Synthesis of Thin Film, Nonfouling, Polyampholyte Hydrogels

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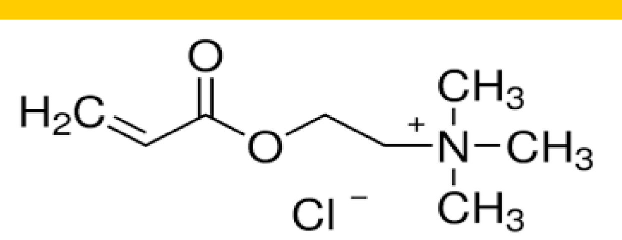
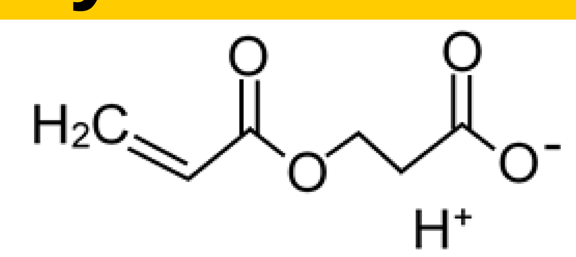
Introduction

Polyampholyte hydrogels are a major subject of research due to their nonfouling property. Their nonfouling property is due to the hydrogels having both a positively and negatively charged section in the polymer chain but an overall net charge of zero. It has been seen in previous work that changing the proximity of charges in the polymer chain impacted the nonfouling property[1,2]. With that in mind, the long-term goal for this project is to test and see how changing the proximity between the charges on the polyampholyte polymer chain affect their nonfouling property. Before this can be done, procedures for coating gold need to be developed and eventually refined to produce 25nm thick or less hydrogel coatings.

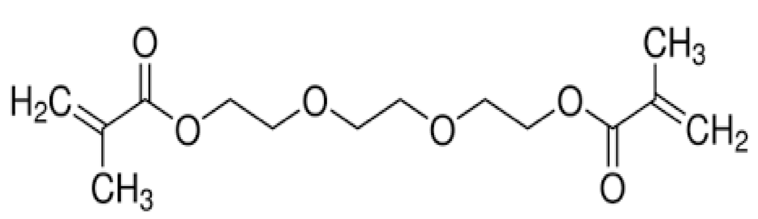
Chemistry



[2-(Acryloyloxy)ethyl]trimethylammonium chloride (TMA)

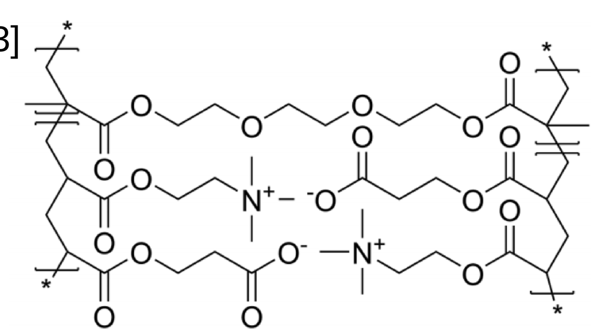


2-Carboxyethyl acrylate (CAA)

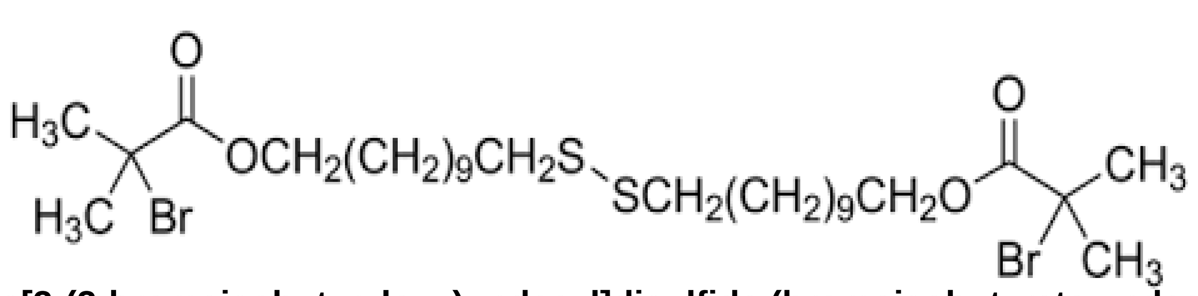


Triethylene glycol dimethacrylate (TEGDMA)

[3]

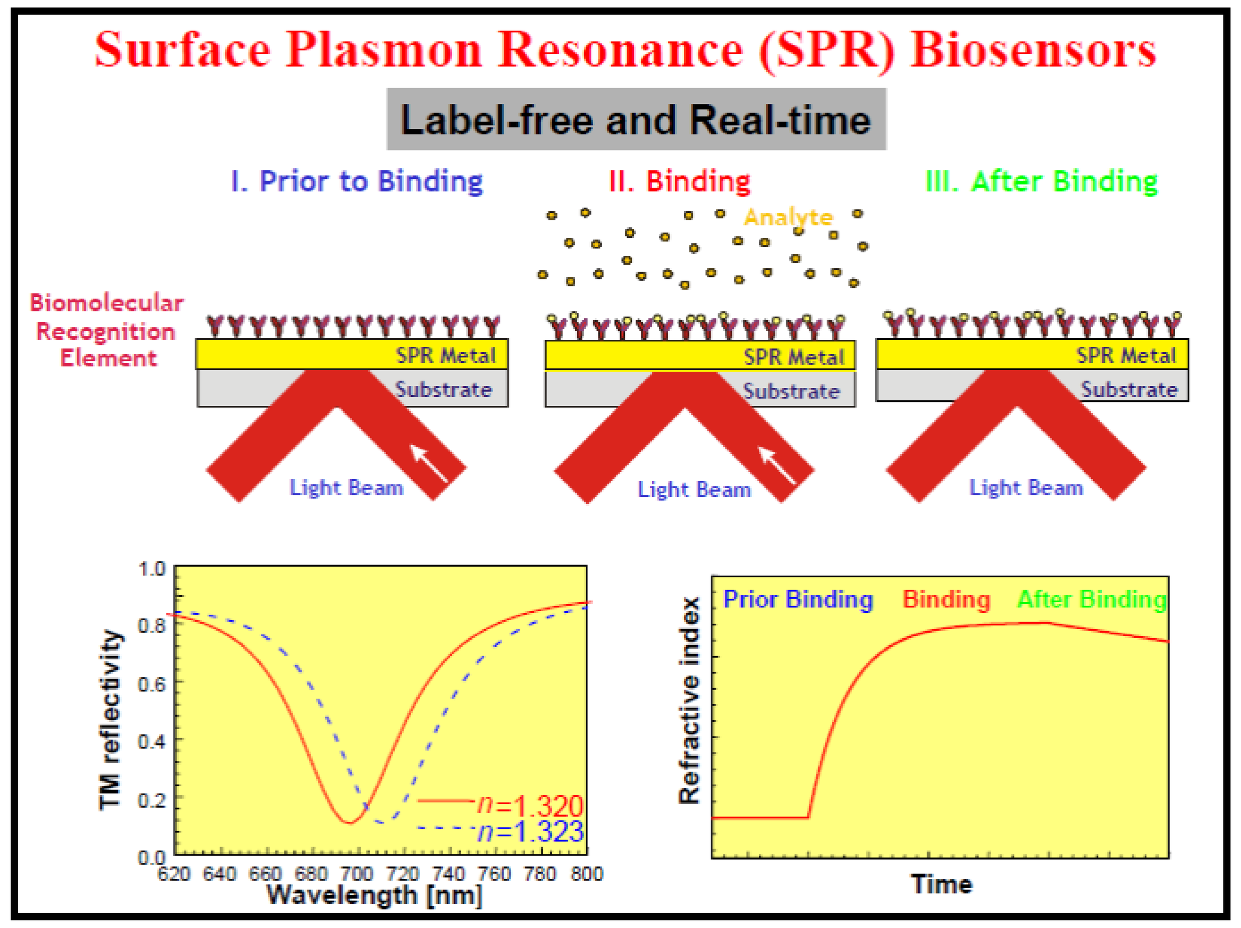


Formed polyampholyte hydrogel structure



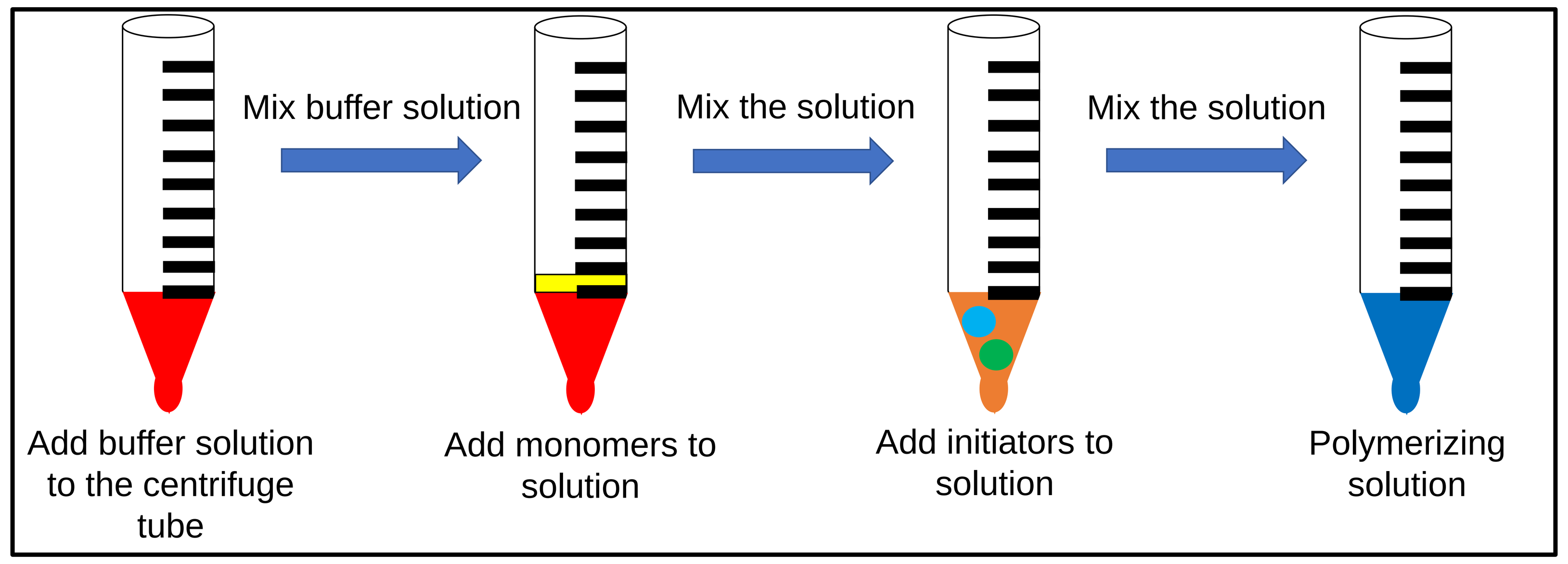
Bis[2-(2-bromoisobutyryloxy)undecyl]disulfide (bromoisobutyrate undecyl disulfide) (gold surface initiator)

Surface Plasmon Resonance

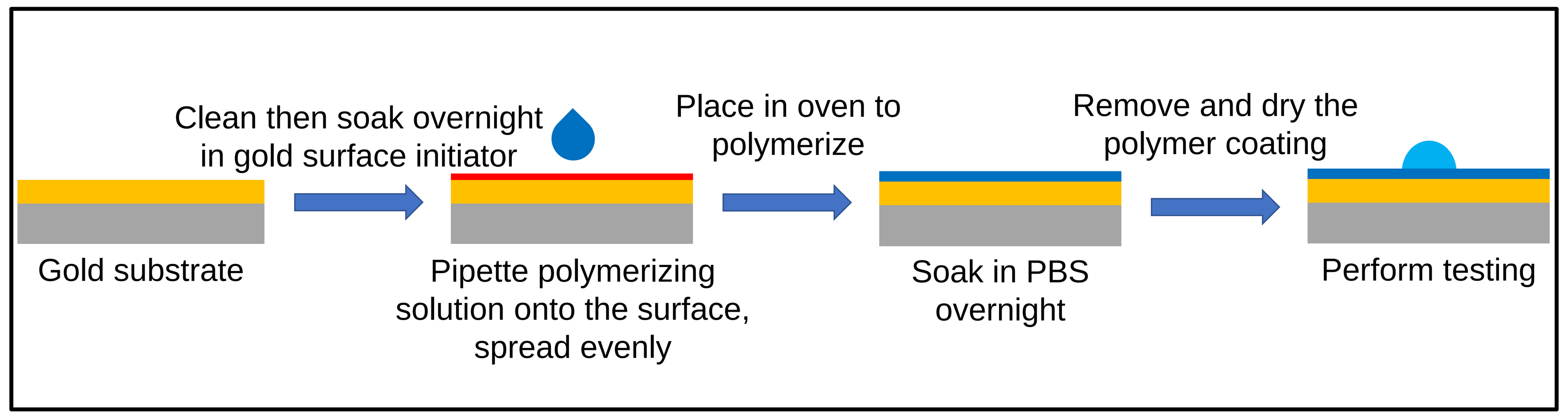


Methods

- General method developed based on previous works[1,4]

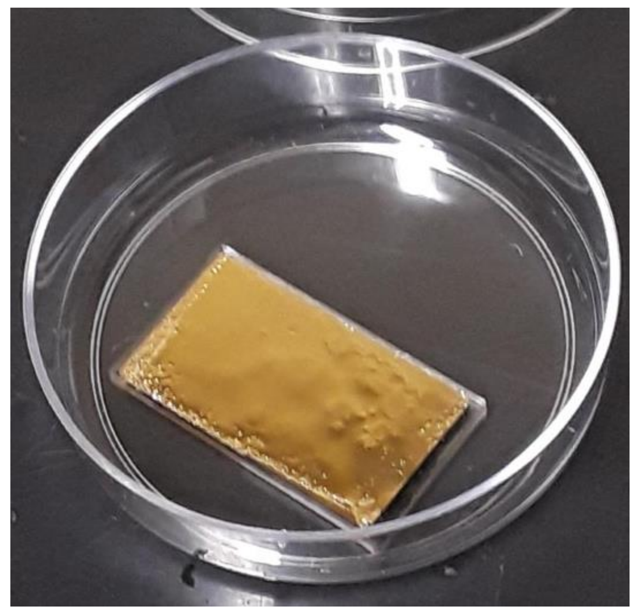


Procedure for creating monomer solution

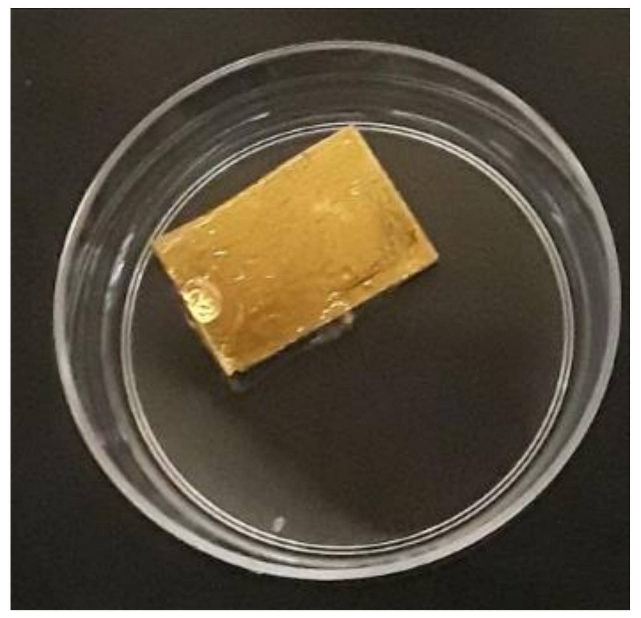


Procedure for hydrogel synthesis on gold substrate

Polymer Coatings on Gold

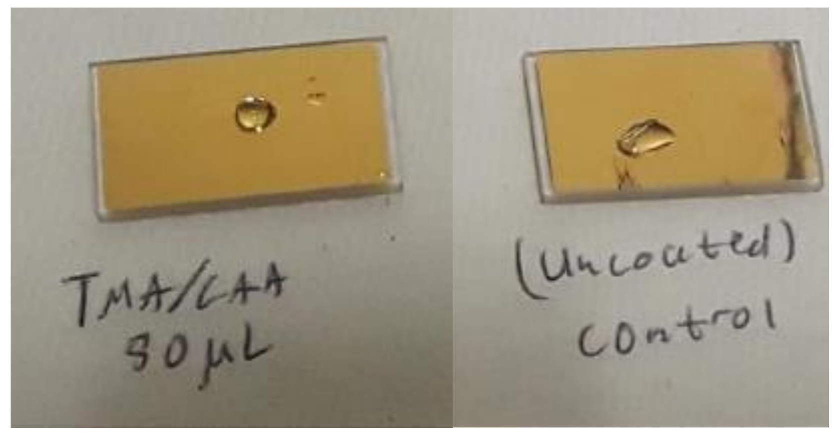


TMA/CAA polymer coating on gold substrate (50μL)



TMA/CAA polymer coating on gold substrate (100μL)

Water Droplet Tests



Water droplet test of 50μL coated coupon

Water droplet test of 100μL coated coupon

Conclusion

- Developed procedures for coating gold
- Formed hydrogels on gold successfully
- 3 hours needed in oven for polymerization

Future Research

- Measure polymer coating thickness using SEM
- Spin coat the substrates to form 25nm or thinner polymer coatings
- Measure contact angles of a water droplet on polymer coatings
- Measure the swelling of polymer coatings that occur during overnight PBS soak
- Test nonspecific protein adhesion on formed polymer coatings using a plasmon resonance biosensor in future work
- Find ideal thickness of coatings for desired physical properties
- Form polymer coatings using newly developed crosslinkers and test their physical properties

Acknowledgements

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References

[1] Tah, T.; Bernards, M.T. Nonfouling polyampholyte polymer brushes with protein conjugation capacity. Colloids and surfaces B: Biointerfaces 93 (2012) 195-201.
[2] Koc, J.; Schönemann, E.; Amuthalingam, A.; Clarke, J.; Finlay, J.A.; Clare, A.S.; Laschewsky, A.; Rosenhahn, A. Low-Fouling Thin Hydrogel Coatings Made of Photo-Cross-Linked Polyzwitterions. *Langmuir* 2019, 35, 1552-1562.
[3] Mariner, E.; Haag, S.L.; Bernards, M.T. Impacts of cross-linker chain length on the physical properties of polyampholyte hydrogels. Biointerphases 14, 031002 (2019); doi: 10.1116/1.509741.
[4] Haag, S.L.; Bernards, M.T. Enhanced Biocompatibility of Polyampholyte Hydrogels. *Langmuir* 2020, 36, 3292-3299.

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