Boronic Acid Fluorophores for Saccharide Sensing

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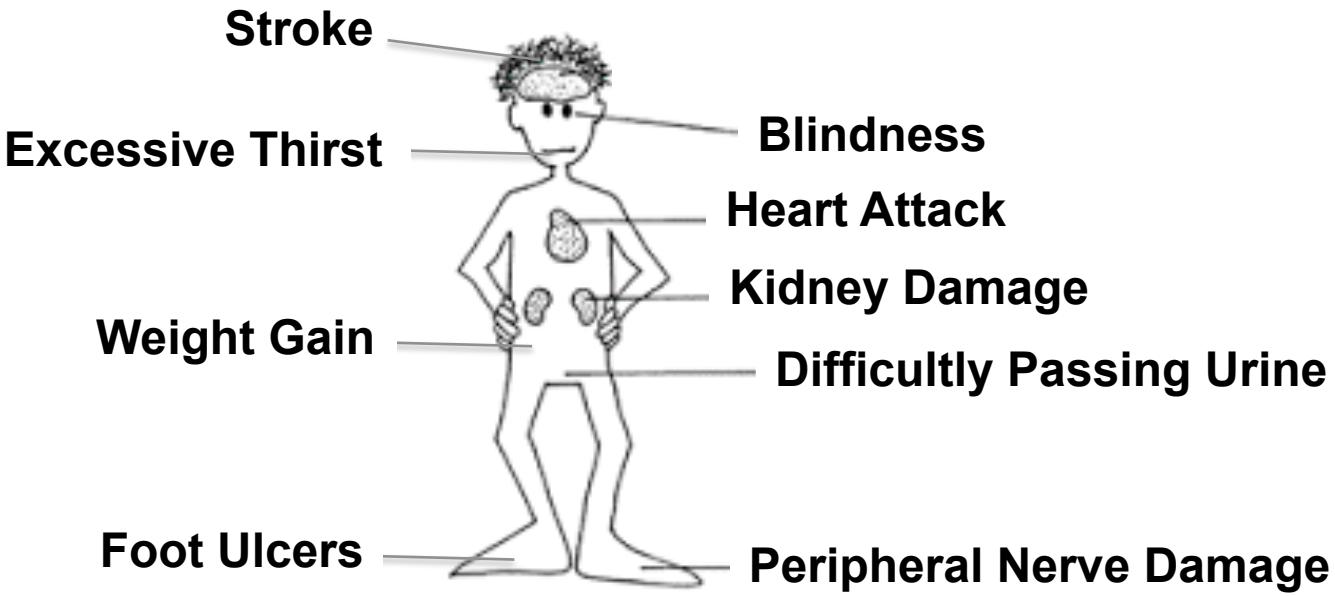
Overview

- Background
  - Diabetes – Side Effects
  - Monitoring Devices
- Project Goal
- Boronic Acids (BAs) for Sugars Recognition
- Sensing Mechanism
- Fluorescence Results
- Future Work
- Conclusions

Importance of Saccharide Sensing

- Disease: Diabetes and the consequential side effects



- Monitoring glucose levels to prolong life expectancy
- Currently no noninvasive, continuous monitoring systems available
- Demonstrates a need for real-time, non-invasive monitoring

Current Monitoring Methods

Implanted Devices

Roche

ACCU-CHEK®

Advantages:

- Real-time monitoring
- Continuous
- Coupled to insulin pump
- Elimates injections *via* syringe

Disadvantages:

- Invasive

Finger Pricking Method

Advantages:

- Minimally Invasive

Disadvantages

- Not continuous
- Insulin injections required
- Miss episodes of hyper- and hypoglycaemia

https://www.accu-chek.co.uk/gb/products/

Contact Lenses – The Answer!

Electrochemical sensor in a wearable platform

Battery Powered

Interference from Electroactive Species in Ocular fluid

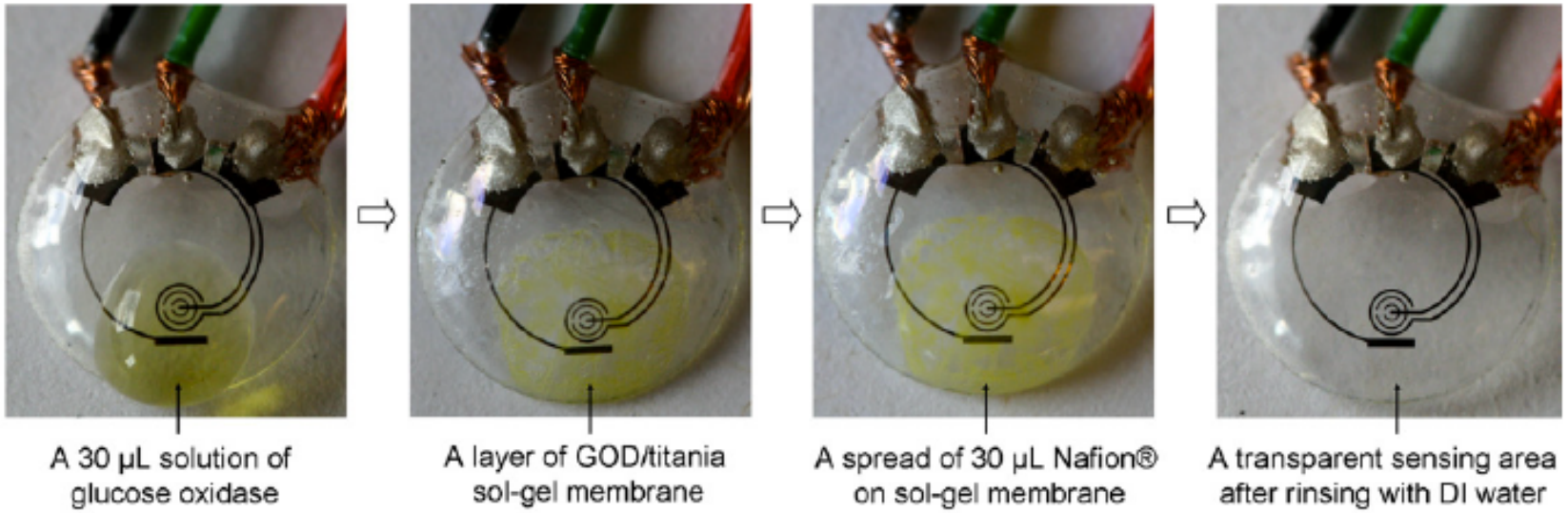
Use of Enzymes

Google

NOVARTIS

H. Yao, et al, *Biosensors and Bioelectronics*, **2011**, *26*, 3290-3296

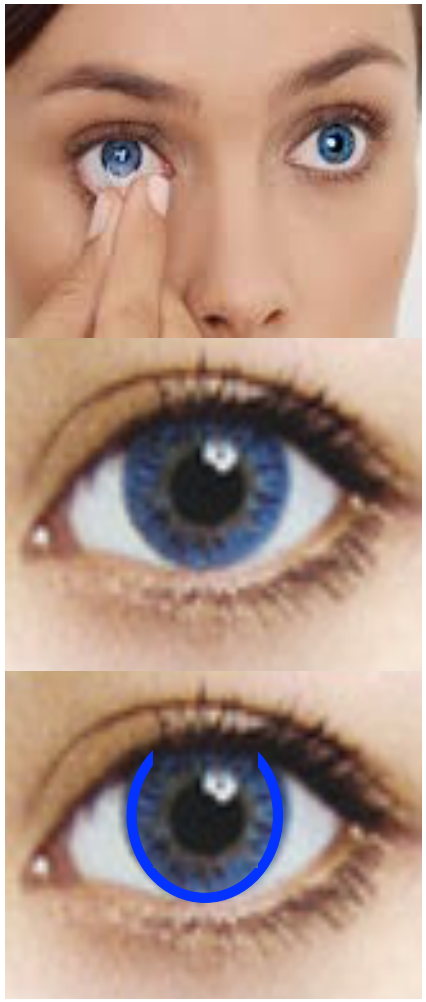
Realistically....Not a Real Working Device

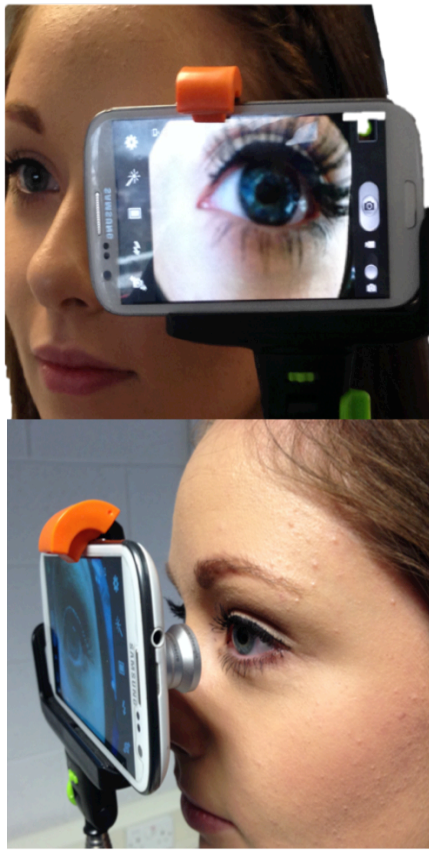


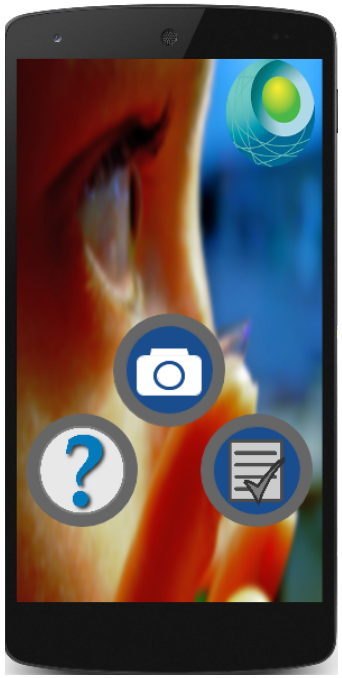
- Attached to a BASi Epsilon- EC Potentiostat +400 mV
- Sensing platform proposes glucose monitoring between 0.5-50 mM
- Ocular glucose range is 0.05-0.5 mM and up to 5 mM in diabetics
- Major shortcomings to meet immediate expectations

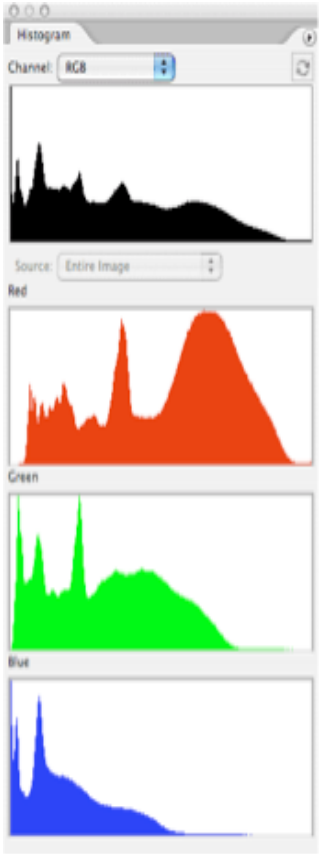
H. Yao, et al, *Biosensors and Bioelectronics*, **2011**, *26*, 3290-3296

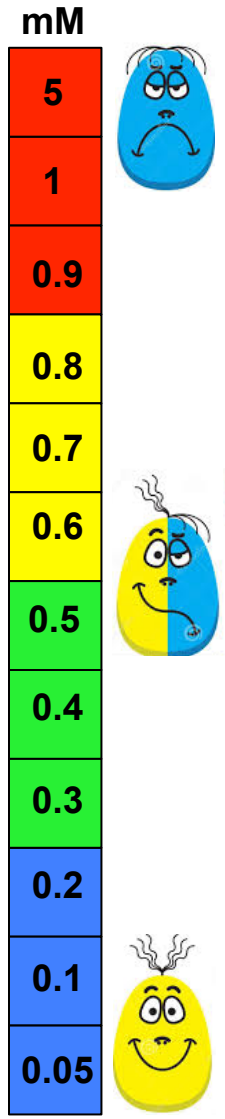
The Solution!



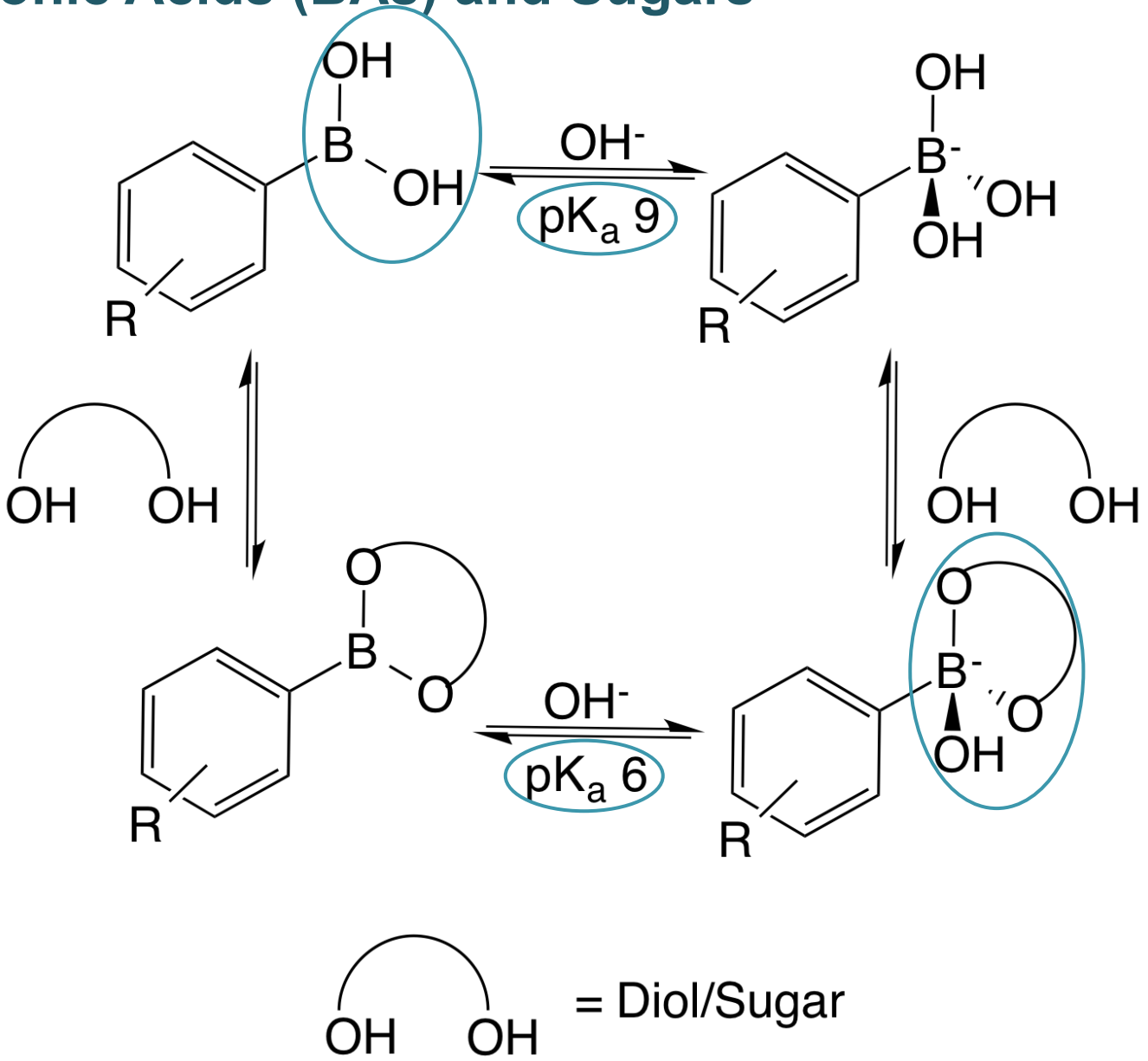




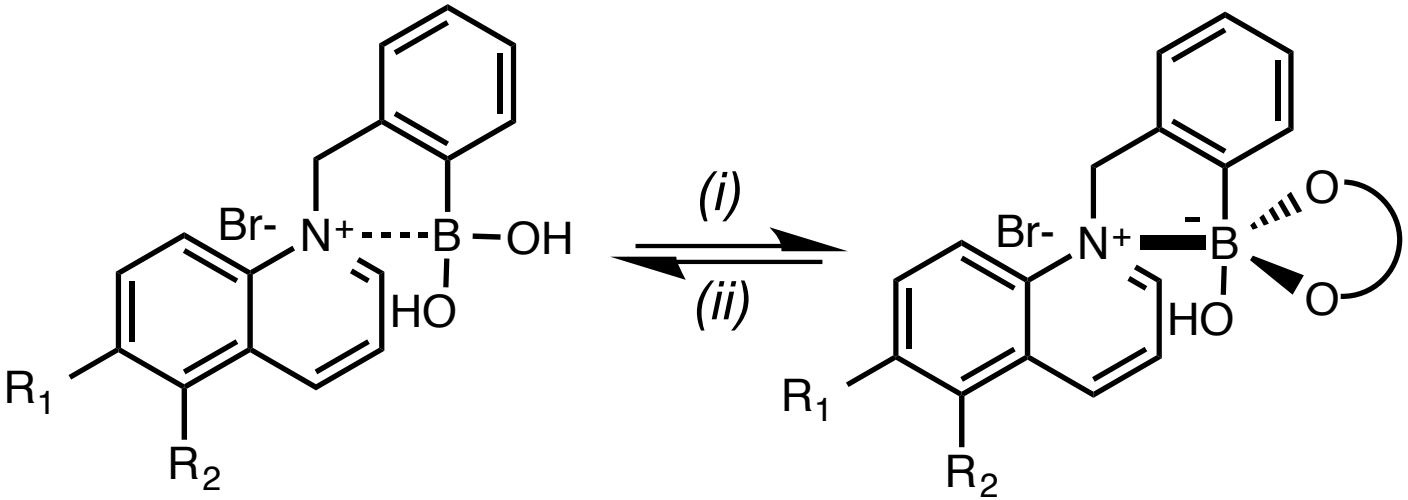




Boronic Acids (BAs) and Sugars



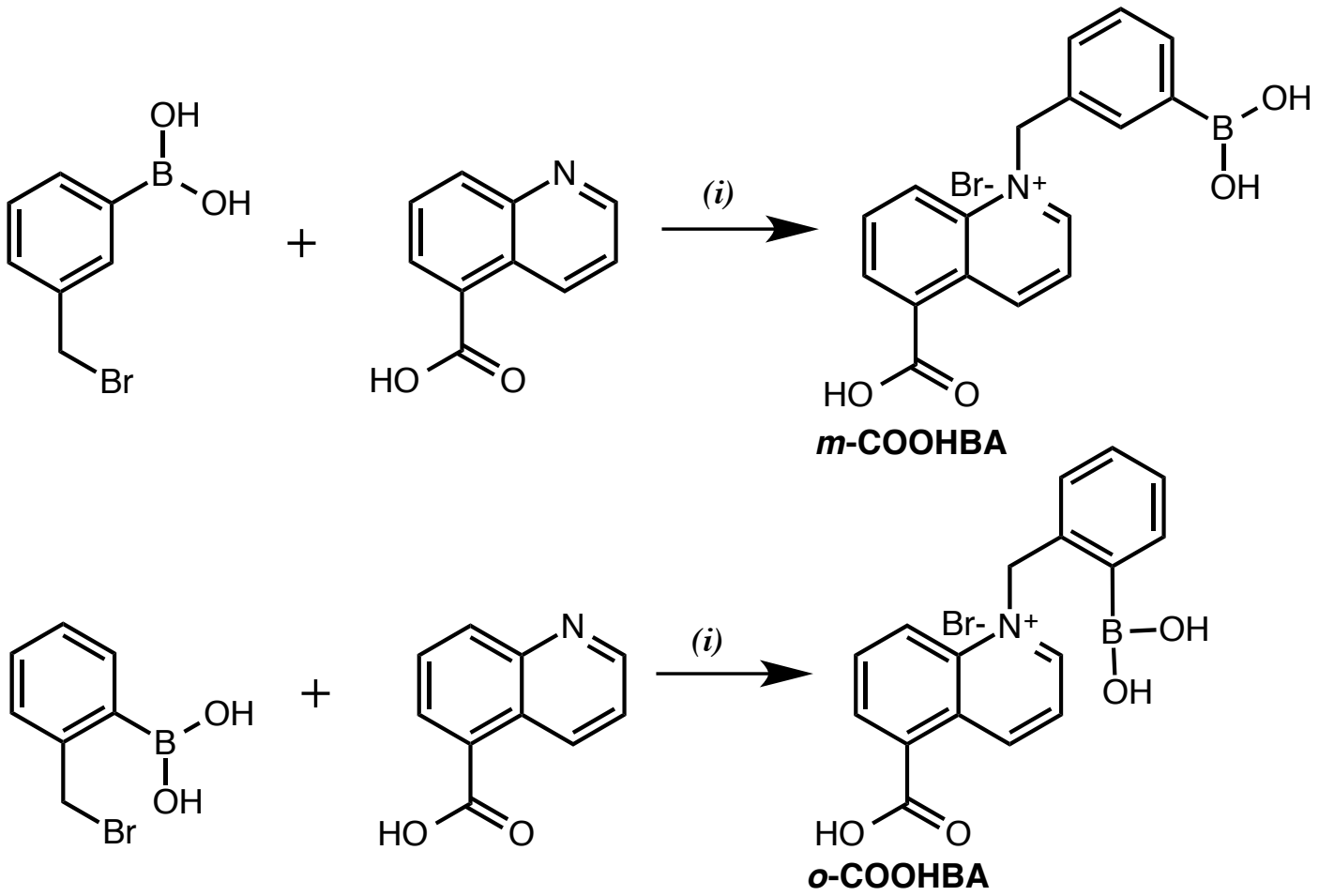
Charge Neutralisation-Stabilisation Interaction



Fluorescent **Non-Fluorescent**

(i) Addition of OH^- ions/glucose
(ii) Addition of water/removal of glucose

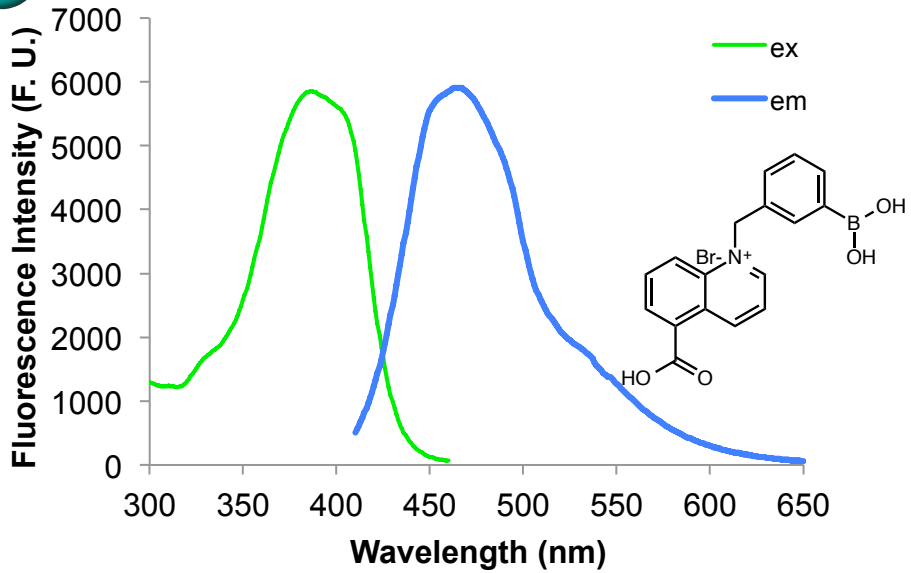
Synthesis of COOHBA Sensors

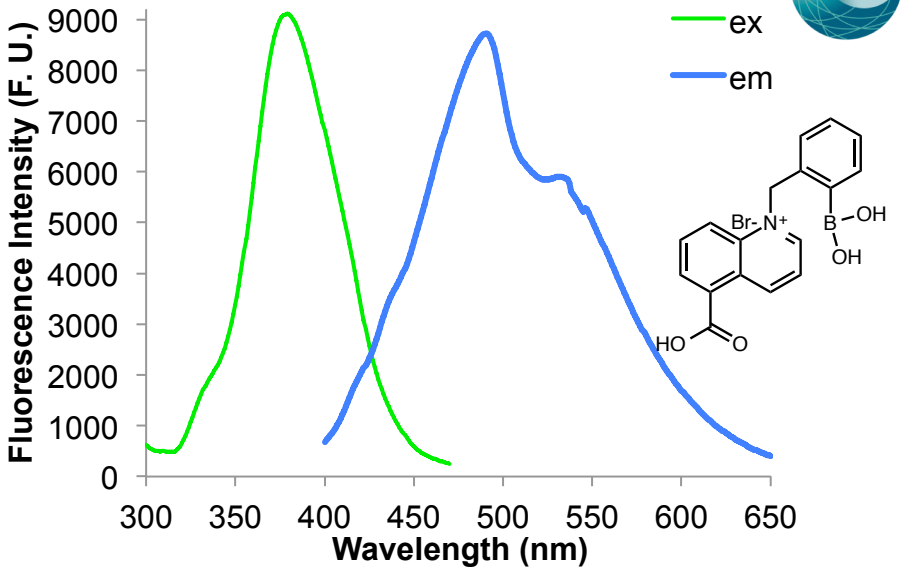


(i) Anhydrous dimethylformamide, N_2, 80 ^{0}C for 48h.

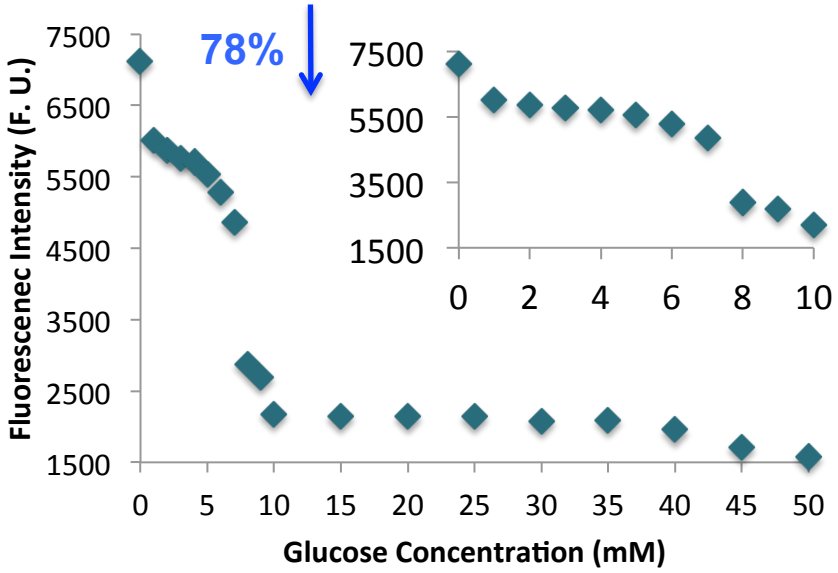
Successful synthesis of novel BA sensors were confirmed by ^{1}H NMR.

Fluorescence Results

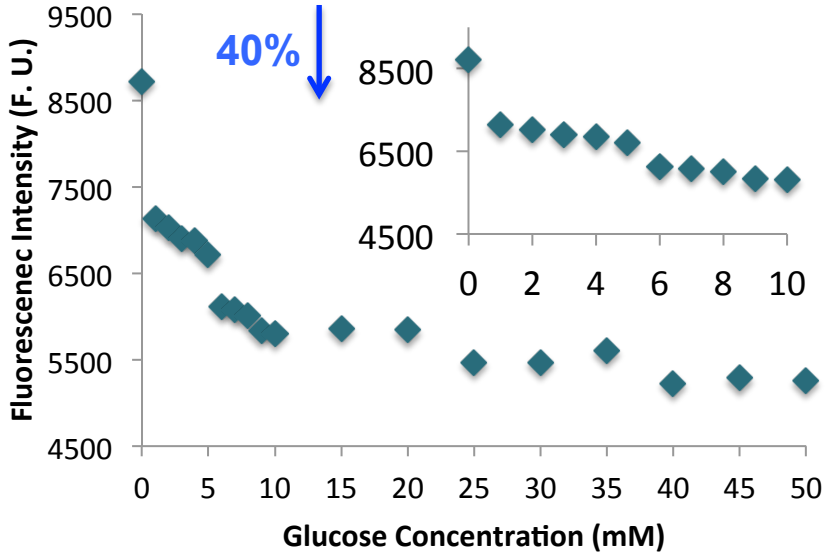




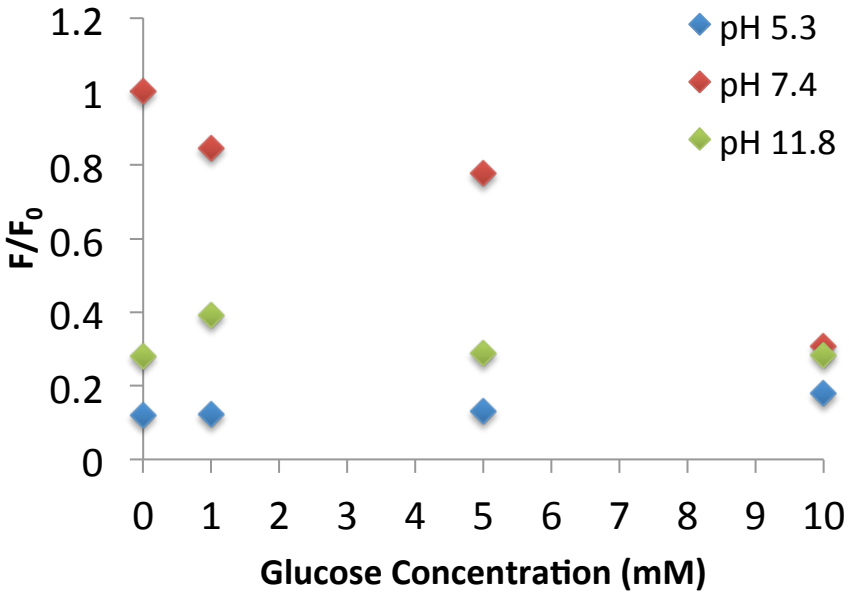
m-COOHBA *0.5 mM in pH 7.4 phosphate buffer; Excitation 390 nm; Emission 465 nm*

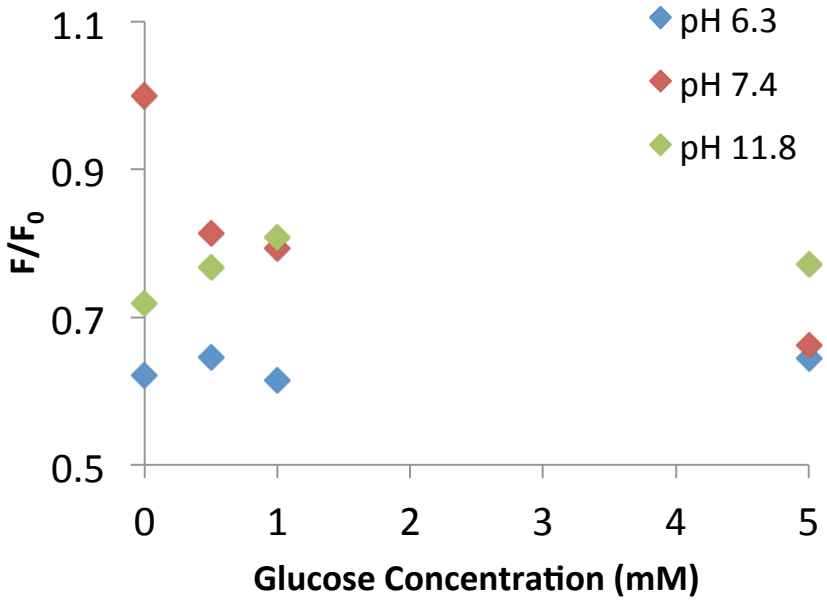


o-COOHBA *0.5 mM in pH 7.4 phosphate buffer; Excitation 380 nm; Emission 485 nm*

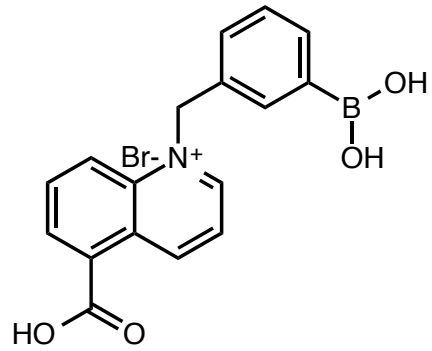


pK_a Investigation – Glucose Sensing pH Range

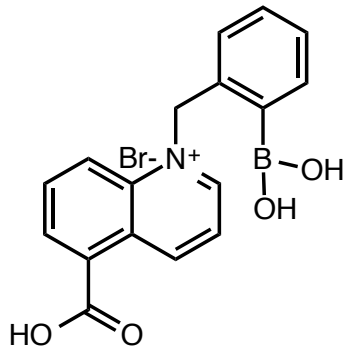




Glucose response for m-COOHBA and o-COOHBA (0.5 mM) in different pH buffer solutions ranging from pH 5-11.



***m*-COOHBA**



***o*-COOHBA**

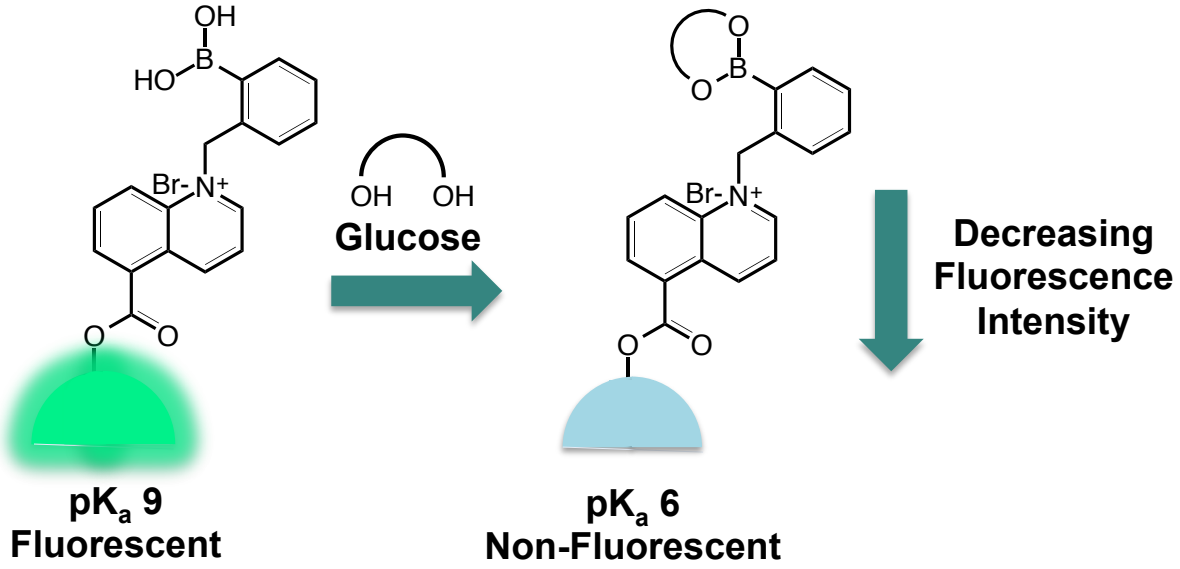
Conclusions and Future Work

Conclusions

- Novel BAs are capable of glucose sensing
- Suitable for ocular glucose sensing
- -COOH substituent for desired anchoring possibilities

Future Work

- Immobilisation of the sensors on to a lens-like platform



Thanks to...

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- Enterprise Ireland
- EU Projects: NAPES, CommonSense, Aquawarn, MASK-IRSES, OrgBio

Thank you for your attention!

DCU

SEVENTH FRAMEWORK PROGRAMME

MARIE CURIE ACTIONS

MASK
Project no: 269302
Materials and Advanced Sensor Knowledge Exchange

OrgBIO
ORGANIC BIOELECTRONICS

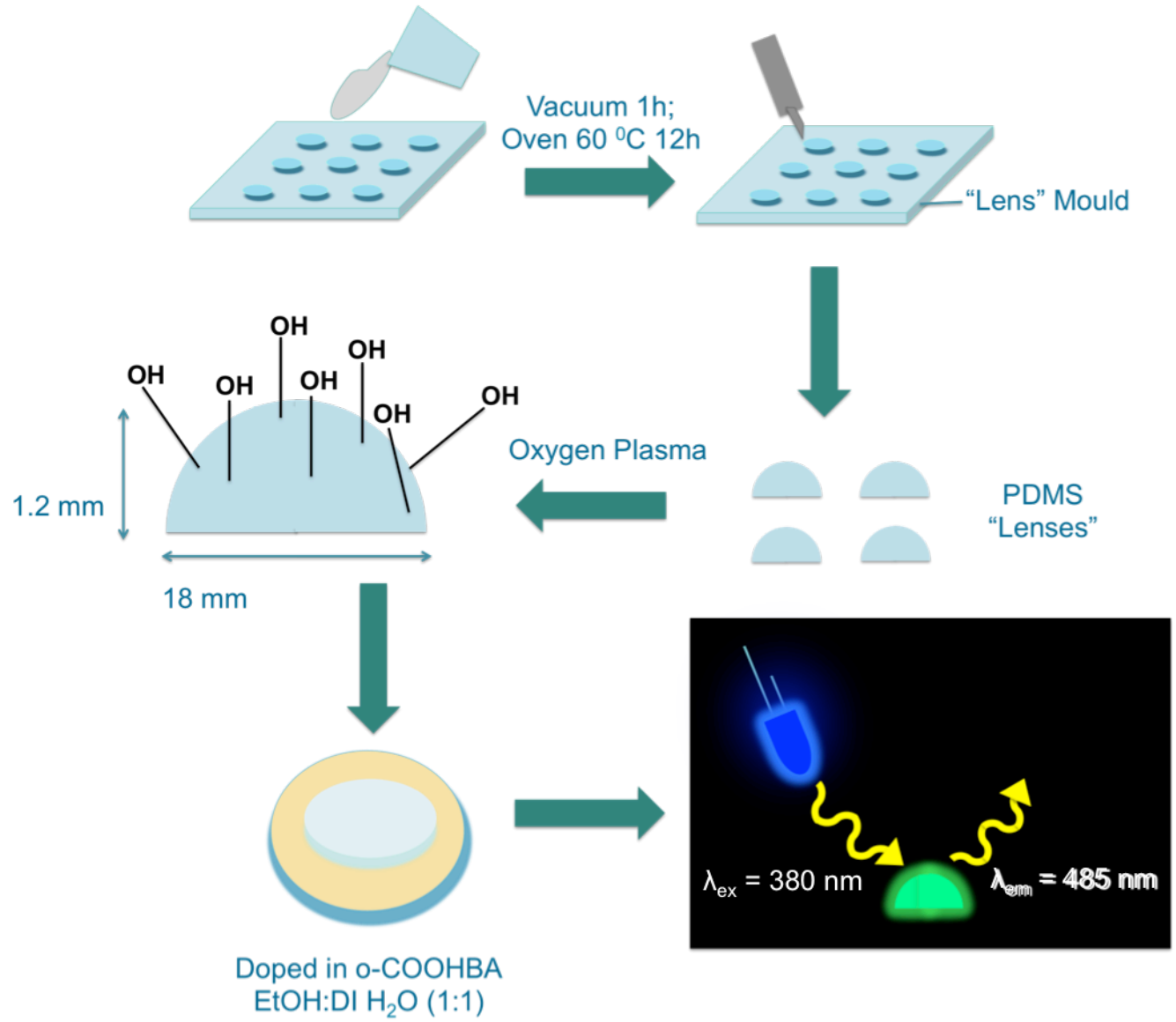
NAPES
NEXT GENERATION ANALYTICAL PLATFORMS FOR ENVIRONMENTAL SENSING

COMMON SENSE
MARINE SENSORS - MARINE MONITORING

aquawarn

sfi DCU UCC OÉ Gaillimh NUI Galway UCD DUBLIN ENTERPRISE IRELAND where innovation means business

PDMS Lens Fabrication



Functionalised PDMS Lens Fluorescence Studies