

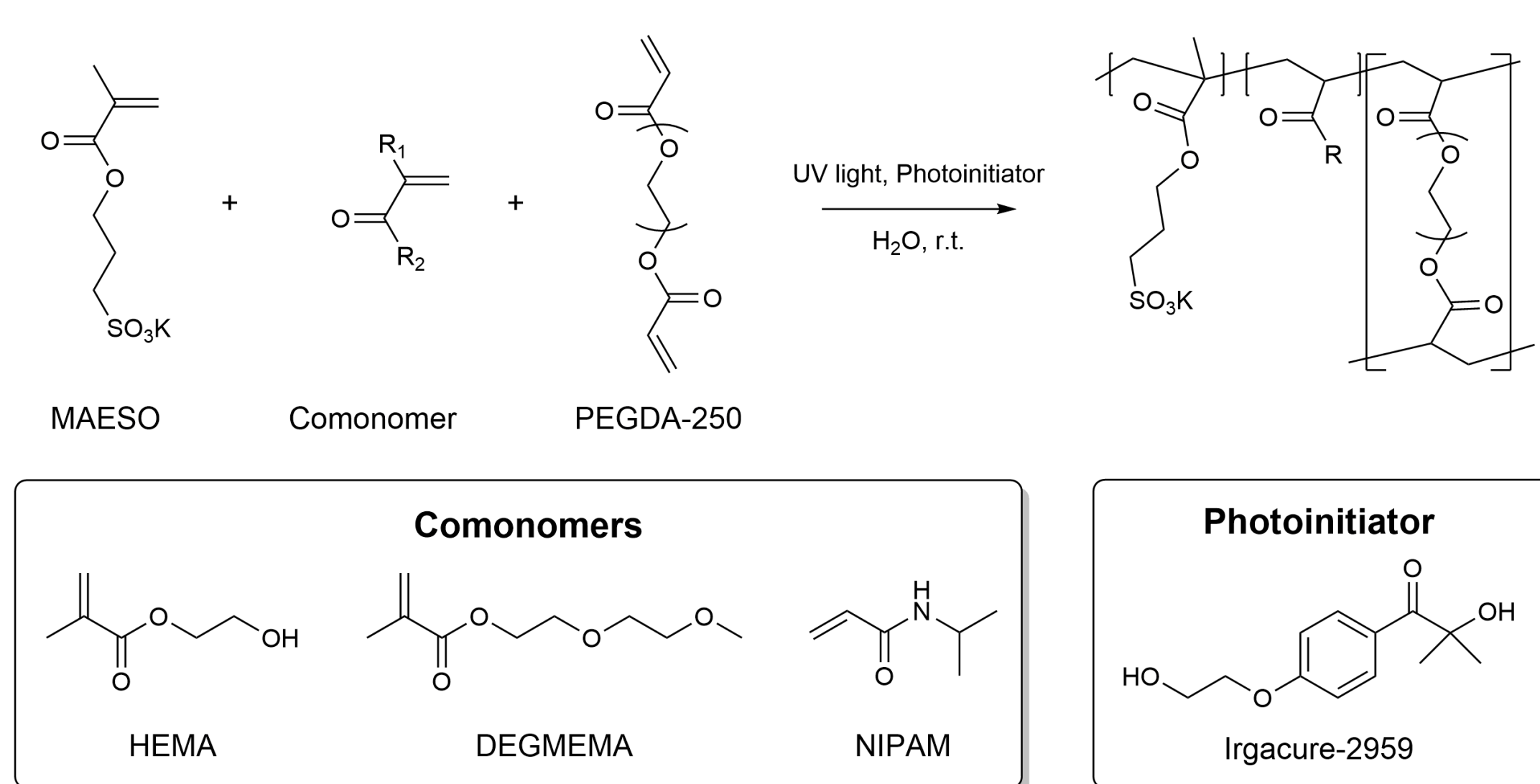
Preparation and Characterisation of Immobilised Hydrogels as Sensor Materials

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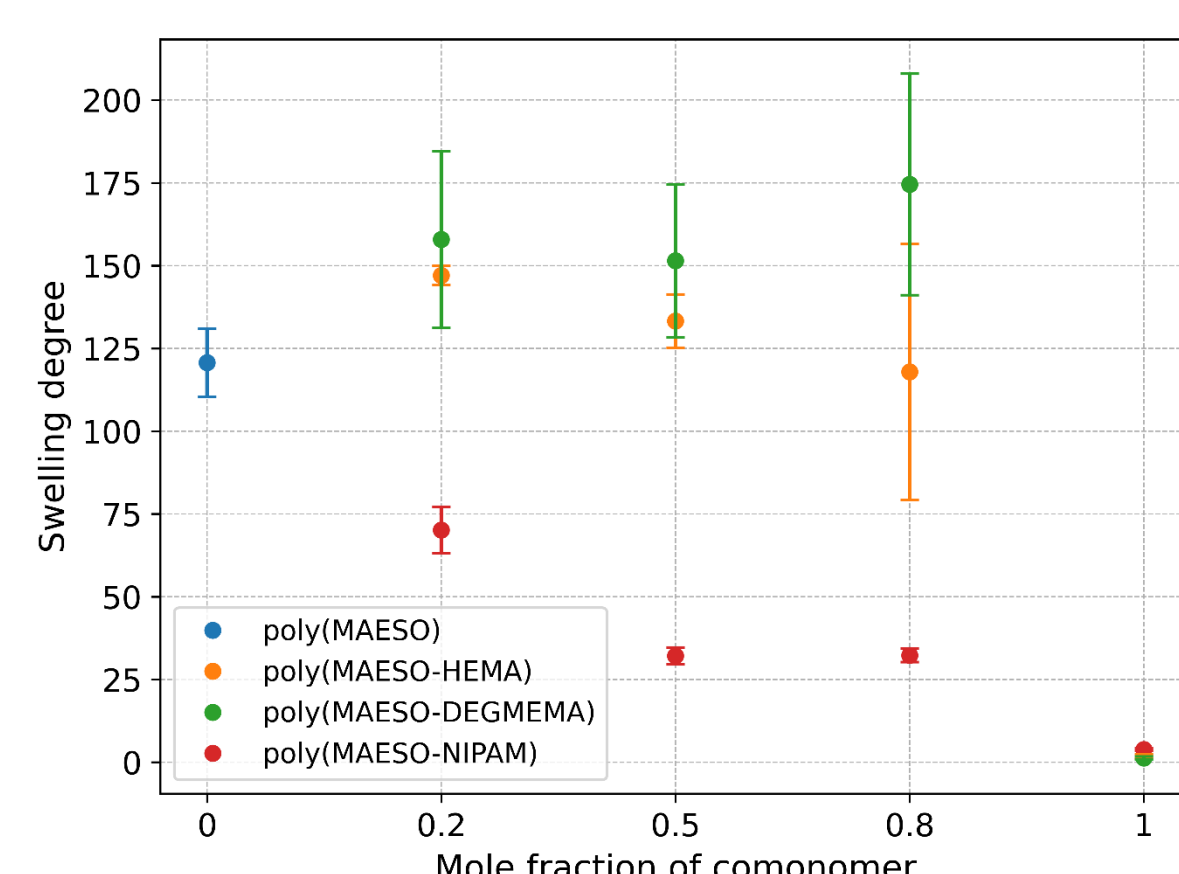
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Copolymeric Hydrogels



Swelling in Water



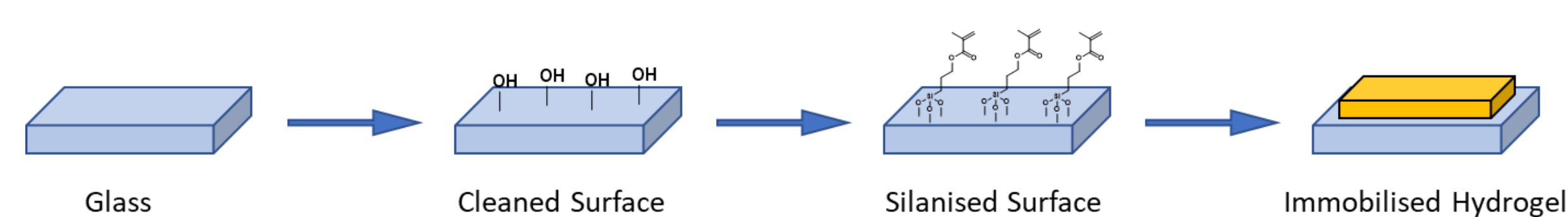
Condition: Mean $\pm$ SD, N = 3-6, 22 $\pm$ 1°C, swelling degree after 24 h

- Modification of the swelling behaviour of hydrogels based on the monomer MAESO
- Variation in the molar fraction of the neutral monomers added to hydrogel
- NIPAM reduces the swelling degree very effective

Hydrogels

Hydrogel Immobilisation

Workflow for Hydrogel Immobilisation

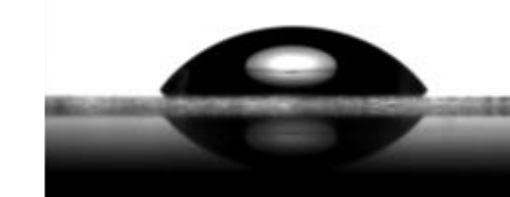
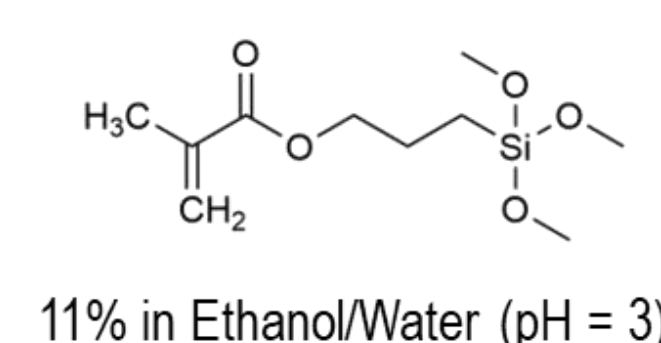


Surface Cleaning

conc. Hydrochloric acid in Ethanol
conc. Sulfuric acid



Surface Silanisation



- Hydrogels are immobilised on standard cover glasses (Borosilicate glass D[®]263)

- Silanisation is easy to carry out and can be verified by measuring the water contact angle

Swelling of Immobilised Hydrogels in Water

MAESO Hydrogel with Comonomer	Immobilised Hydrogel
20% NIPAM	12,067 $\pm$ 5,600
50% HEMA	24,221 $\pm$ 5,297
80% DEGMEMA	21,587 $\pm$ 2,120

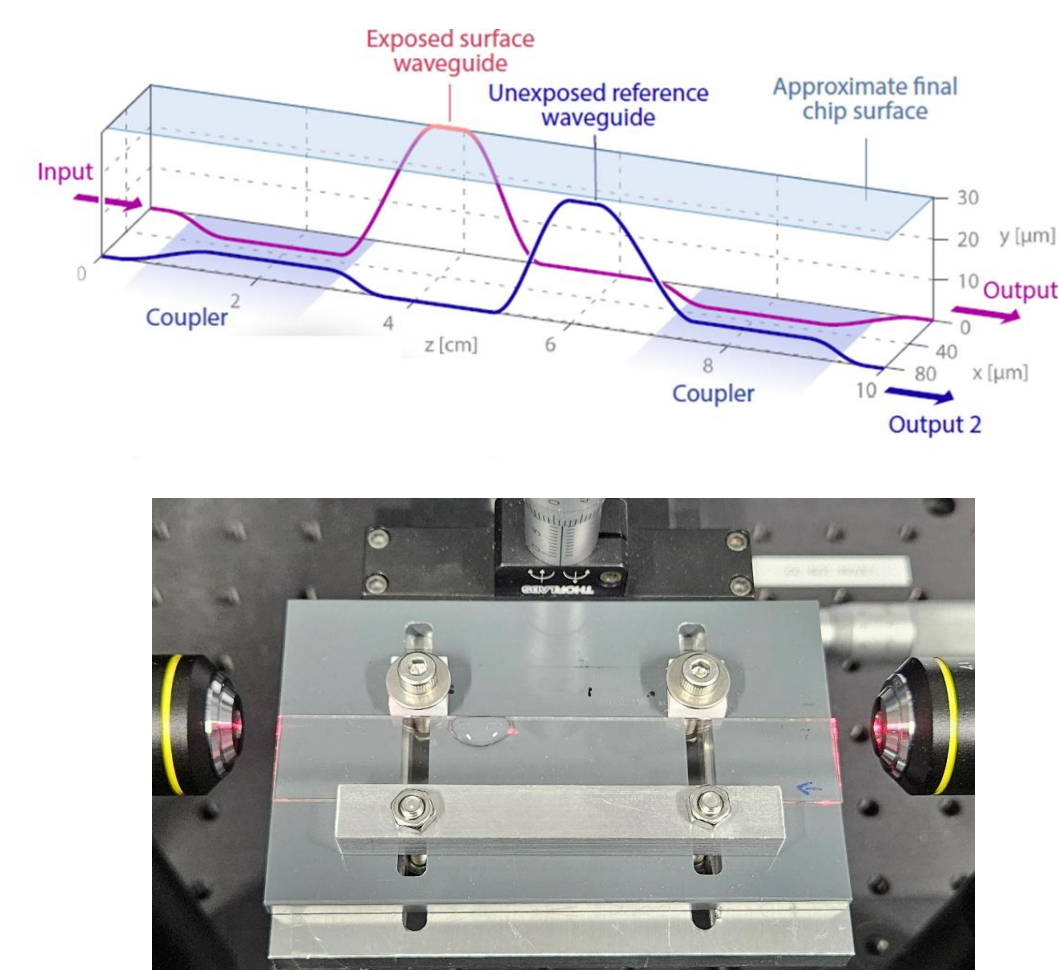
Condition: Mean $\pm$ SD, N = 3-6, 22 $\pm$ 1°C, equilibrium after 20 min



Hydrogel layer on silanised glass

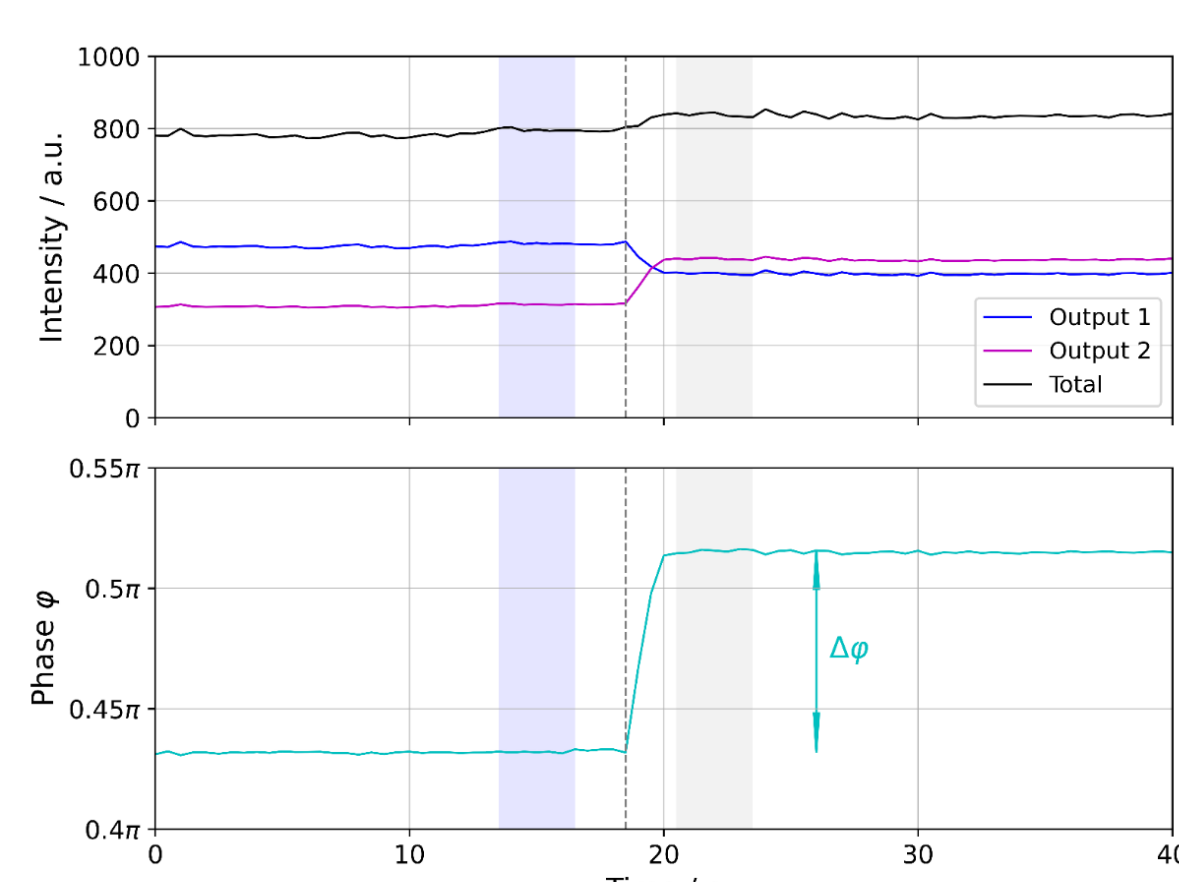
Optical integrated Mach-Zehnder Interferometer

Mach-Zehnder Interferometer (MZI)

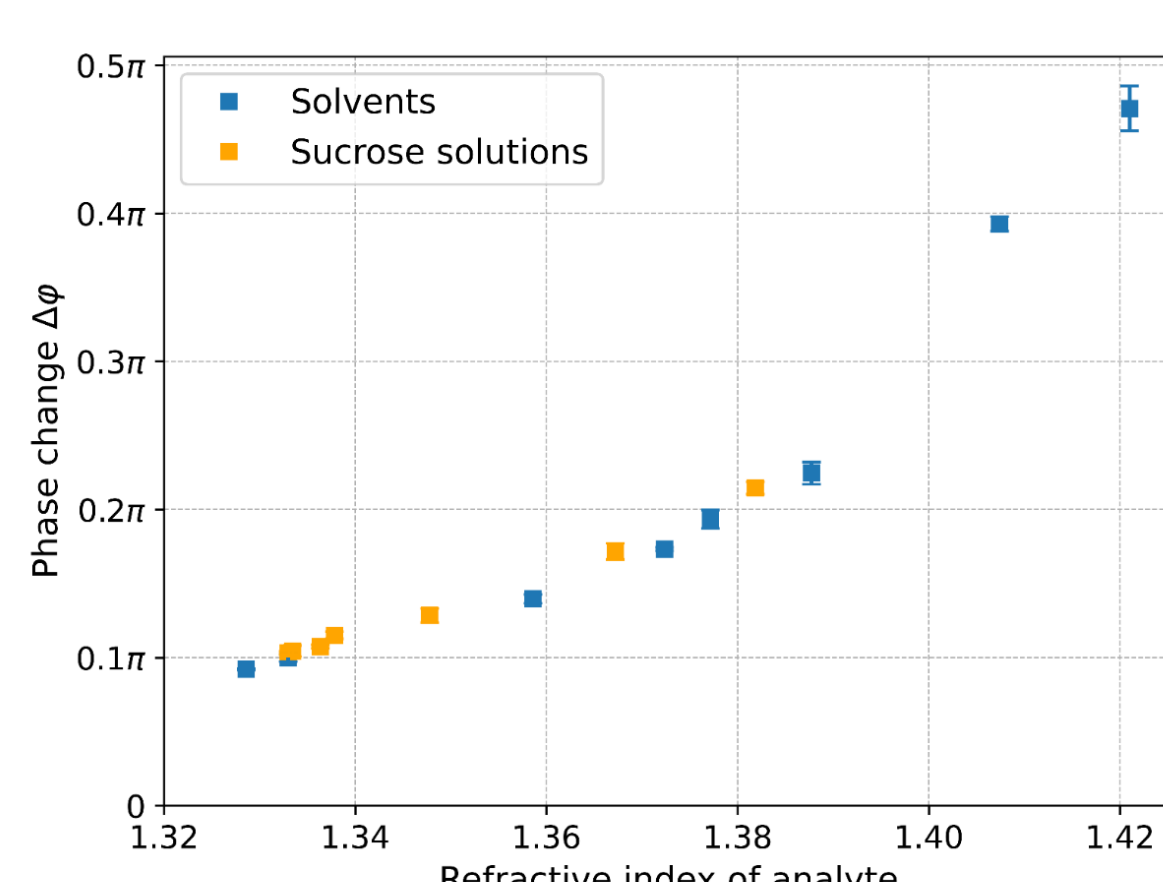


- MZI made of laser-written near-surface waveguides
- Measurement using an evanescent field
- Sample detection in a broad refractive index range

Data Processing



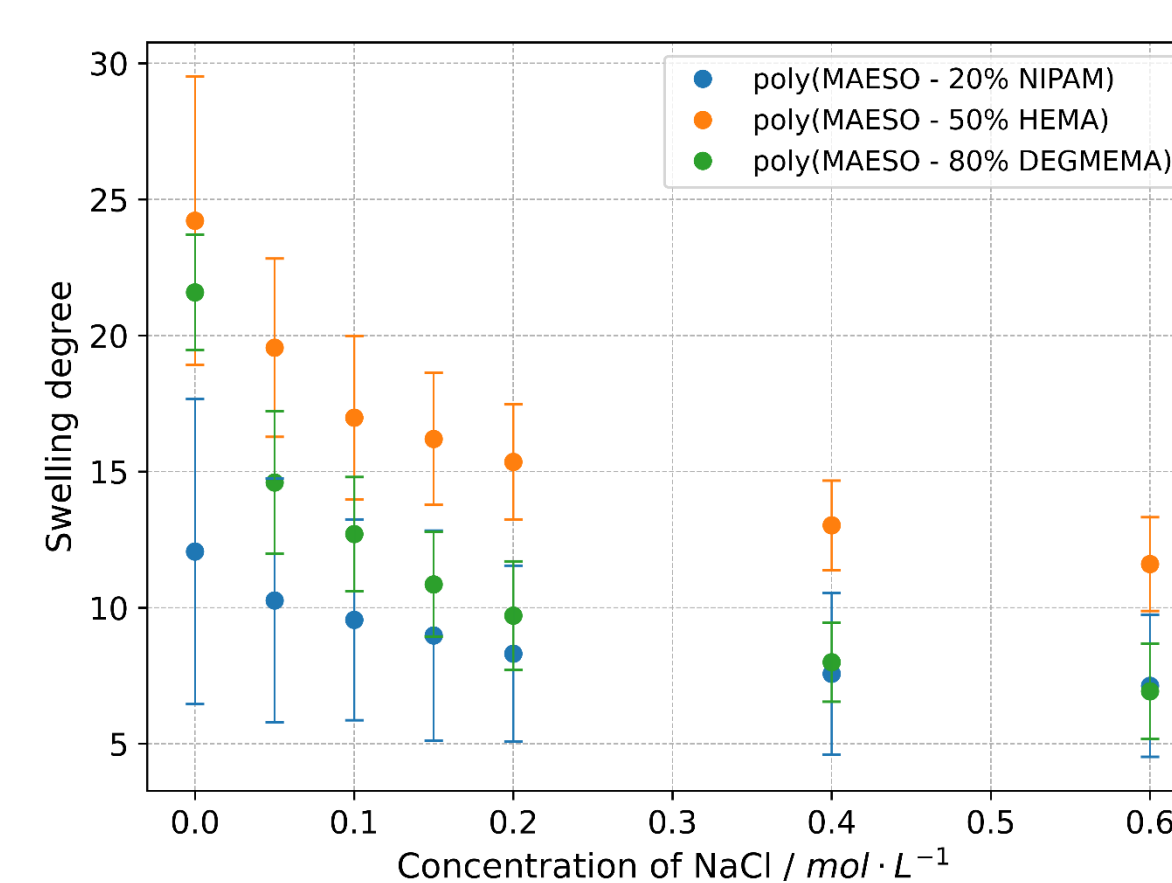
Phase Change and Refractive Index



Sensor application

Stimulus-Responsive Properties

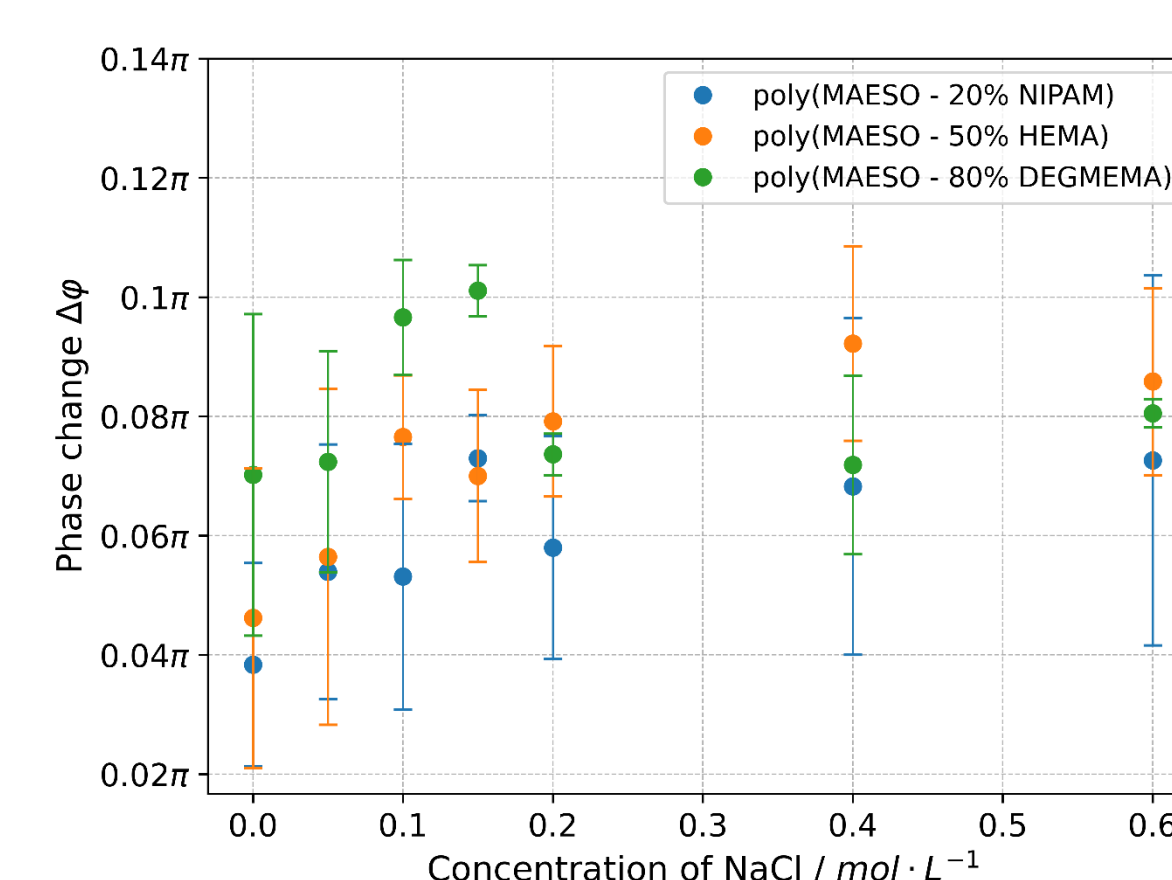
Swelling in Sodium Chloride Solutions



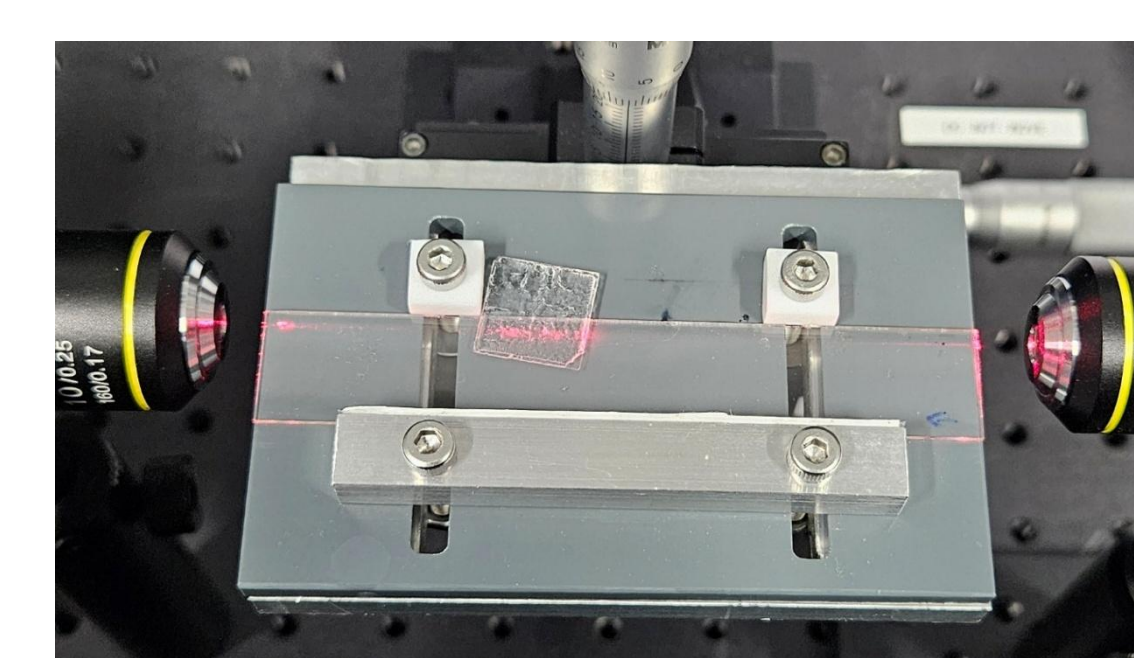
Condition: Mean $\pm$ SD, N = 3, 22 $\pm$ 1°C, swelling degree after 20 min, conditioning in deionized water after swelling

- Swelling of immobilised hydrogels in aqueous sodium chloride solutions
- Decreasing swelling degree as concentration increases
- Increasing phase change due to higher refractive index of hydrogels

MZI Measurements



Condition: Mean $\pm$ SD, N = 3, 22 $\pm$ 1°C



Immobilised hydrogel applied to Mach-Zehnder interferometer

References

- [1] J. Claus, A. Jastram, E. Piktel, R. Bucki, P. A. Janmey, U. Kragl, J. Appl. Polym. Sci. **2021**, 138(16).
- [2] A. Jastram, T. Lindner, C. Luebbert, G. Sadowski, U. Kragl, *Polymers* **2021**, 13(11), 1834.
- [3] K. Becker, J. Schnegas, A. Thies, F. Klauck, T. Korn, A. Szameit, T. Wolterink, U. Kragl, M. Heinrich, *Opt. Mater. Express* **2025**, 15, 2437-2446.
- [4] F. Yang, R. Hlushko, D. Wu, S. A. Sukhishvili, H. Du, F. Tian, *ACS Omega* **2019**, 4, 2134-2141.

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