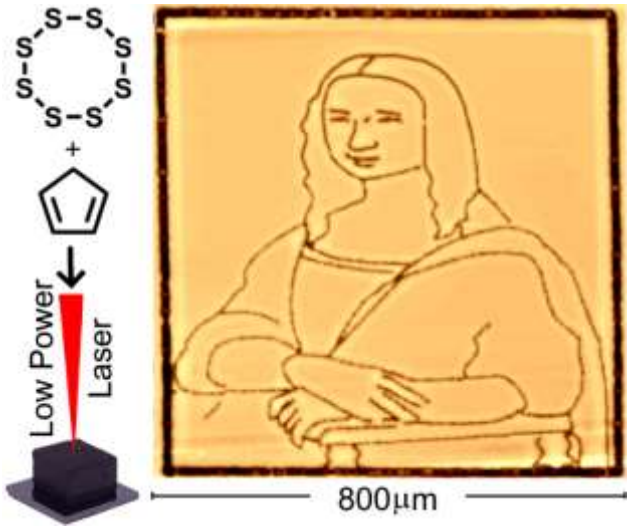
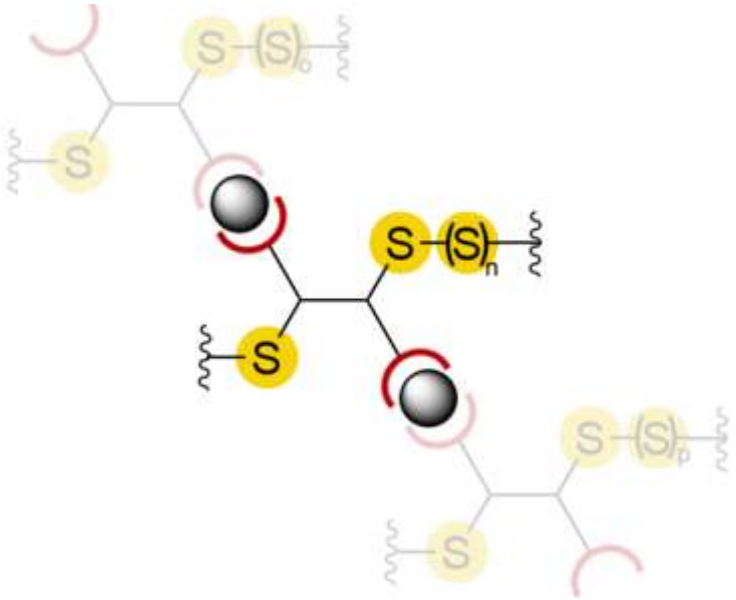
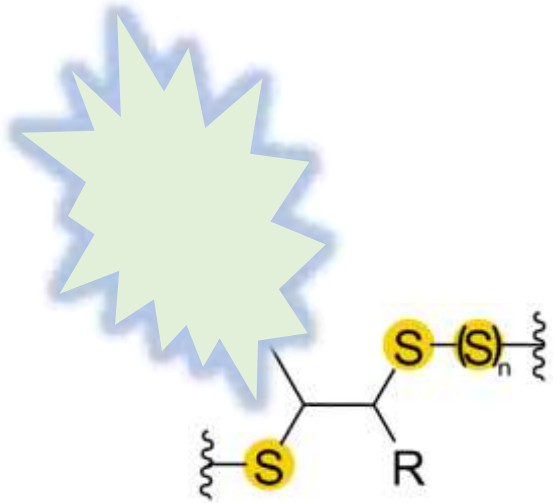
Functionalising Sulfur Polymers



Lithography and Erasable Encoding



Water Solubility and Metal Binding



Fluorescence Imaging

Flinders University

Dr Lynn Lisboa

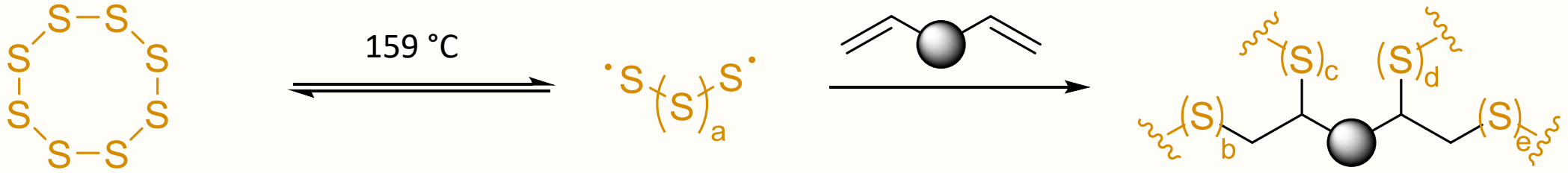
lynn.lisboa@flinders.edu.au

Supervisor: Justin Chalker

South Australia

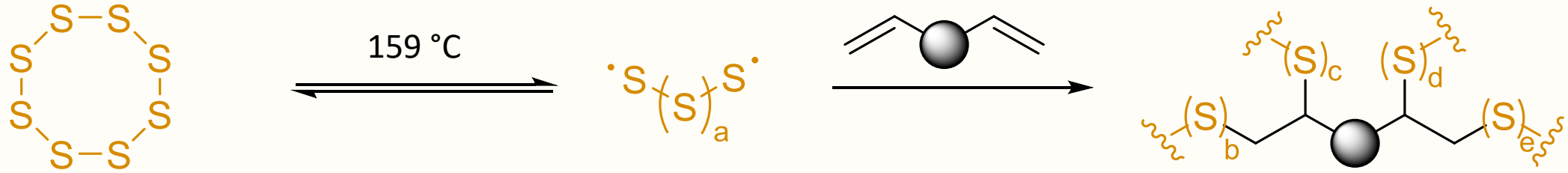
Institute for Nanoscale Science & Technology

Inverse Vulcanisation

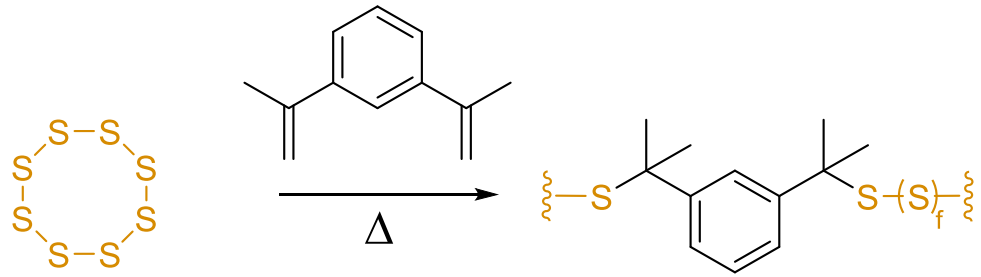


Sung Y-E., Char K., Pyun J., et al., *Nat. Chem.* **2013**, *5, 518-524*

Inverse Vulcanisation



Sung Y-E., Char K., Pyun J., et al., *Nat. Chem.* **2013**, *5, 518-524*



Pyun J., et al. *J. Am. Chem. Soc.* **2023**, *145*, 12386-12397

Li-S Batteries

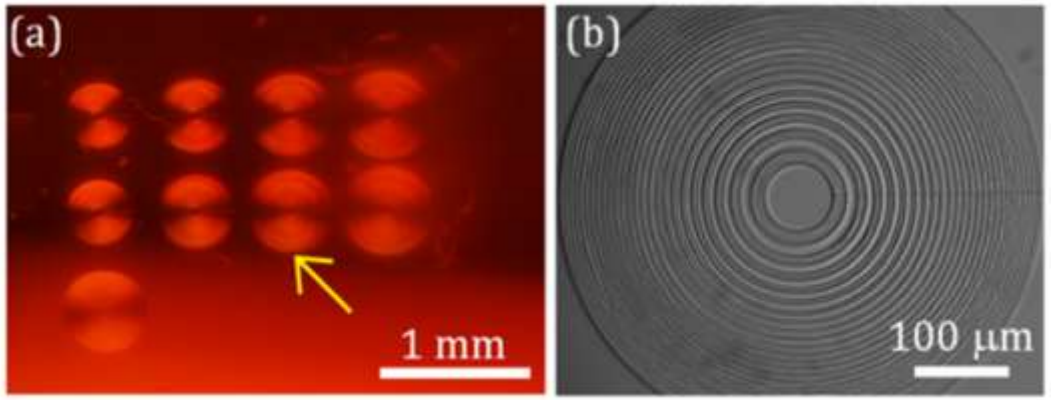
Pyun J., et al. *ACS Macro Lett.* **2014**, *3*, 229-232

IR Optics

Pyun J., et al. *Adv. Mater.* **2014**, *26*, 3014-3018

Dynamic Repairable Materials

Pyun J., et al. *ACS Macro Lett.* **2015**, *4*, 862-866

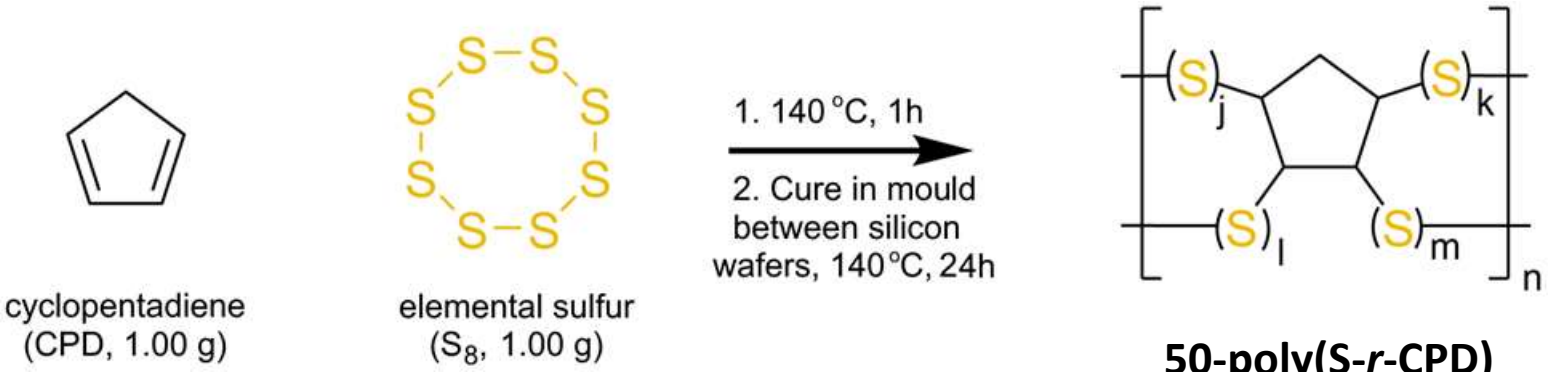


High-powered pulsed laser etching

Zhao J., et al. *Opt. Lett.* **2023**, *48*, 1056-1059

Zhao J., et al. *Opt. Mater. Express* **2022**, *12*, 2541-2549

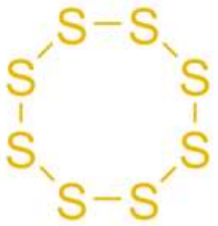
Lithography and Information Encoding



Chalker J. M., et al. *Adv. Optical Mater.* **2023**, *11*, 2300058
Chalker J. M., et al. *Polym. Chem.* **2022**, *18*, 1320-1327

Lithography and Information Encoding

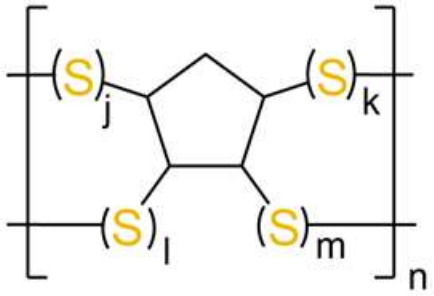
cyclopentadiene
(CPD, 1.00 g)



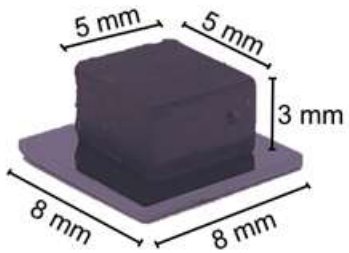
elemental sulfur
(S_8, 1.00 g)

1. 140 °C, 1h

2. Cure in mould between silicon wafers, 140 °C, 24h



50-poly(S-*r*-CPD)



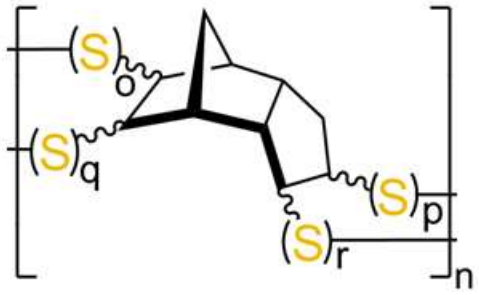
T_g = ~40 °C
R_a = 109 nm ± 5 nm

dicyclopentadiene
(DCPD, 1.00 g)

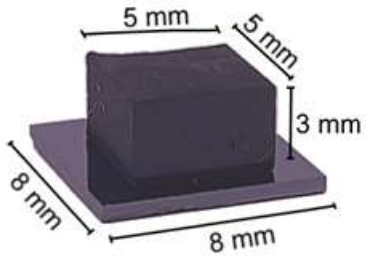
elemental sulfur
(S_8, 1.00 g)

1. 140 °C, 2h

2. Cure in mould between silicon wafers, 140 °C, 24h



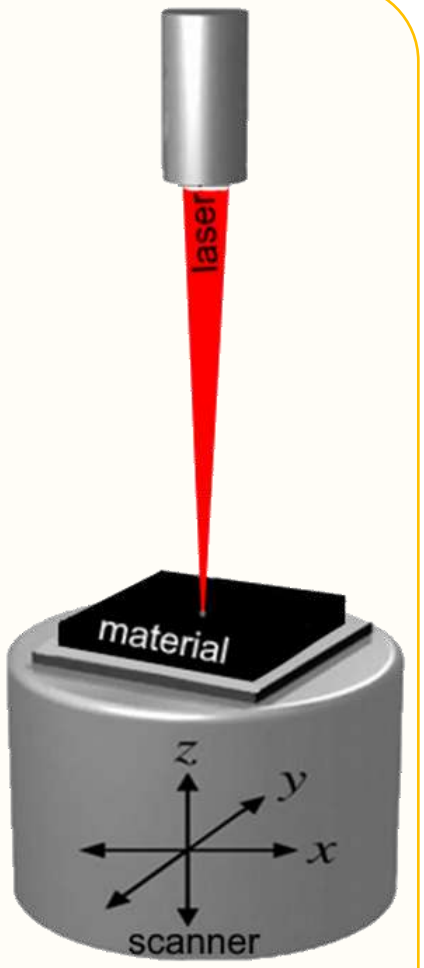
50-poly(S-*r*-DCPD)



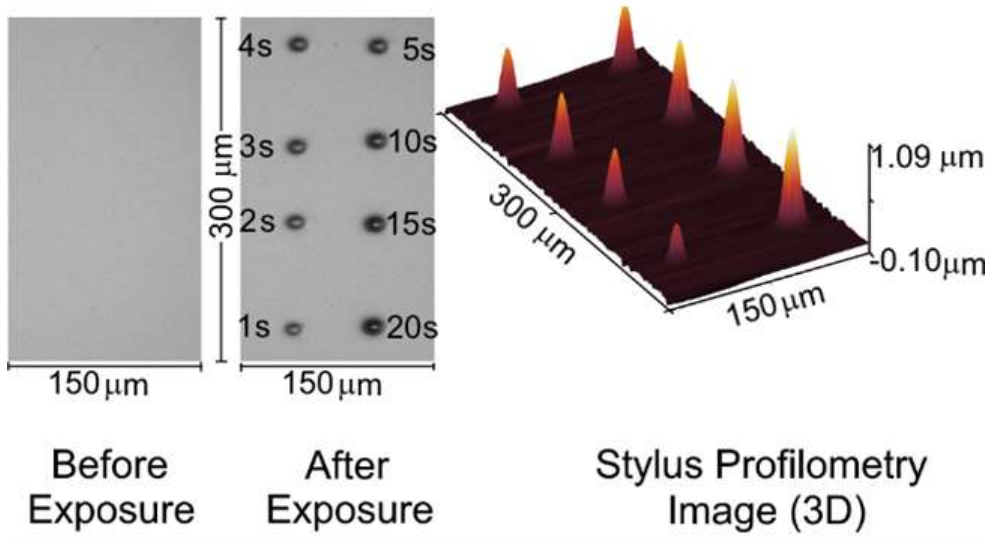
T_g = >100 °C
R_a = 109 nm ± 1 nm

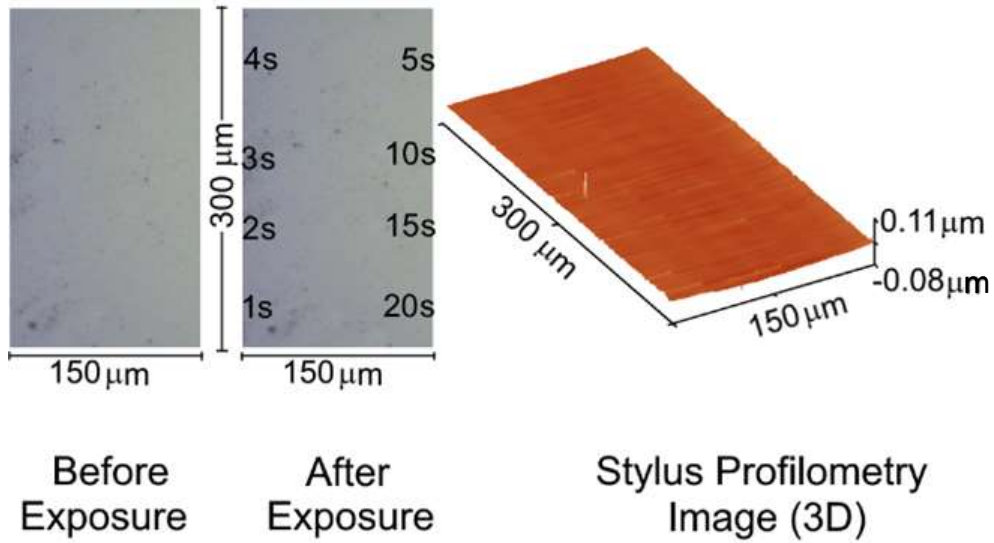
Chalker J. M., et al. *Adv. Optical Mater.* **2023**, *11*, 2300058
Chalker J. M., et al. *Polym. Chem.* **2022**, *18*, 1320-1327

Lithography and Information Encoding

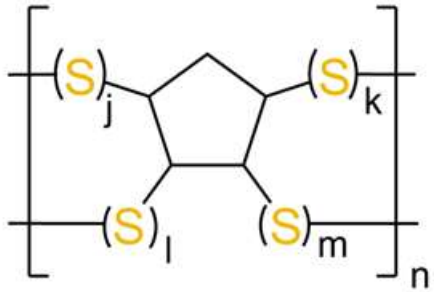


690 nm, 1.10 mW,
1.4 kW/cm^2
Low Power Laser

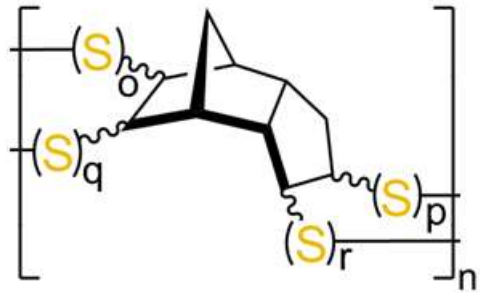




50-poly(S-*r*-CPD)

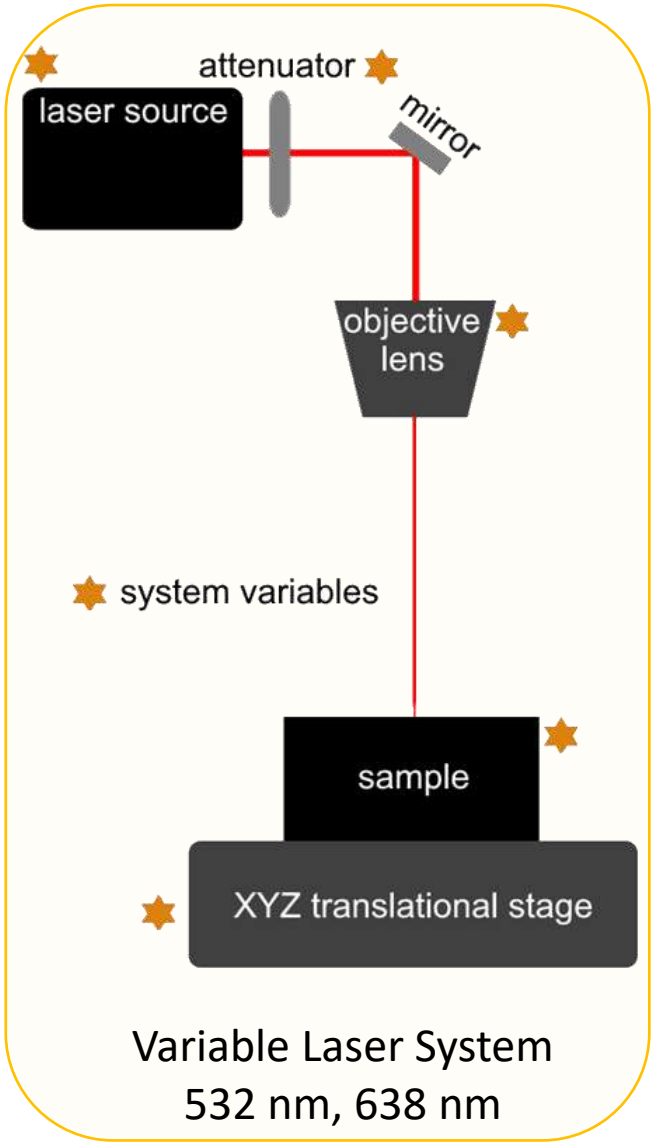


50-poly(S-*r*-DCPD)

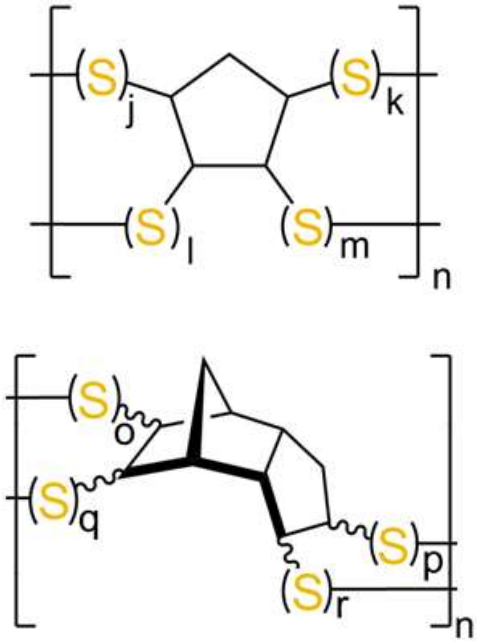


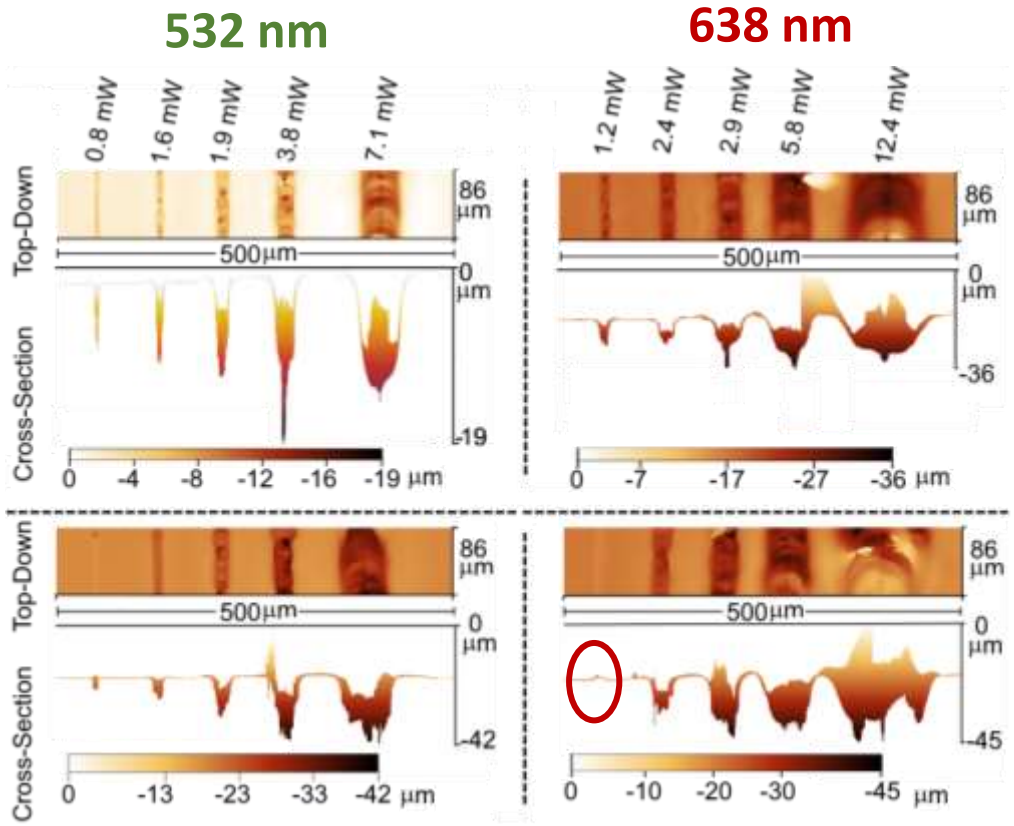
Mann A., **Lisboa, L. S.,** Tonkin S., Gascooke J., Chalker J. M., Gibson C., *ChemRxiv.* **2023** doi: 10.26434/chemrxiv-2023-v23n6

Lithography and Information Encoding



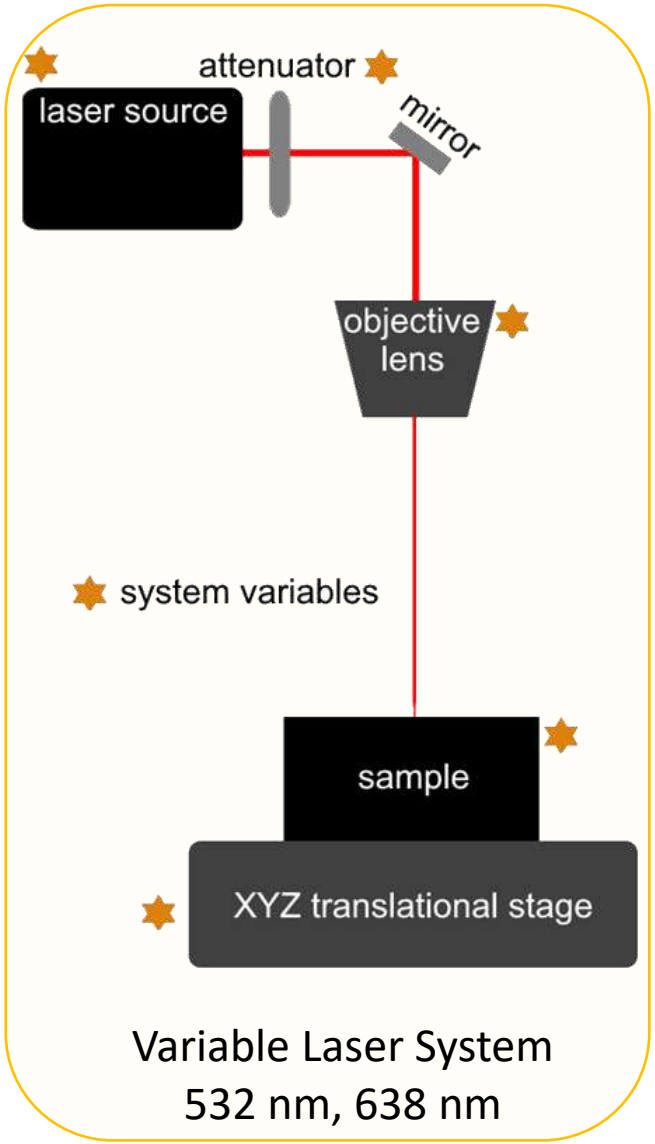
Variable Laser System
532 nm, 638 nm



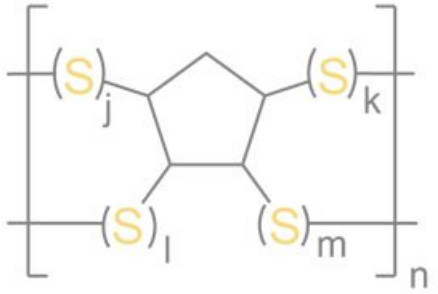


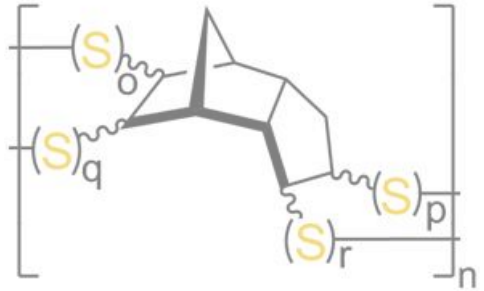
Optical Profilometry

Lithography and Information Encoding



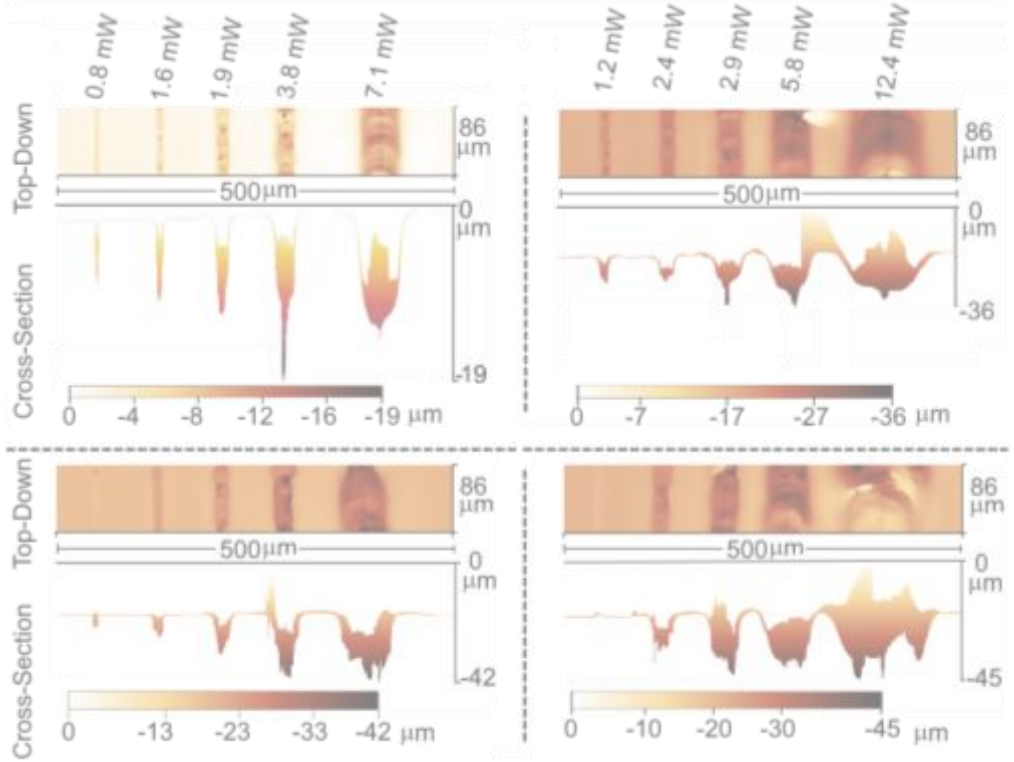
Variable Laser System
532 nm, 638 nm

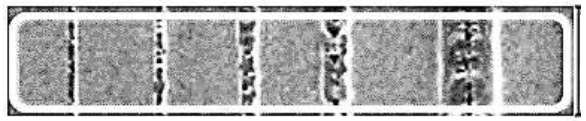




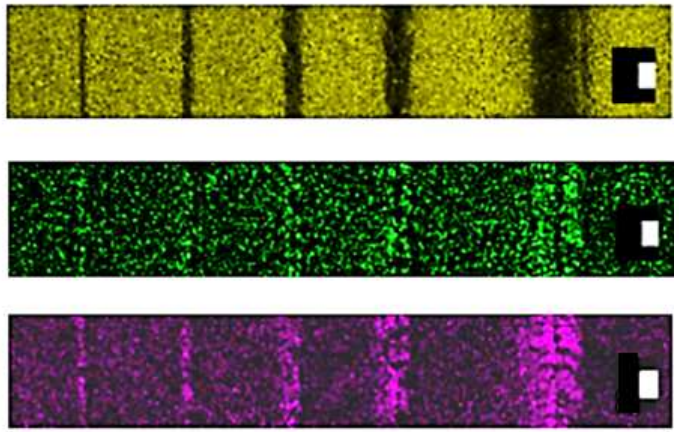
532 nm

638 nm





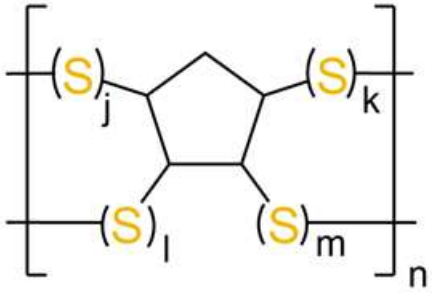
100µm
SEM



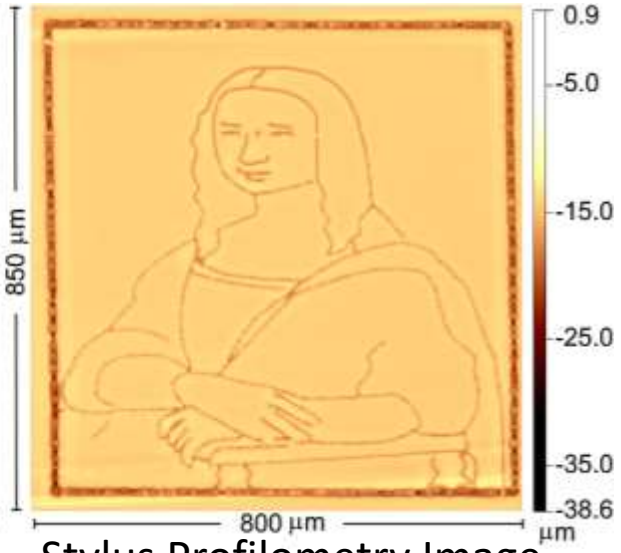
Lithography and Information Encoding

Programmable lithography – Micro-lisa

Reference Image

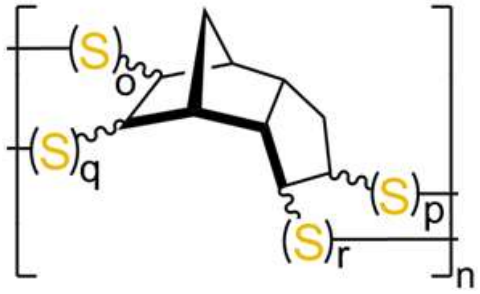


Optical Image



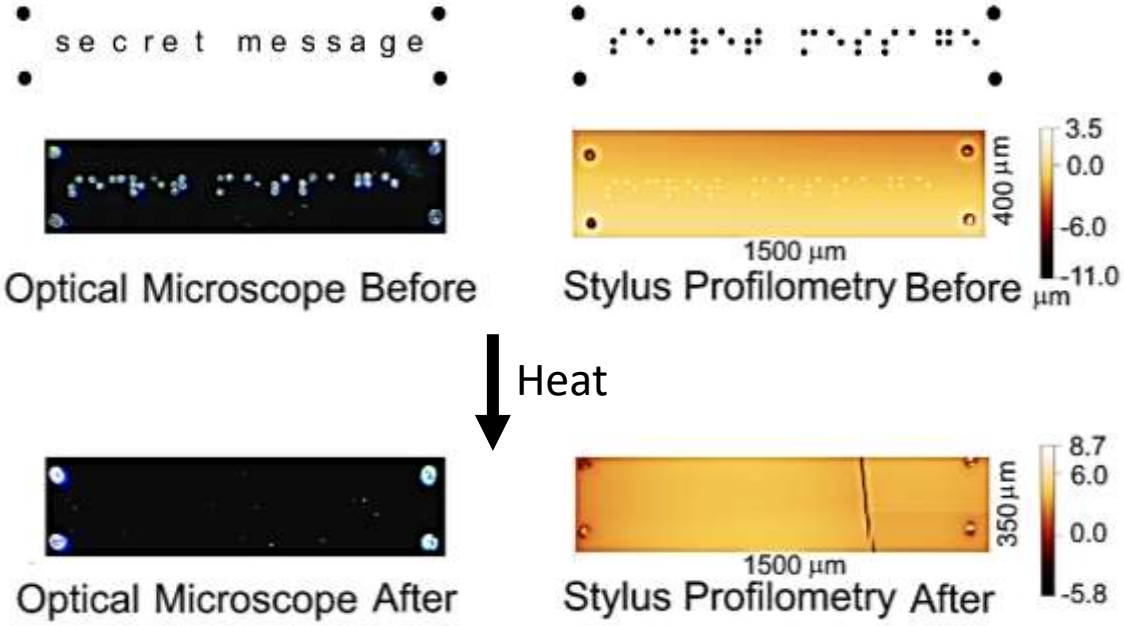
Stylus Profilometry Image

Erasable information encoding



Text

Braille



Optical Microscope Before

Stylus Profilometry Before

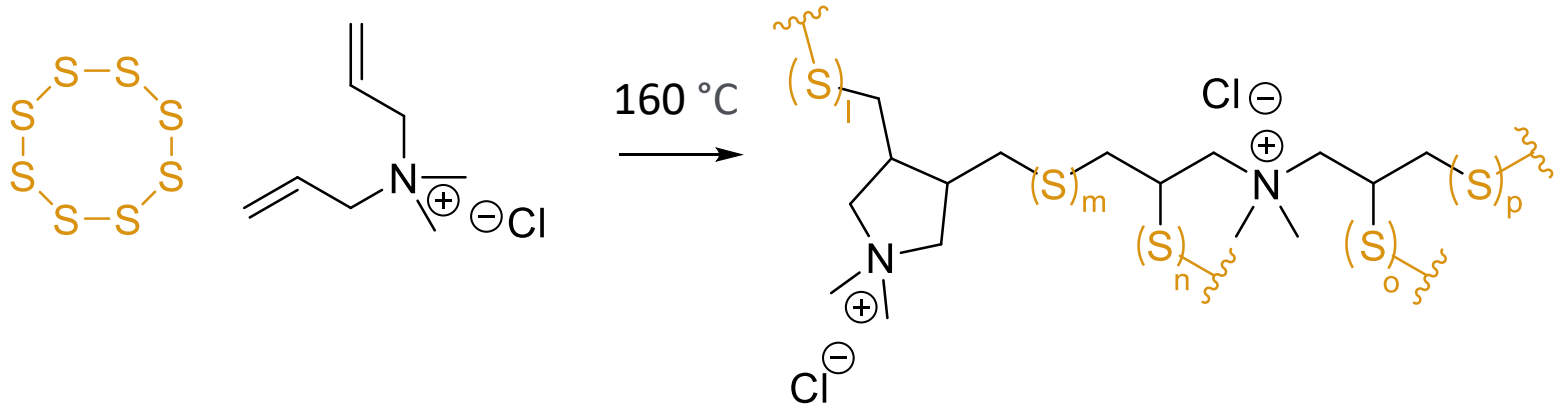
Optical Microscope After

Stylus Profilometry After

Mann A., **Lisboa, L. S.,** Tonkin S., Gascooke J., Chalker J. M., Gibson C., *ChemRxiv.* **2023** doi: 10.26434/ chemrxiv-2023-v23n6

Water Solubility and Metal Binding

Water Solubility and Metal Binding



Water Soluble

Jenkins, C. L., et al. *ACS Appl. Polym. Mater.* **2022**, *13, 2782-2790*

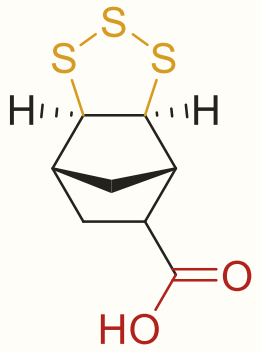
Polymer made with sulfur and canola oil

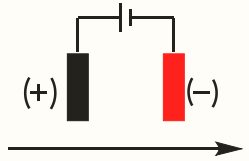
Metal binding – Hg, Au, Pb, Ag

Chalker J. M., et al. *Chem. Eur. J.* **2017**, 23, 16219

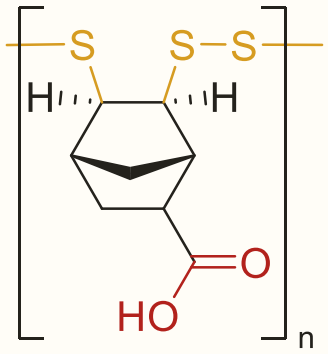
Muller F. G., **Lisboa L. S.,** Chalker J. M., et al. *Adv. Sustainable Syst.* **2023,** 23, 2300010

Water Solubility and Metal Binding



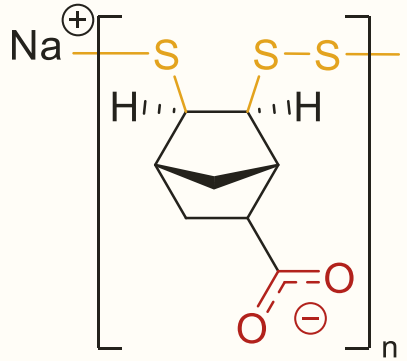


Anode: glassy carbon
Cathode: glassy carbon
nBu$_4$NPF$_6$ (0.1 M)
CH$_3$CN, rt, 4 h
E = -2.0 V vs. Ag/AgCl
Undivided cell



Polymer

NaOH



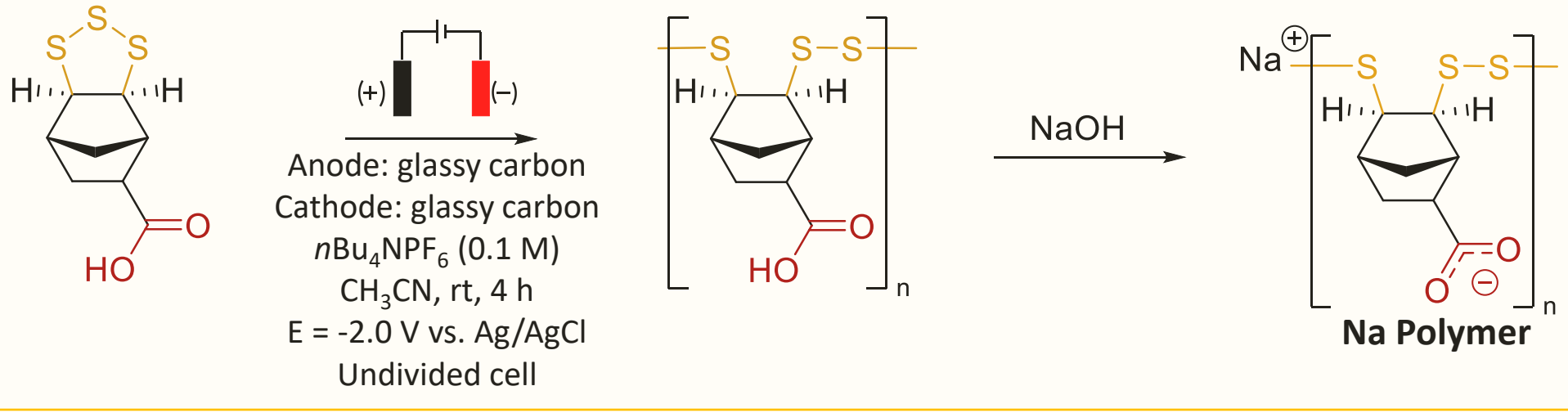
Na Polymer

Polymer in Water
Insoluble

Na Polymer in Water
Soluble

Pople J. M. M., Nicholls T. P., Pham L. P., Bloch W. M., **Lisboa, L. S.,** Perkins M. V., Gibson C., Coote M. L., Jia. Z., Chalker J. M., *J. Am. Chem. Soc.* **2023**, *145*, 11798 - 11810

Water Solubility and Metal Binding

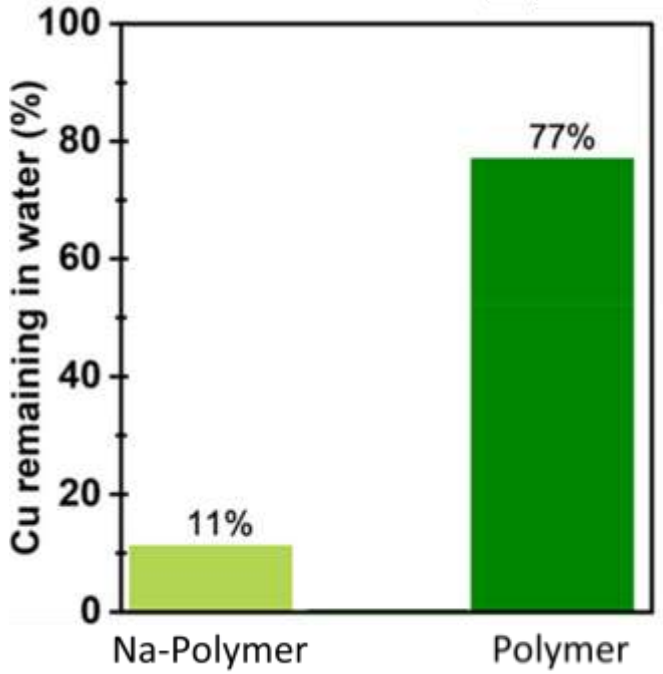


Copper Binding – 0.5:1 Cu^{2+}/COO^-

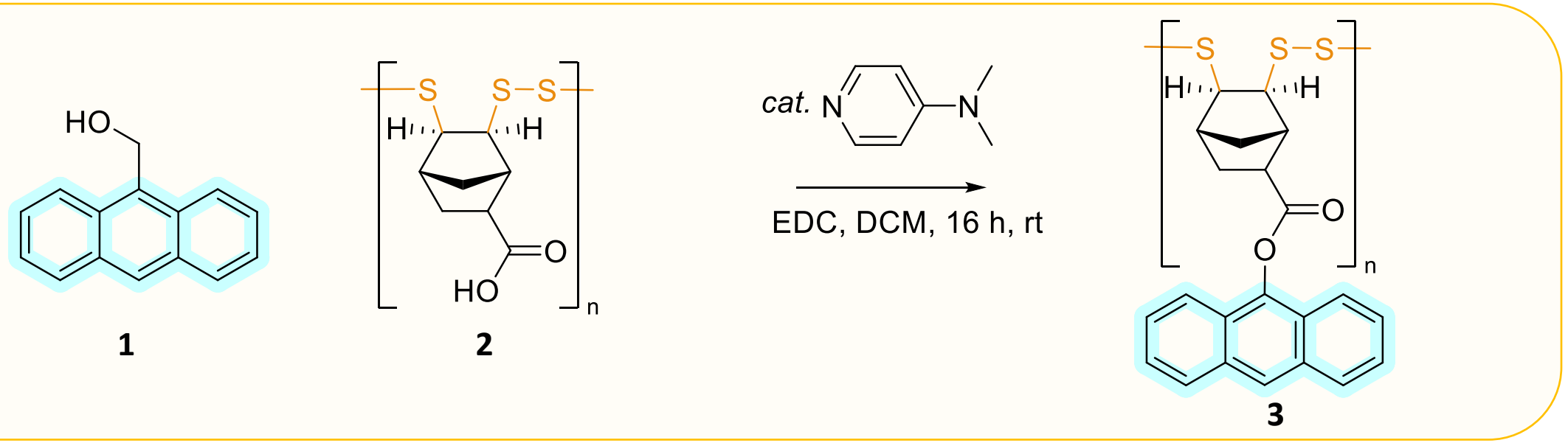
NaPolymer in Water

$CuSO_4$

centrifuge

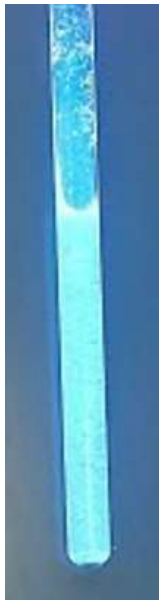


Ongoing work



Fluorescent polymers for biological imaging

- Quantify the number of fluorescent groups on the polymer
- Make a water-soluble fluorescent polymer
- Biological testing



365 nm, $CHCl_3$

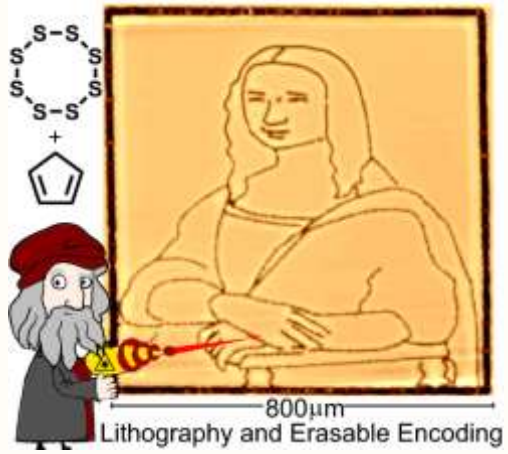
Acknowledgements

Prof Justin Chalker
Dr Christopher Gibson
Dr Jason Gascooke

Abigail Mann
Samuel Tonkin
Federico Müller
Jasmine Pople
Dr Harshal Patel
Dr Yanlin Shi

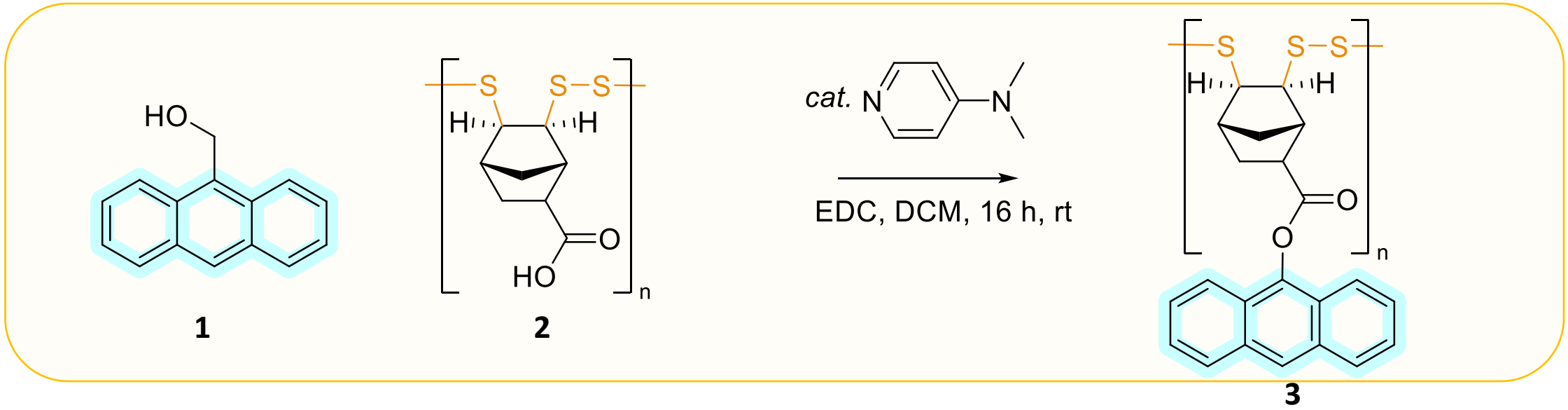
The Chalker Group

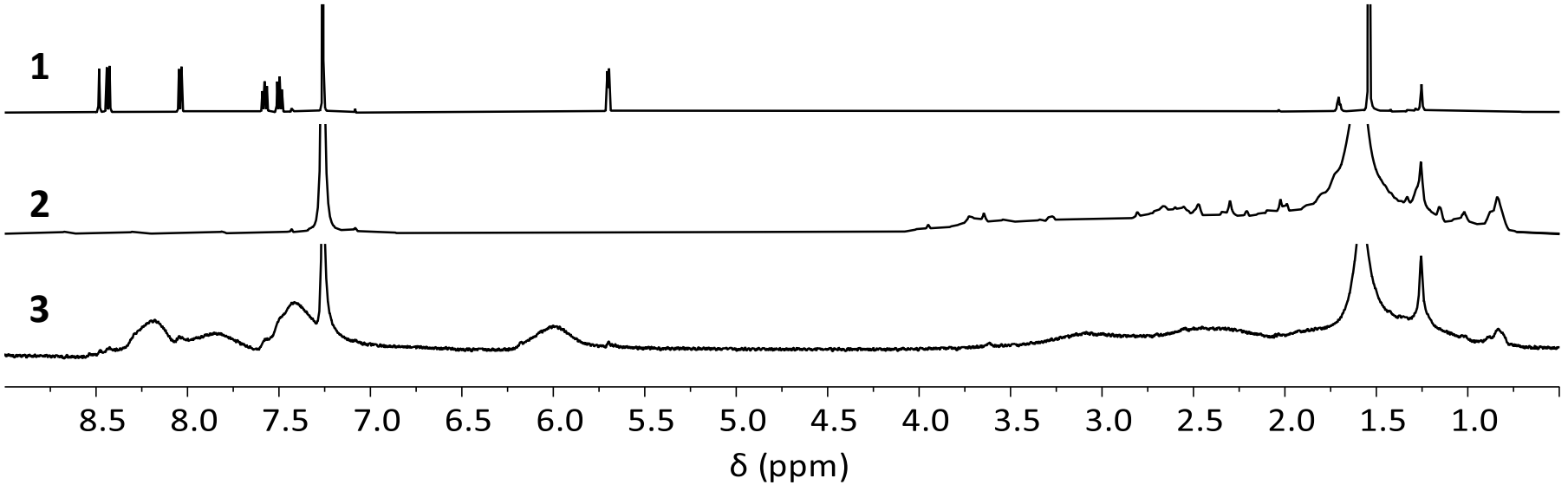
Modification of Polysulfide Surfaces with Low-Power Lasers



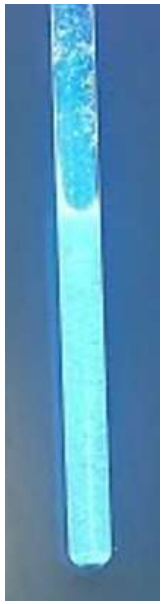
Coming Soon!

Fluorescent Sulfur Polymers



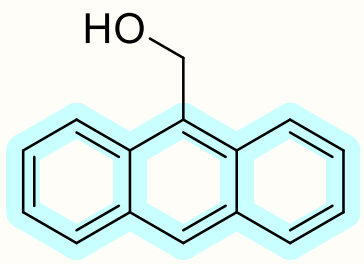


Partial stacked ^{1}H NMR ($CDCl_3$, 298 K 600 MHz)

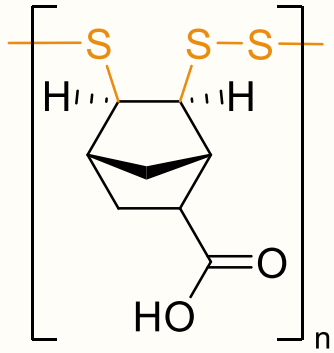


365 nm, $CHCl_3$

Fluorescent Sulfur Polymers



1



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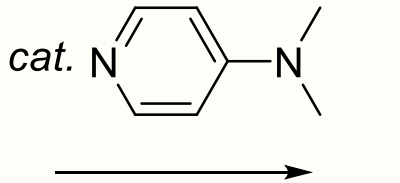
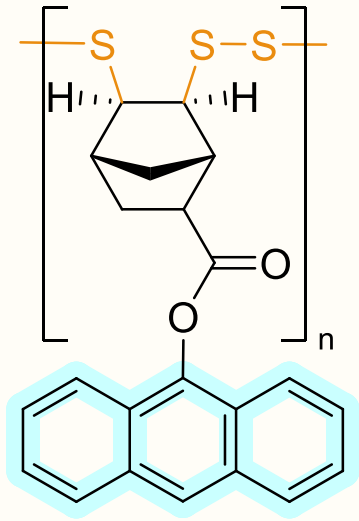


EDC, DCM, 16 h, rt



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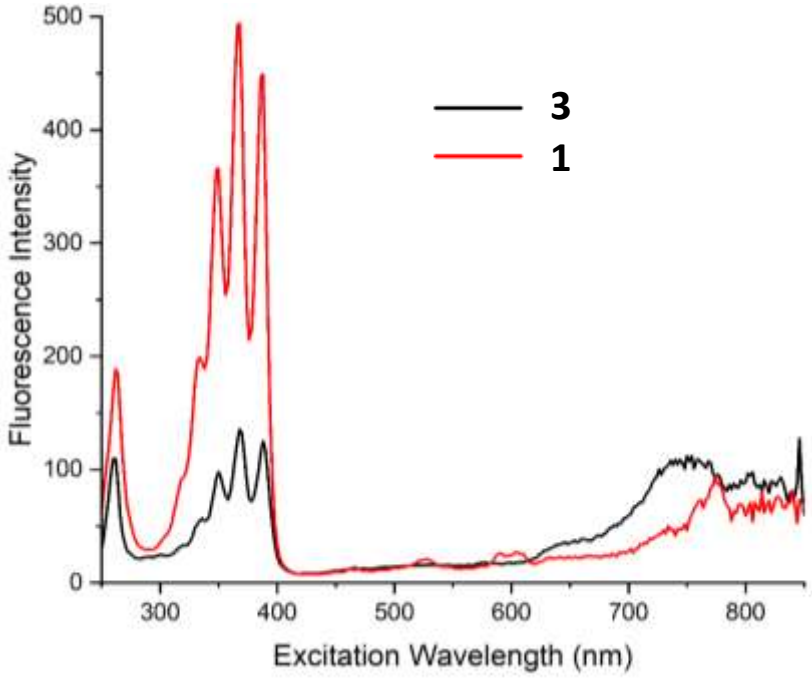

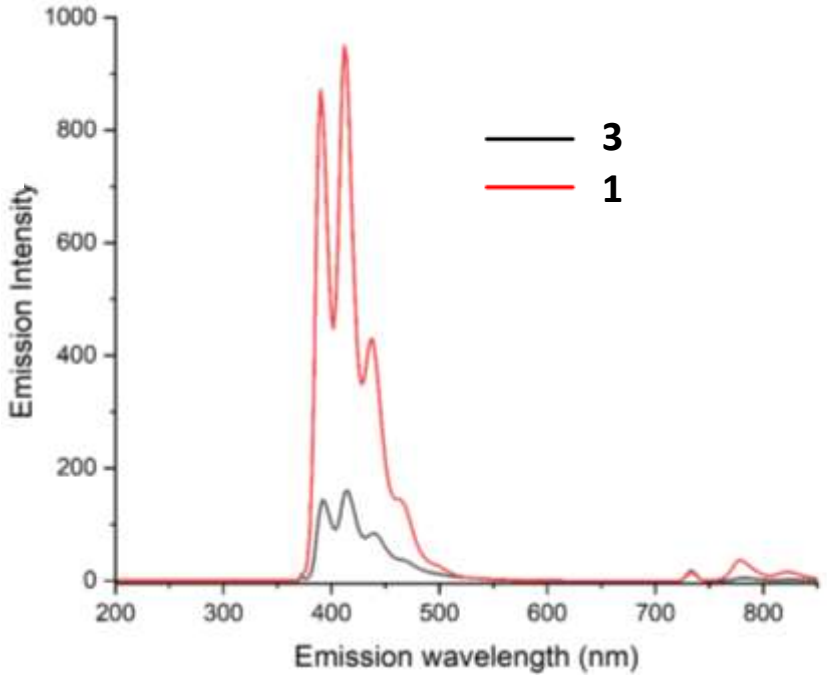

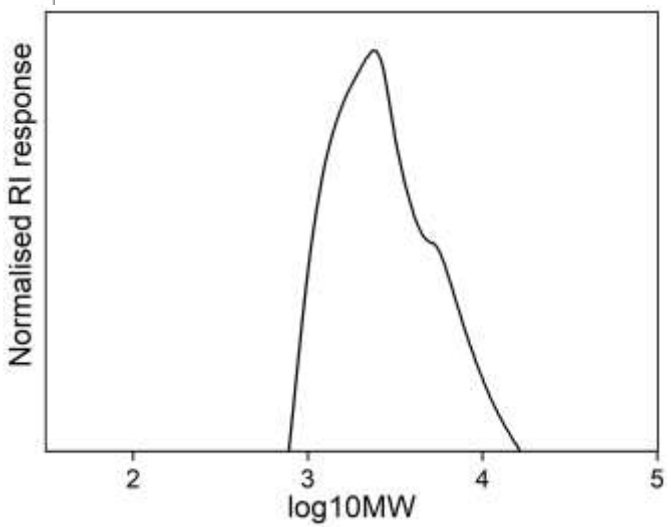

GPC trace

Average MW = 8078

Đ = 3.12