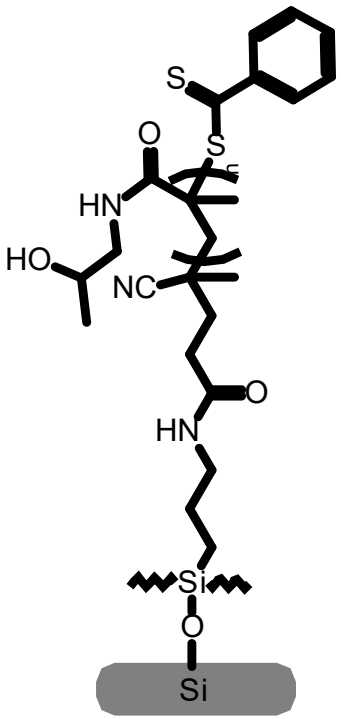


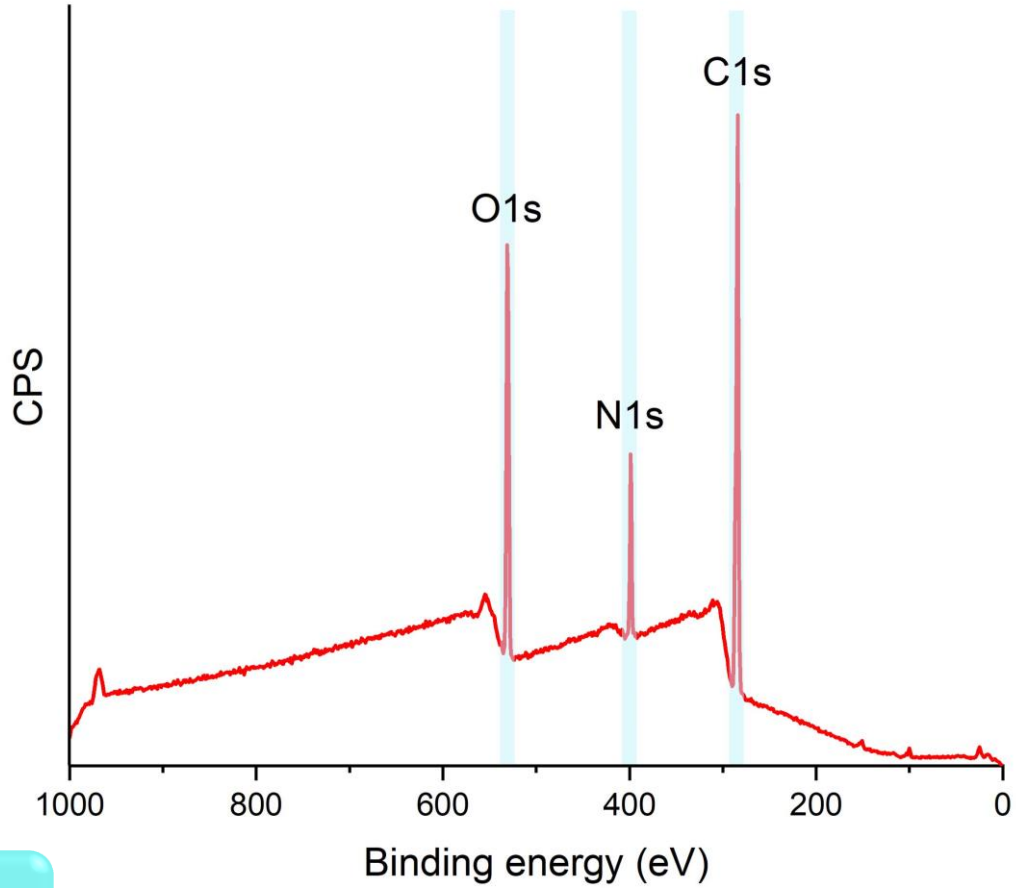
Narrow C1s region XPS spectra

Thickness by ellipsometry : 29 nm

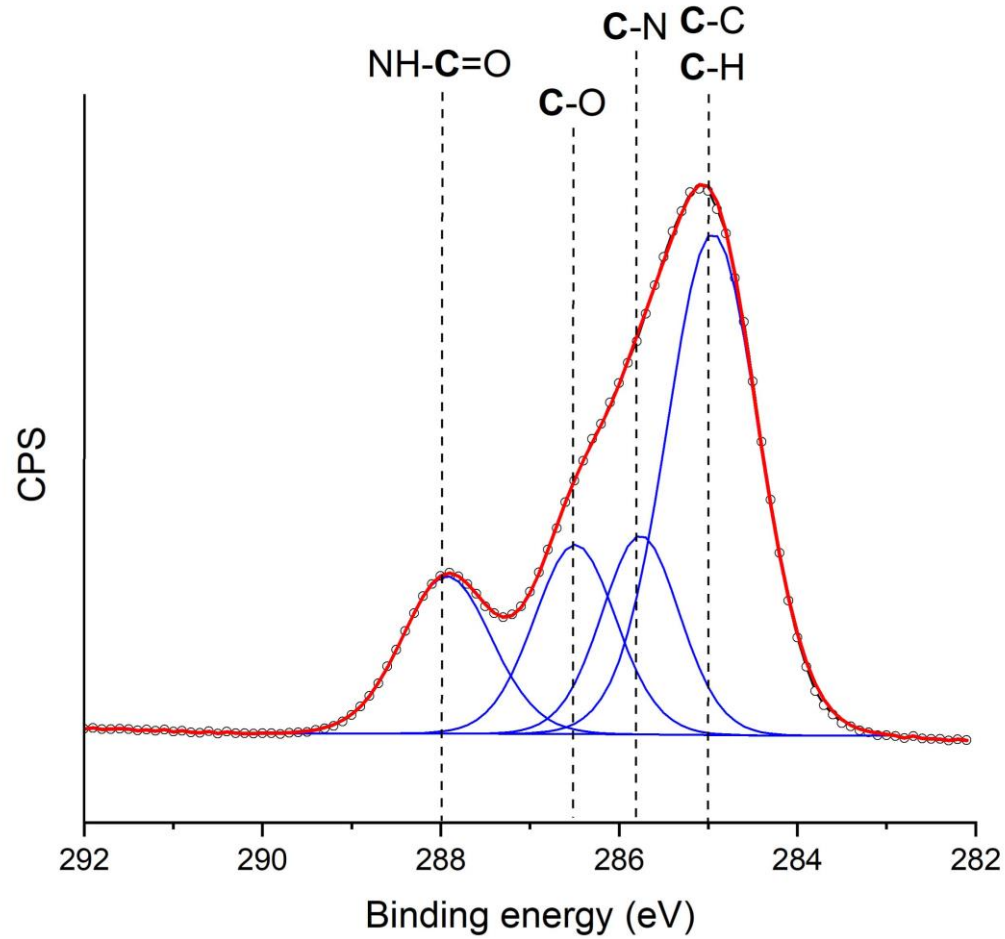
Kuzmyn, A. R., Nguyen, A. T., Teunissen, L. W., Zuilhof, H., & Baggerman, J. Antifouling Polymer Brushes via Oxygen-Tolerant Surface-Initiated PET-RAFT. Langmuir, (2020), 36(16), 4439

Chemical Characterization of Poly(HPMA) Brushes





Wide XPS spectra

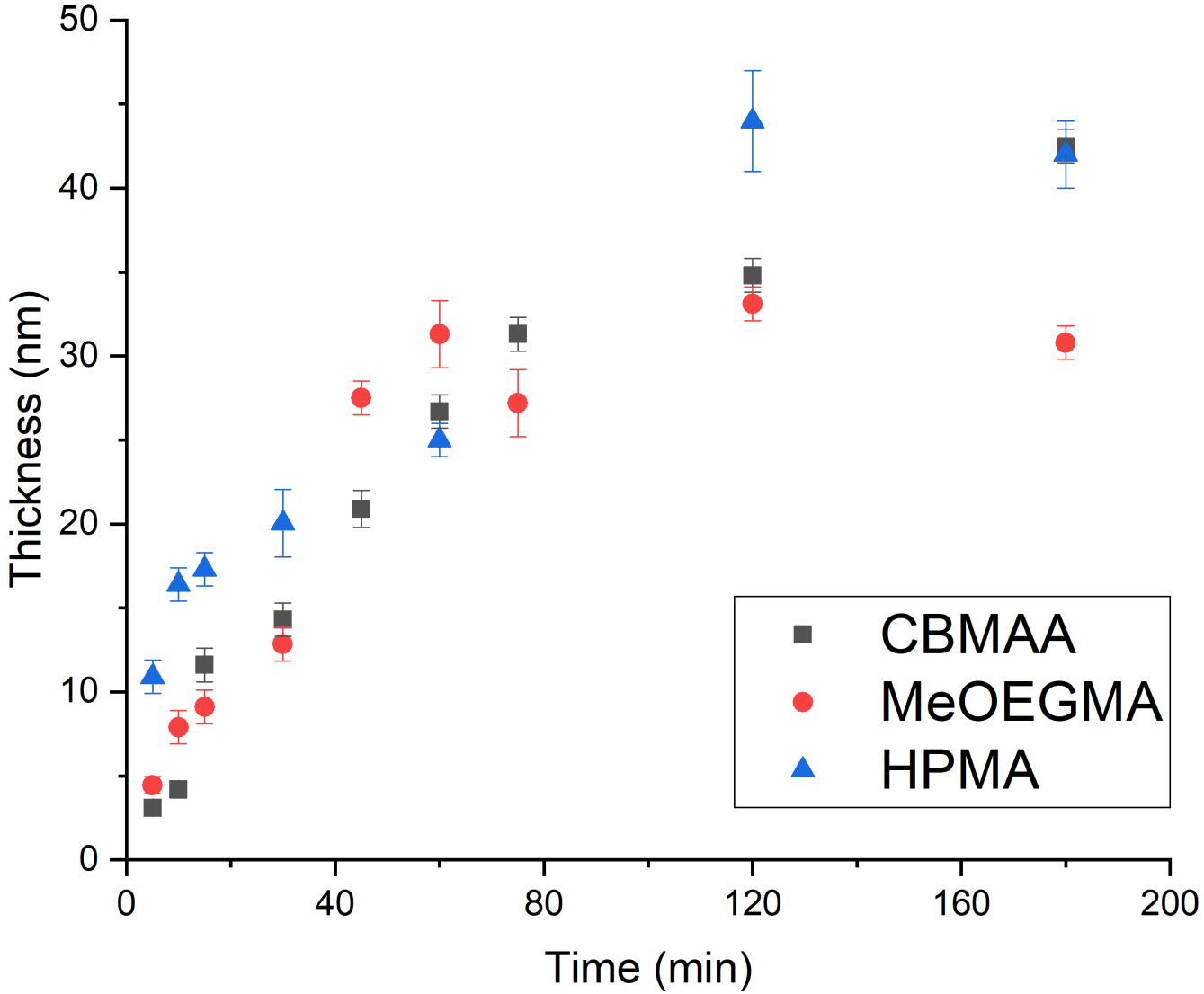


Narrow C1s region XPS spectra

Thickness by ellipsometry : 27 nm

Kuzmyn, A. R., Nguyen, A. T., Teunissen, L. W., Zuilhof, H., & Baggerman, J. Antifouling Polymer Brushes via Oxygen-Tolerant Surface-Initiated PET-RAFT. Langmuir, (2020), 36(16), 4439

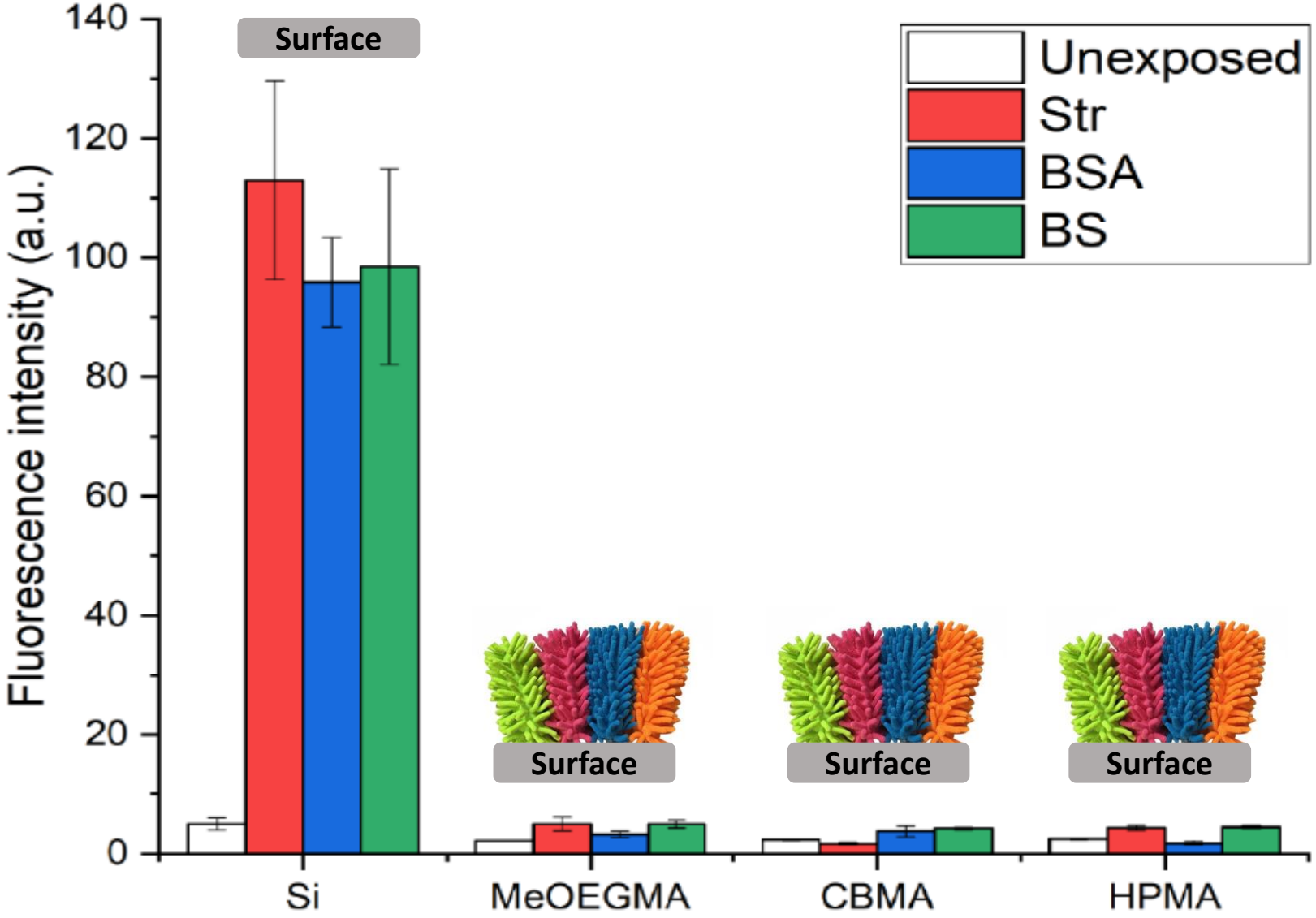
Kinetics of Polymerization



Controlled nature of polymerization

Kuzmyn, A. R., Nguyen, A. T., Teunissen, L. W., Zuilhof, H., & Baggerman, J. Antifouling Polymer Brushes via Oxygen-Tolerant Surface-Initiated PET-RAFT. Langmuir, (2020), 36(16), 4439

Antifouling Properties



Good antifouling properties

Kuzmyn, A. R., Nguyen, A. T., Teunissen, L. W., Zuilhof, H., & Baggerman, J. Antifouling Polymer Brushes via Oxygen-Tolerant Surface-Initiated PET-RAFT. Langmuir, (2020), 36(16), 4439

Summary

Hierarchical diblock polymer brushes using living radical polymerization and iridium-based catalyst:

- antifouling, bioactive & patternable

Simple technique for creation antifouling coating using PET-RAFT:

- Oxygen tolerant
- Does NOT require heavy metals
- Scalable
- Visible light-triggered

Thank you for you attention ! Questions ?

Acknowledgments

Han Zuilhof

Lucas Teunissen *Sidharam Pujari*
Esther van Andel *Barend van Lagen*
Jacob Baggerman *Jan Willem Borst*

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UNIVERSITY & RESEARCH
ORGANIC CHEMISTRY

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