Towards

SELF-CLEARING IMPLANTABLE BIOSENSORS FOR NEURODEGENERATION RESEARCH

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LABORATORY OF IMPLANTABLE MICROSYSTEMS RESEARCH

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Acknowledgements first…

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Jinjia Xu – Postdoc

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NIH National Institute of Neurological Disorders and Stroke

INDIANACTSI Clinical and Translational Sciences Institute

PURDUE RESEARCH FOUNDATION

SAMSUNG

SAMSUNG ADVANCED INSTITUTE OF TECHNOLOGY

The Jackson Laboratory

Lilly

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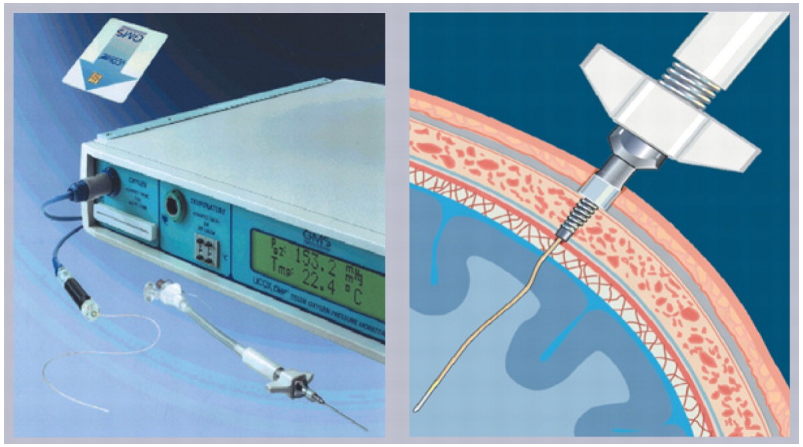
State-of-the-art in implantable sensors

G6, Dexcom CGM: 10 days

Abbott Freestyle Libre CGM: 14 days

Eversense, Senseonics: 90 days



LICOX Brain Tissue Oxygenation Monitor Integration Neurosciences: 7-14 days

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Spinal cord injury statistics and facts

2.5 millions worldwide

347,000 in the US

Demographic

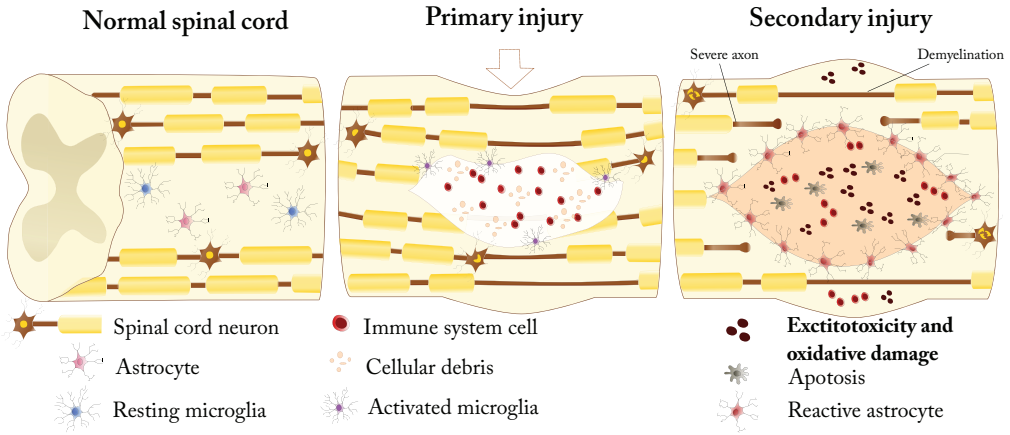
0 years — 75 years

29-42

Annual national cost

$9.7 billions

Long term complication



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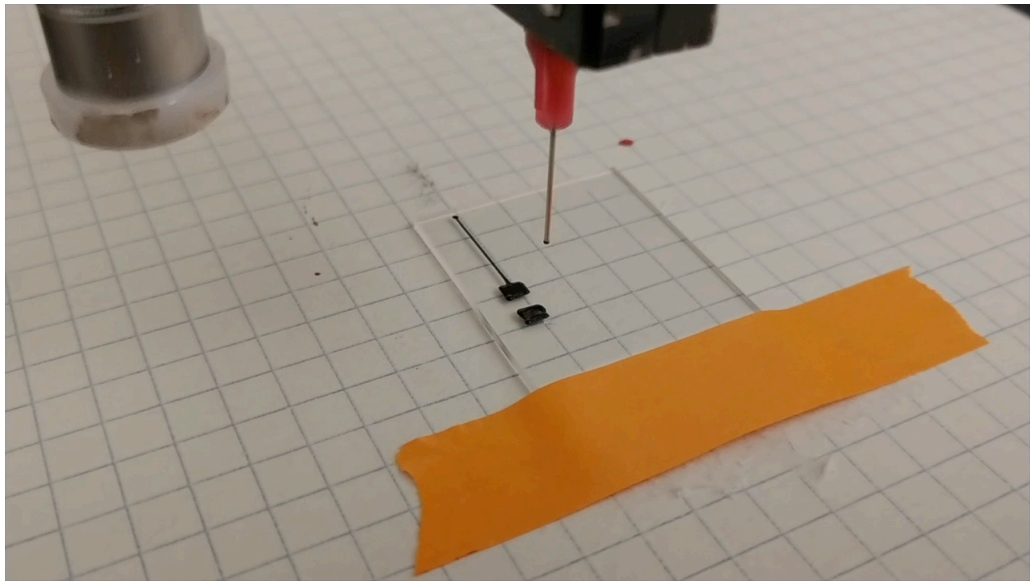
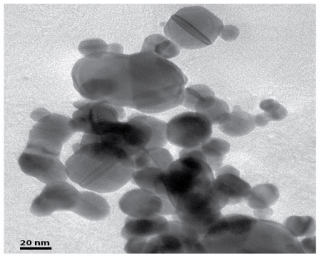
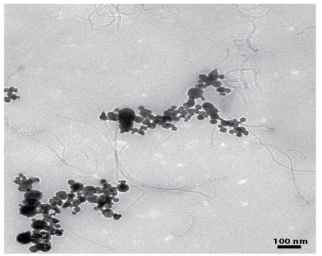
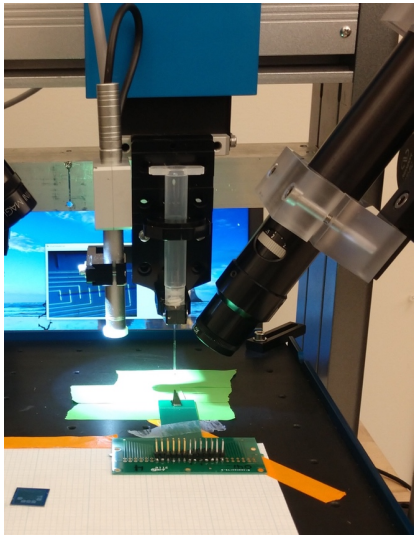
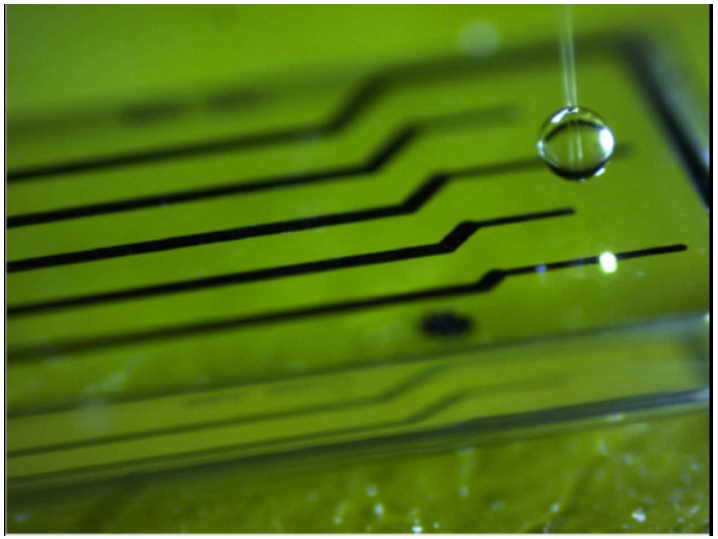
Nanocomposite-based flexible biosensor

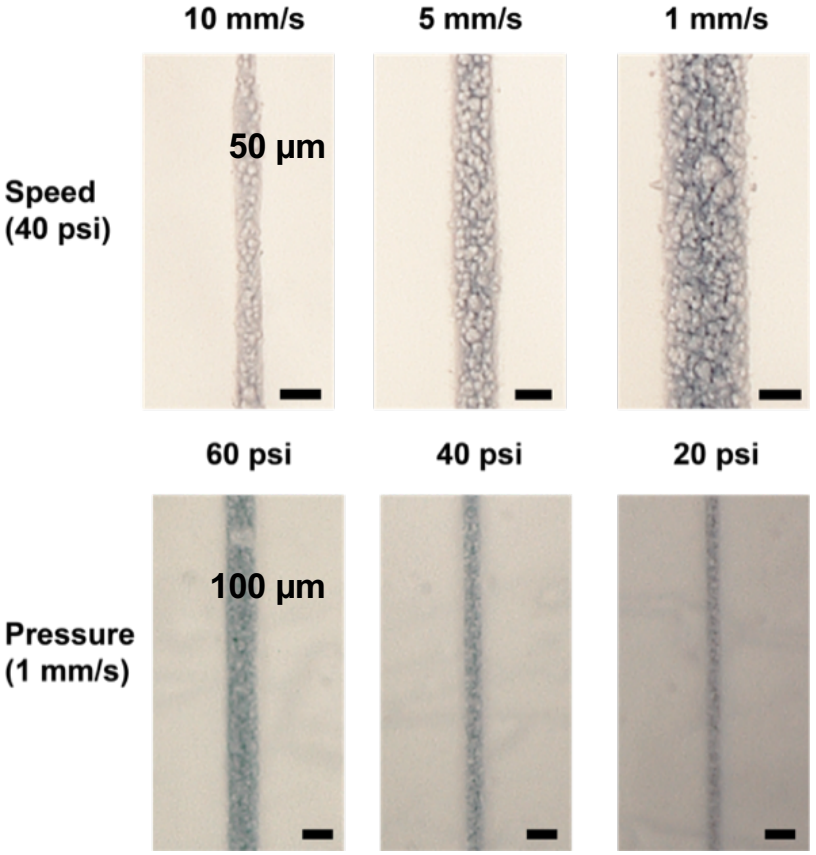






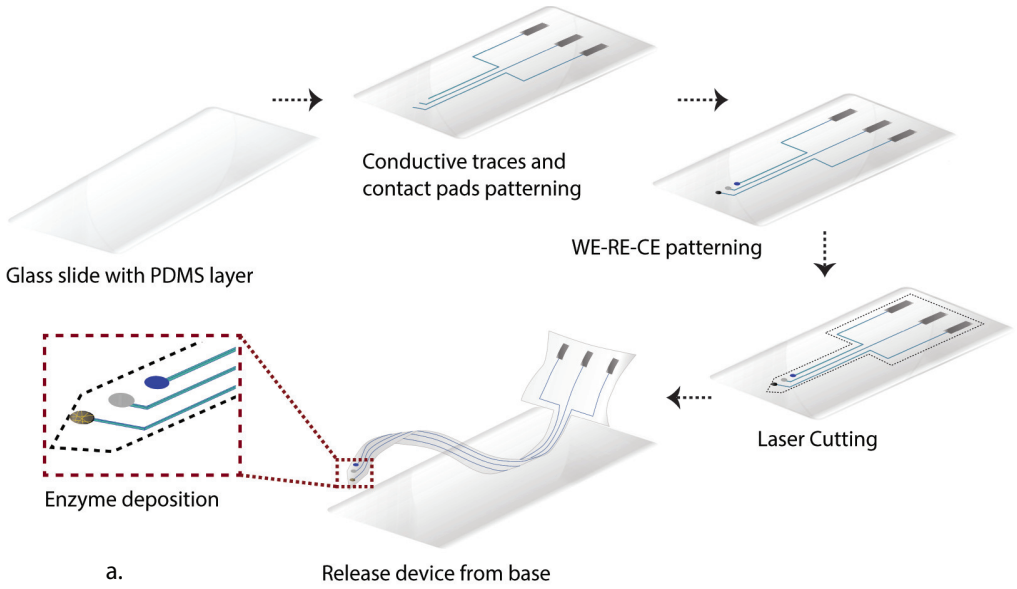


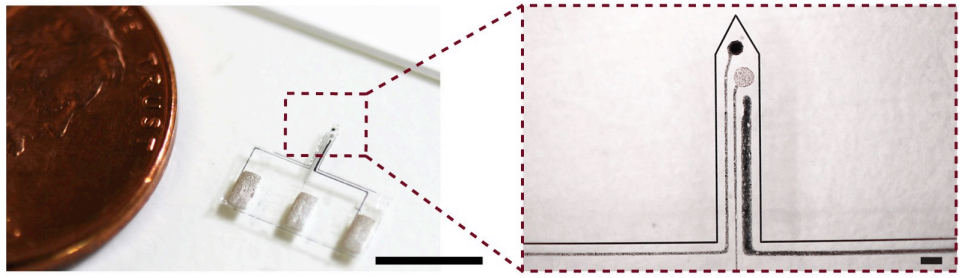


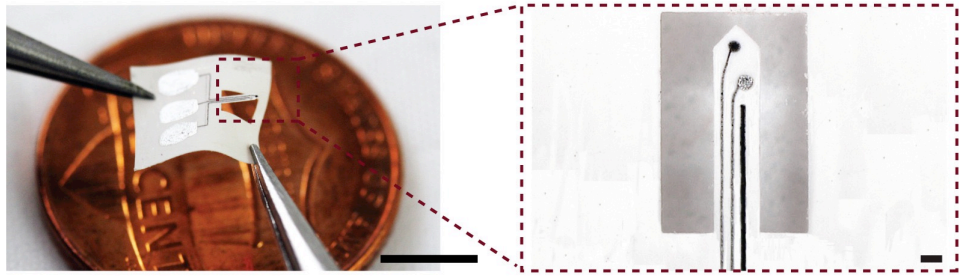


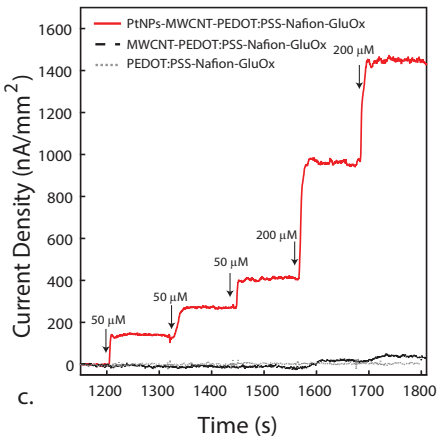
Nguyen et al., Biosens. Bioelectron. 2019

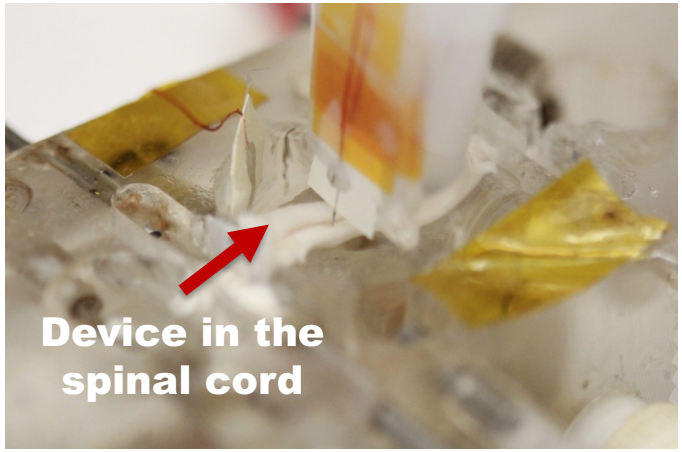
Fabrication, in vitro, ex vivo tests

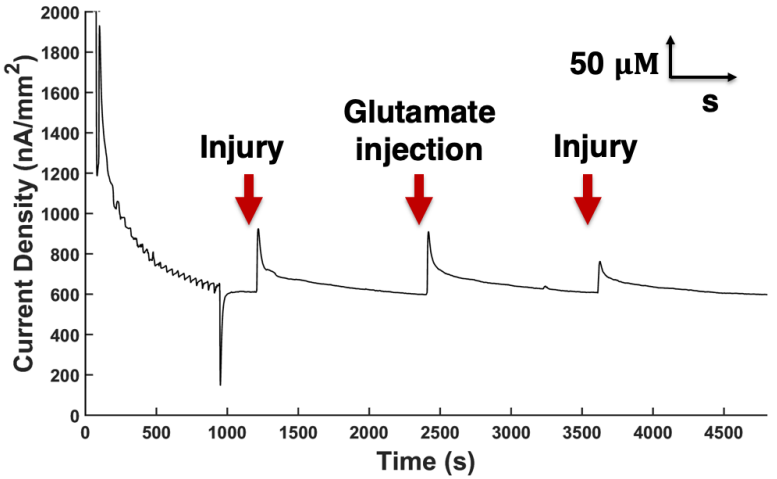












Nguyen et al., Biosens. Bioelectron. 2019

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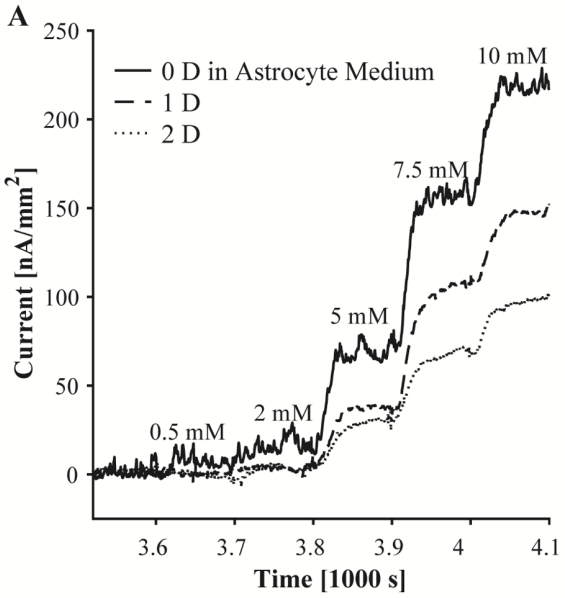
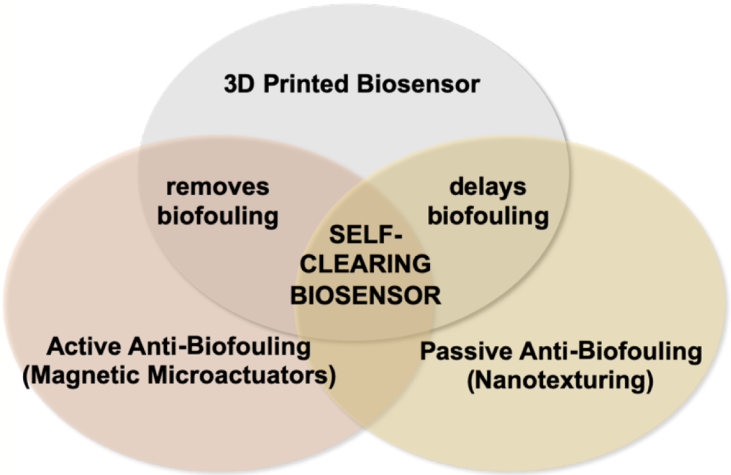
Reliability issues → opportunity!



Prevent & Disrupt Biofouling!

Nonspecific protein adsorption → Immune cell infiltration → Macrophage activation & fusion → Fibrous encapsulation

Strategy: Use Active and Passive Approaches



- Active anti-biofouling
  - \+ On-demand
  - \+ Perpetual
  - \+ Prophylactic or rescue
  - – Energy input required
- Passive anti-biofouling
  - \+ Automatic
  - \+ Delays fouling
  - – Limited lifetime

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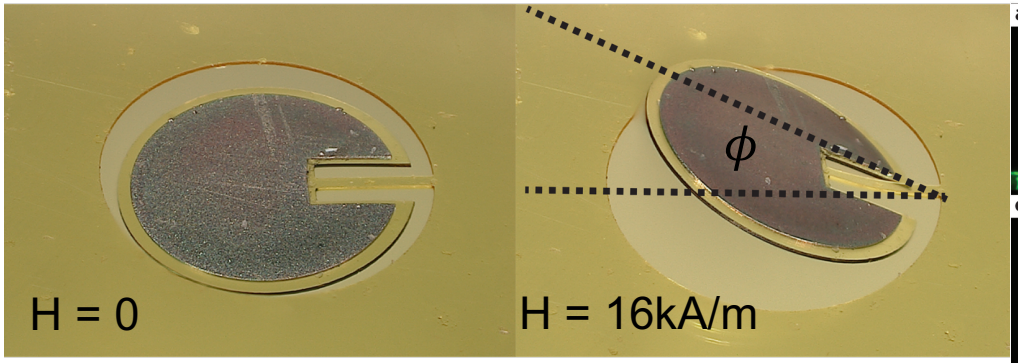
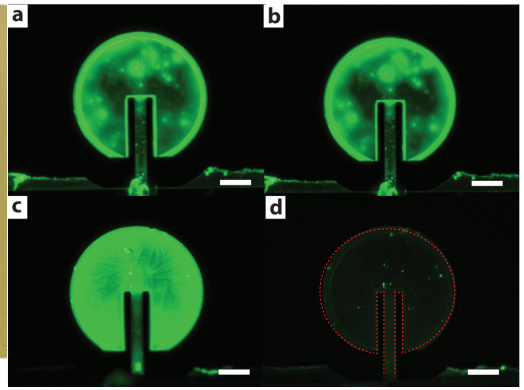
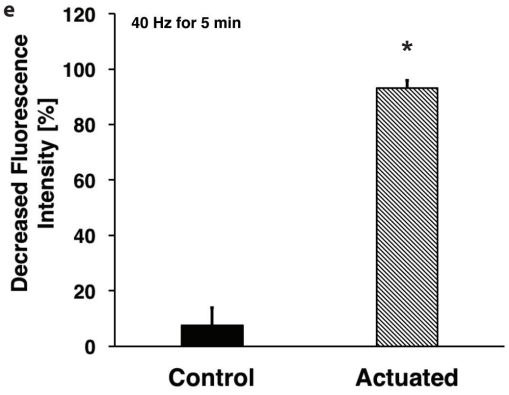
Active anti-biofouling strategy





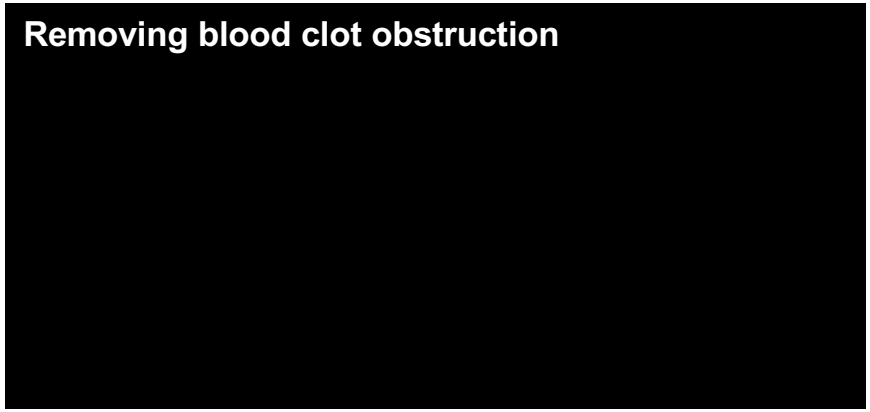


Yang et al., S&A:B, 2018

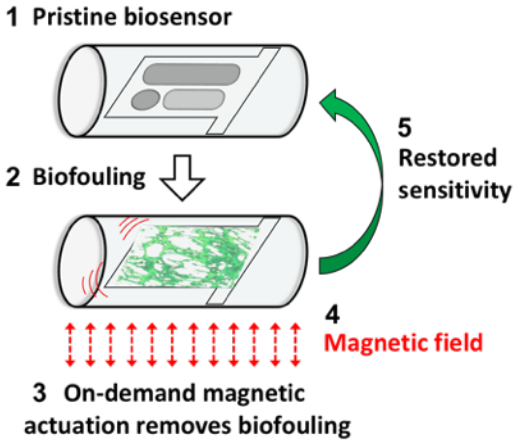
$$\phi = V_m MHsin\left(\frac{\pi}{2} - \phi\right)/\mathrm{k_{beam}}$$

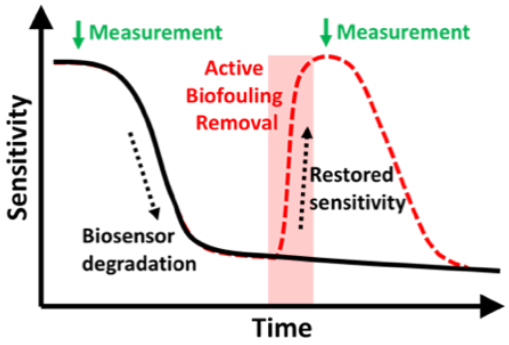
$$k_{beam} = \frac{EI}{L}, \qquad I = \frac{wt^3}{12}$$

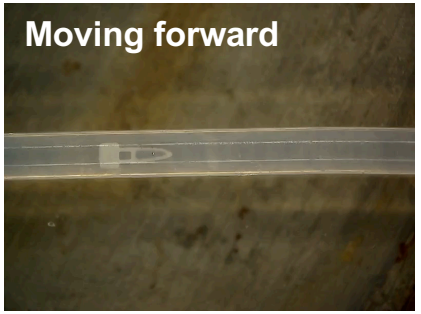
Dynamic responses of microactuators

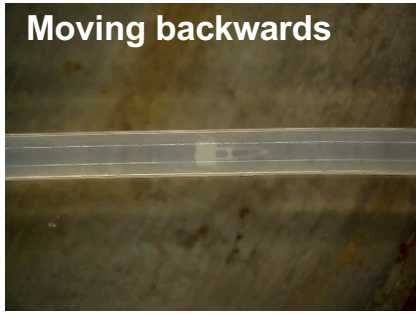


Large amplitude actuation for self-cleaning



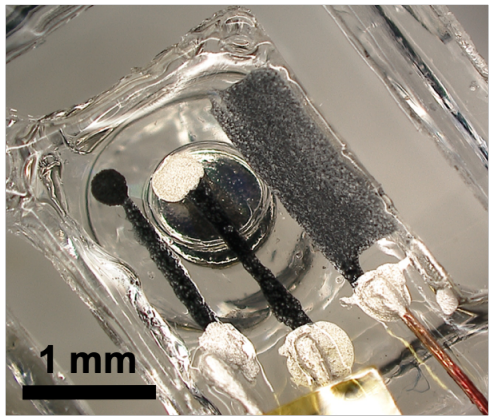




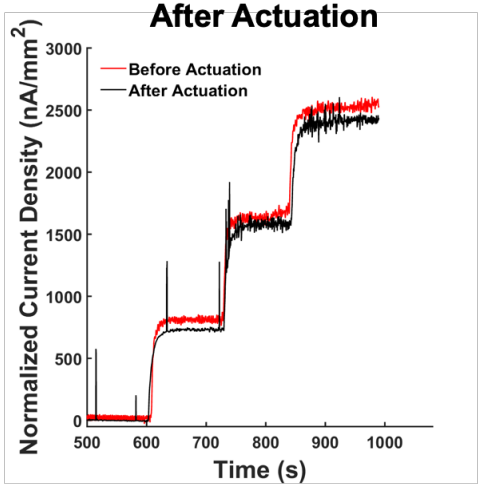


Towards self-clearing biosensors

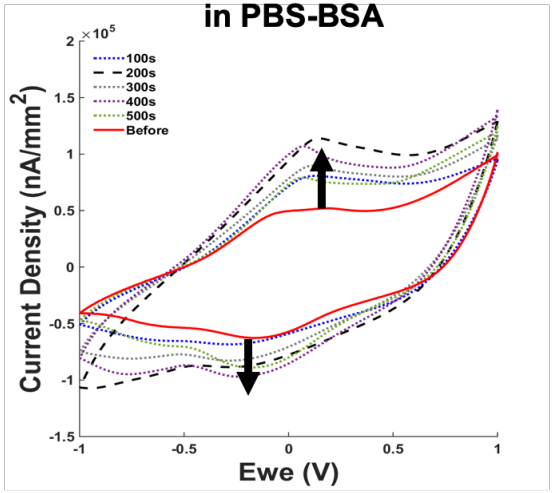
Printed Biosensor on Magnetic Actuator



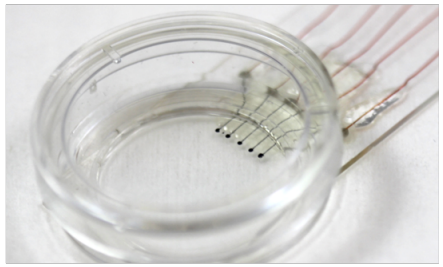
Stability of Biosensor After Actuation

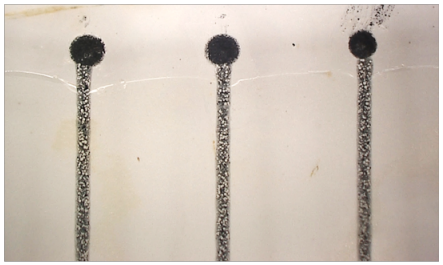


CV vs. Actuation Time in PBS-BSA

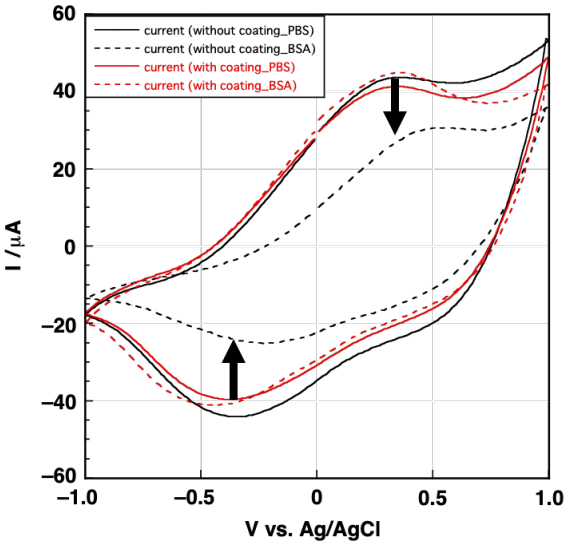


PCBTh-co-BF-coated Biosensor

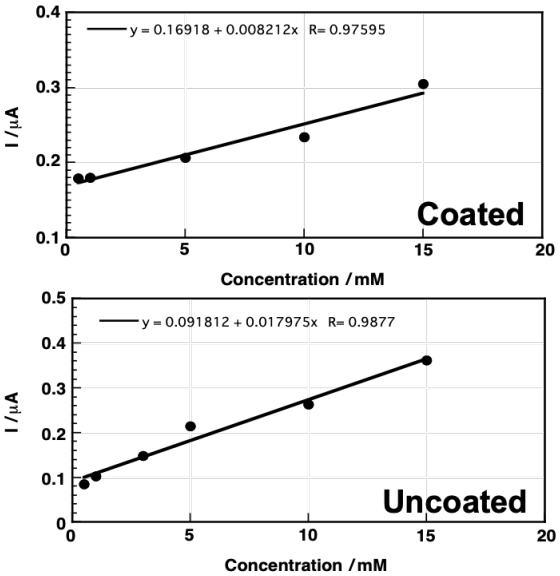




Effect of Polymer Coating against BSA



CA in PBS-BSA



Unpublished

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Questions?


BE COMPLETELY HONEST AND TELL US WHAT YOU THINK OF THIS PRODUCT THAT WE'VE SLAVED OVER NIGHTS AND WEEKENDS WITHOUT SLEEP OR A SALARY BECAUSE WE THINK IT'S SUCH A COOL IDEA.
TOM FISH BURNE