



Bioelectronic Ion Pumps for Long Term In-Vitro Applications

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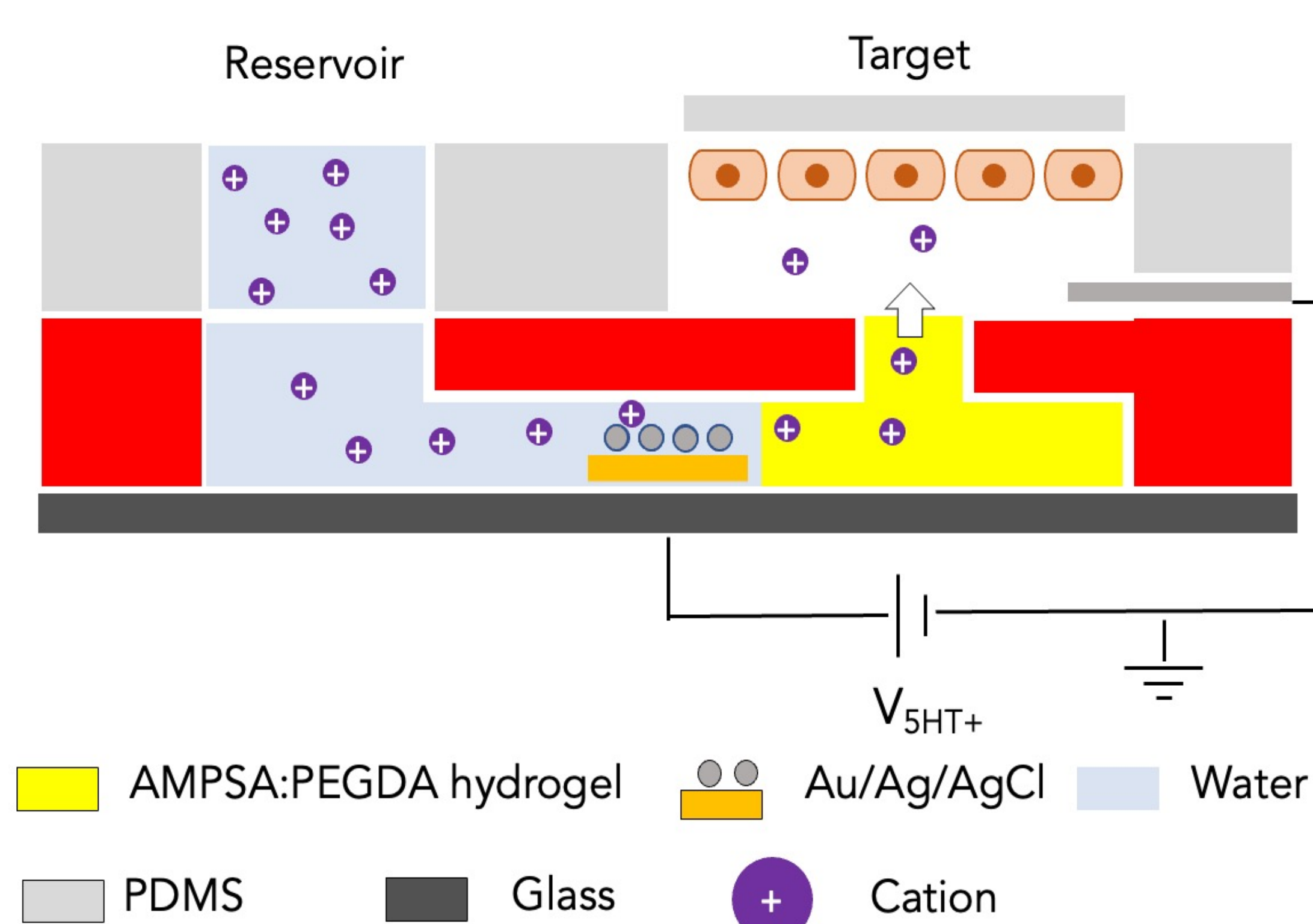
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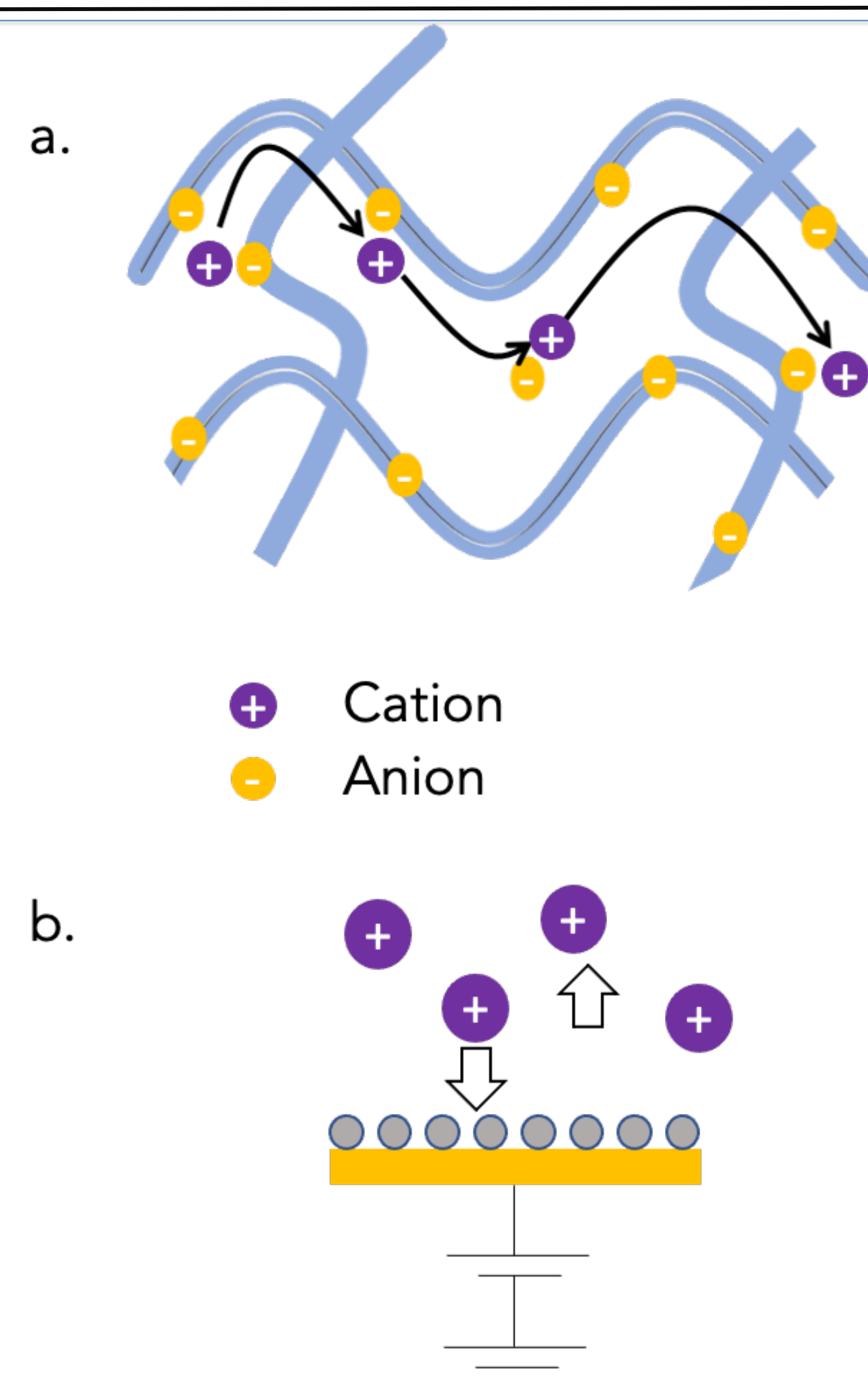
Abstract

Bioelectronic devices that can interface electronics with biological system can be used as actuators to control biological processes. [1] In this work, we present a bioelectronic platform that can control pH and [K+] in buffered media solutions and implement a fluorescence sensing based feedback control algorithm in order to close the loop between sensing and actuation. We also report systematic investigation of various aspects of device performance using electrical characterization techniques and computational modeling.

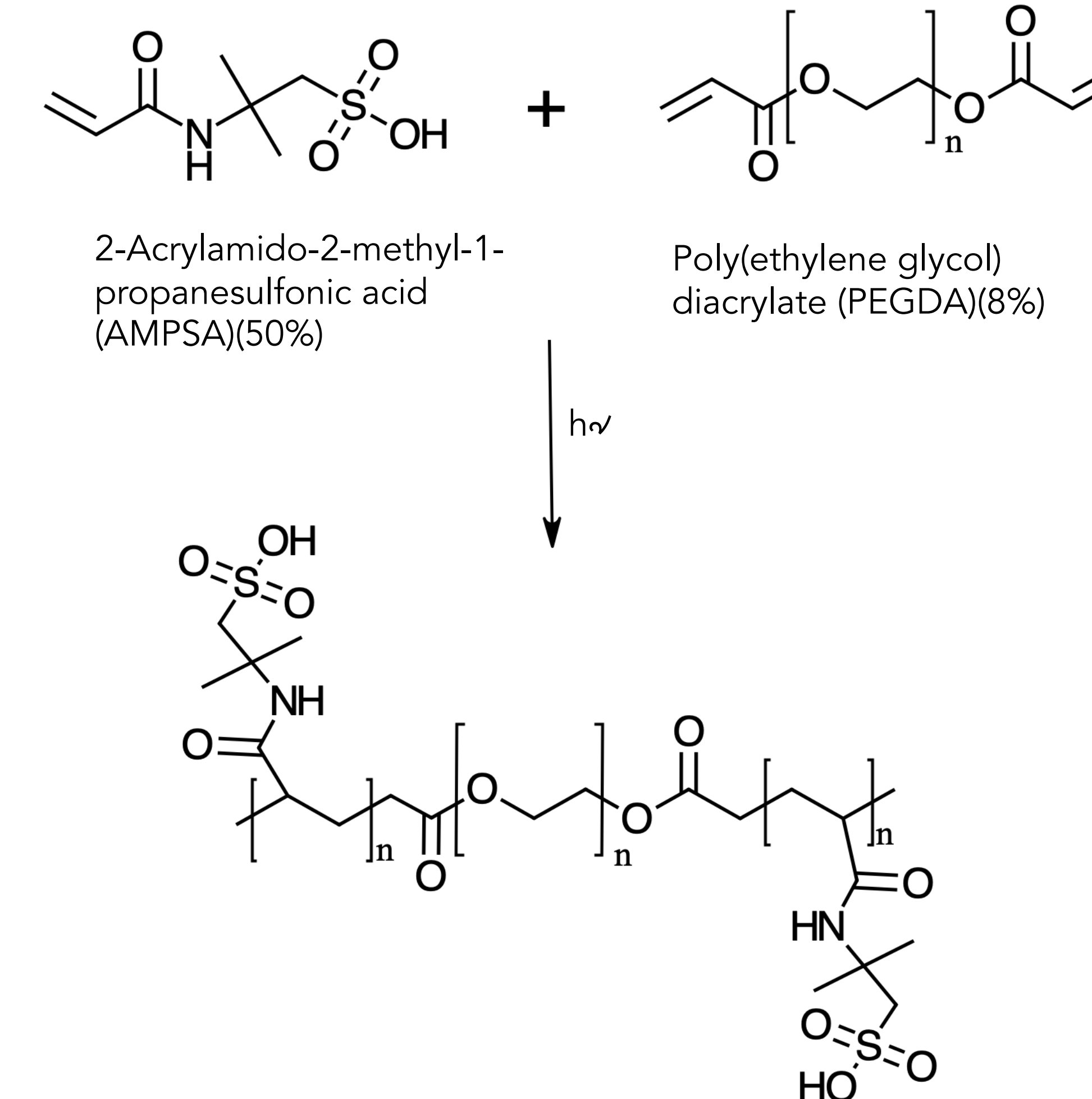
Bioelectronic Ion Pump



Nanoparticle modified- gold electrodes control ionic concentration in response to voltage. A voltage applied between the reservoir and targets moves ions across an ion conducting hydrogel from the reservoir to the target. Gold contacts modified using Ag/AgCl nanoparticles

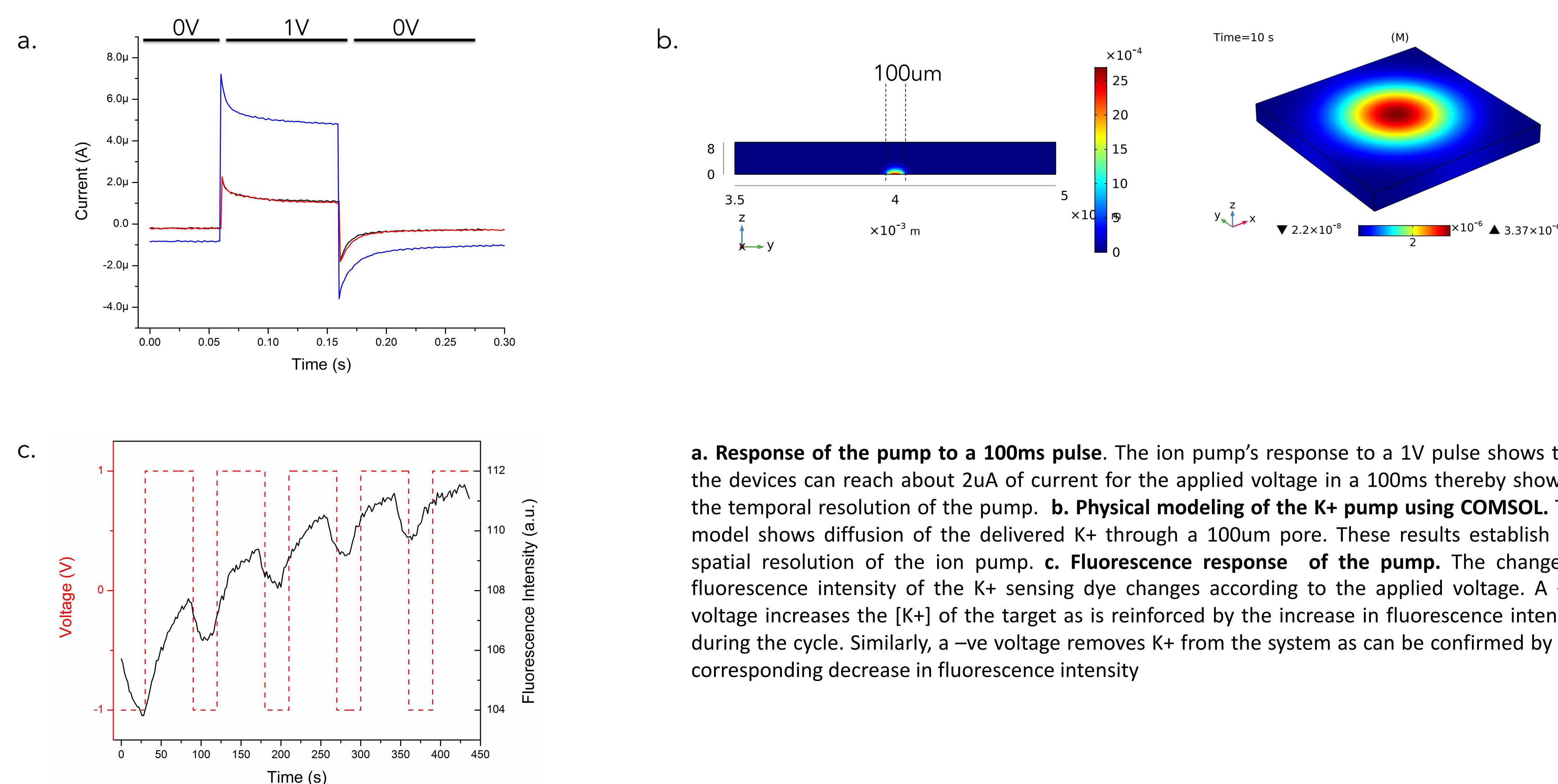


a. Ion conduction through hydrogel. The hydrogel has a large number of fixed negatively charged ions (anion). The positively charged ion of interest (cation) hops along the fixed anions. **b. Ion exchange at gold contacts.** By applying a voltage to the nanoparticle modified contacts, ions are absorbed or released into the target based on the voltage applied.

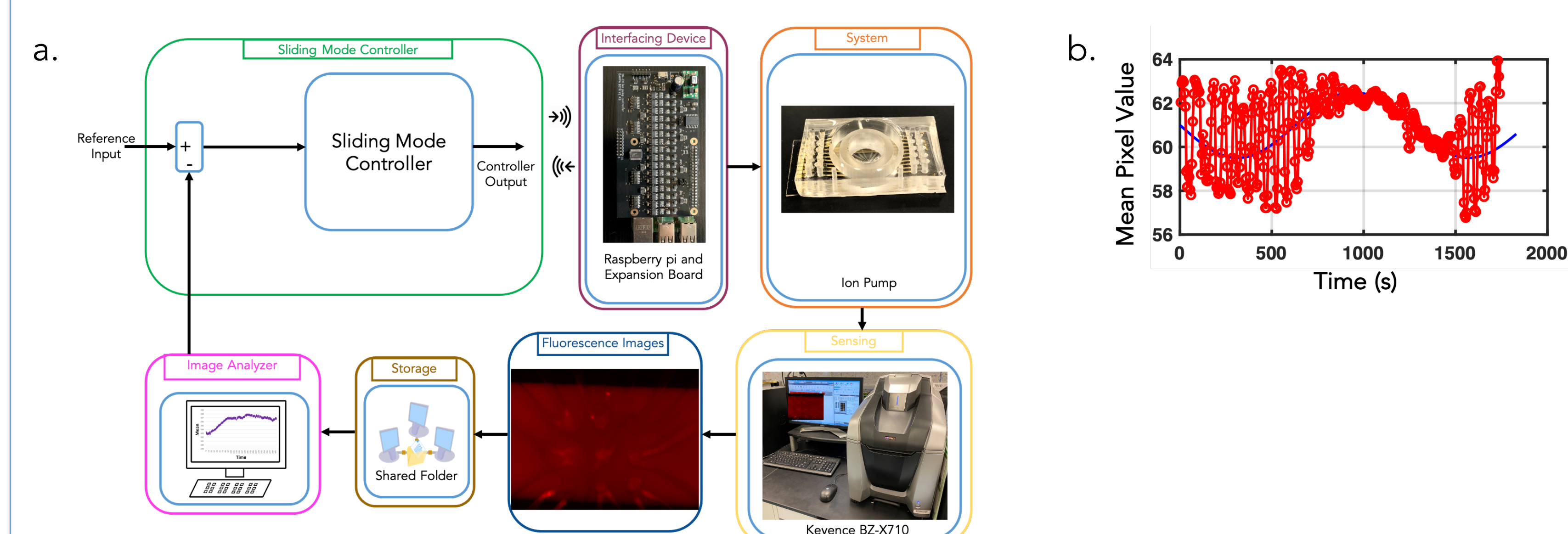


Ion Conducting Hydrogel AMPSA and PEGDA are mixed and the mixture is crosslinked using UV light. The resulting hydrogel is ion conducting and has fixed negative charges. This hydrogel conducts cations upon applying voltage across the polymer.

K⁺ Delivery using Ion Pump



Closed-Loop Control



Future Work

The ion pumps will be integrated with macrophage cell cultures and closed loop control will be used to induce macrophage polarization in-vitro. The performance of the pumps will also be further characterized for various other ions and small biomolecules.

Acknowledgments

We acknowledge Dr. Tom Yuzvinsky and the W.M. Keck Center for Nanoscale Optofluidics for valuable consultation. The fabrication work was performed in part at the Montana Microfabrication Facility, Montana State University.

References

1. [Machine Learning-Driven Bioelectronics for Closed-Loop Control of Cells](#)
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Funding

Research is sponsored by the Defense Advanced Research Projects Agency (DARPA) through Cooperative Agreement Number D20AC00003 awarded by the US Department of the Interior (DOI), Interior Business Center. The content of the information does not necessarily reflect the position or the policy of the Government, and no official endorsement should be inferred.

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