



Glucotrack[™] G

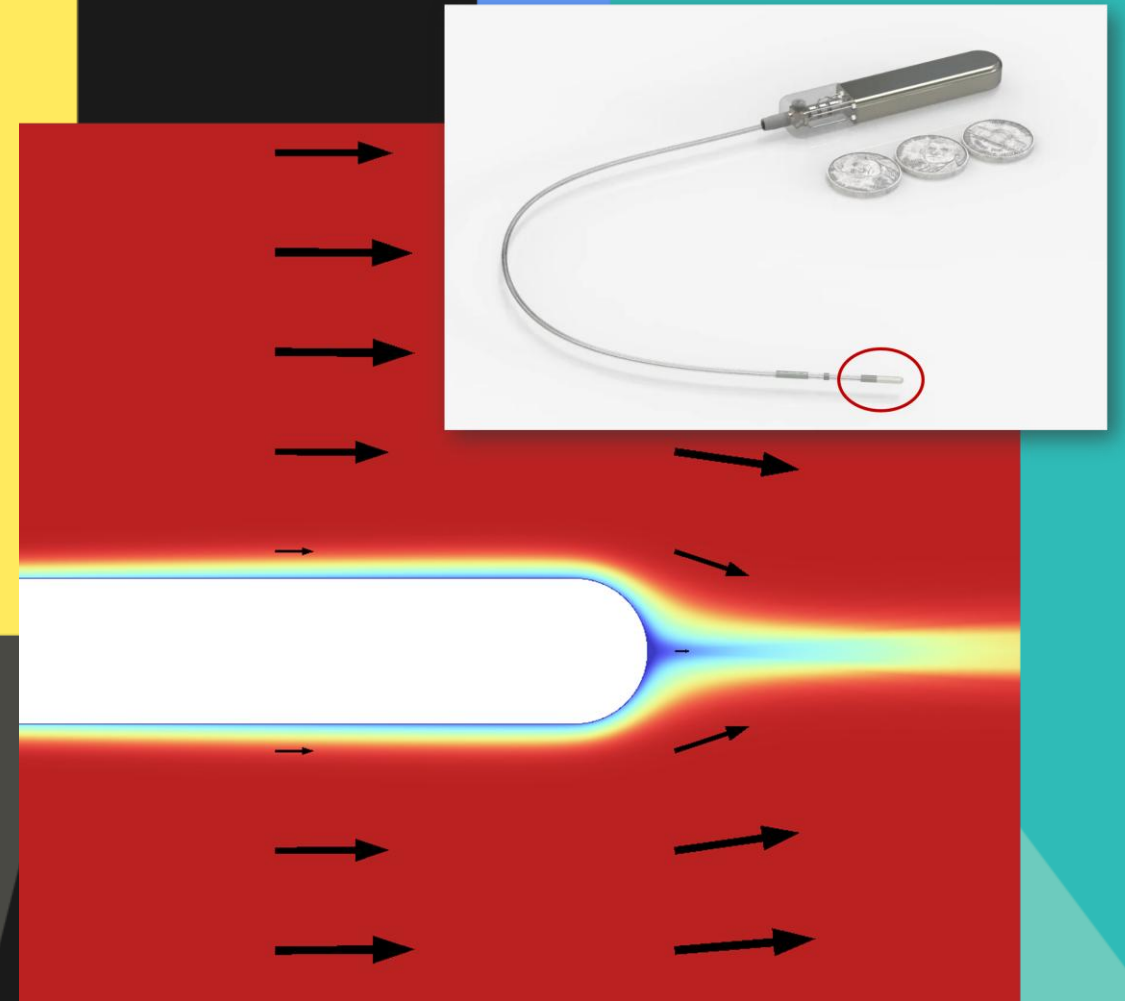
In silico modelling of a long-term implantable continuous blood glucose monitor

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COMSOL Conference 2026 Cambridge



Introduction

Need

- Continuous glucose monitors (CGMs) are widely used to monitor the glucose levels of people living with diabetes. Typically, these are patches worn for 10-15 days
- CGMs help blood glucose control, providing strong health benefits, but are not suitable for everyone, due to skin irritation; poor reliability due to disturbance of the subcutaneous sensor needle; recurring cost of sensors.

To address this need, Glucotrack is developing a fully implantable device to measure glucose over multiple years.

Challenge

- Sensor longevity is the key challenge, due to deactivation of the enzyme over time and resulting sensor drift
- A severe development bottleneck is that it can take months, or years, to test sensor performance and longevity in the lab.

To enable rapid design development, TTP developed a model for Glucotrack to predict sensor performance over life.

Abbott Libre 3 Wearable CGM

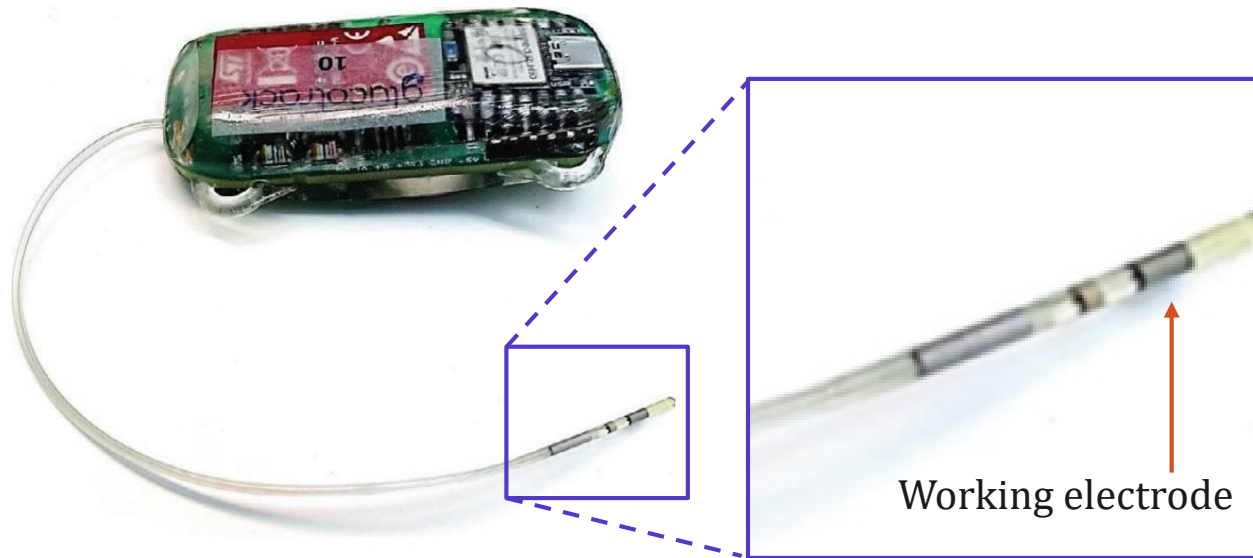


Glucotrack Implantable



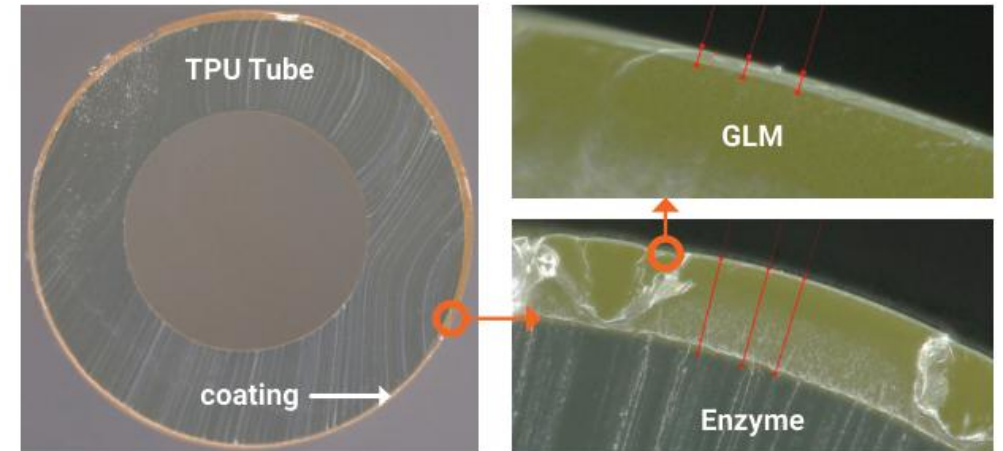
There is an unmet need for implantable continuous blood glucose monitoring

Glucotrack's implantable continuous blood glucose sensor



Prototype Glucotrack CBGM device used for animal studies

<https://doi.org/10.1155/jdr/8838426>

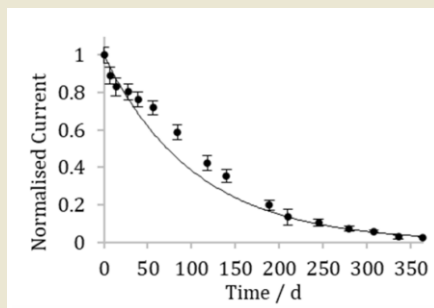


Cross-sectional Slice of Enzyme and Glucose Limiting Membrane (GLM) Coated Layers on an Analogue Sample

Modelling approach

Core model

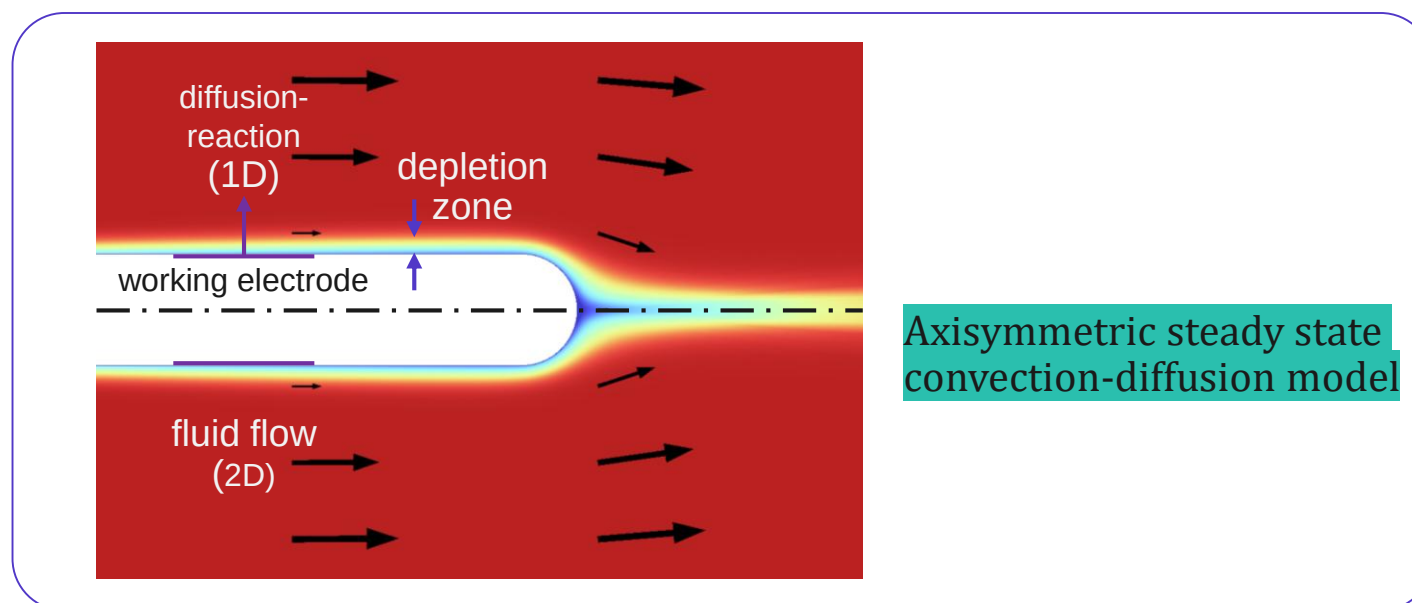
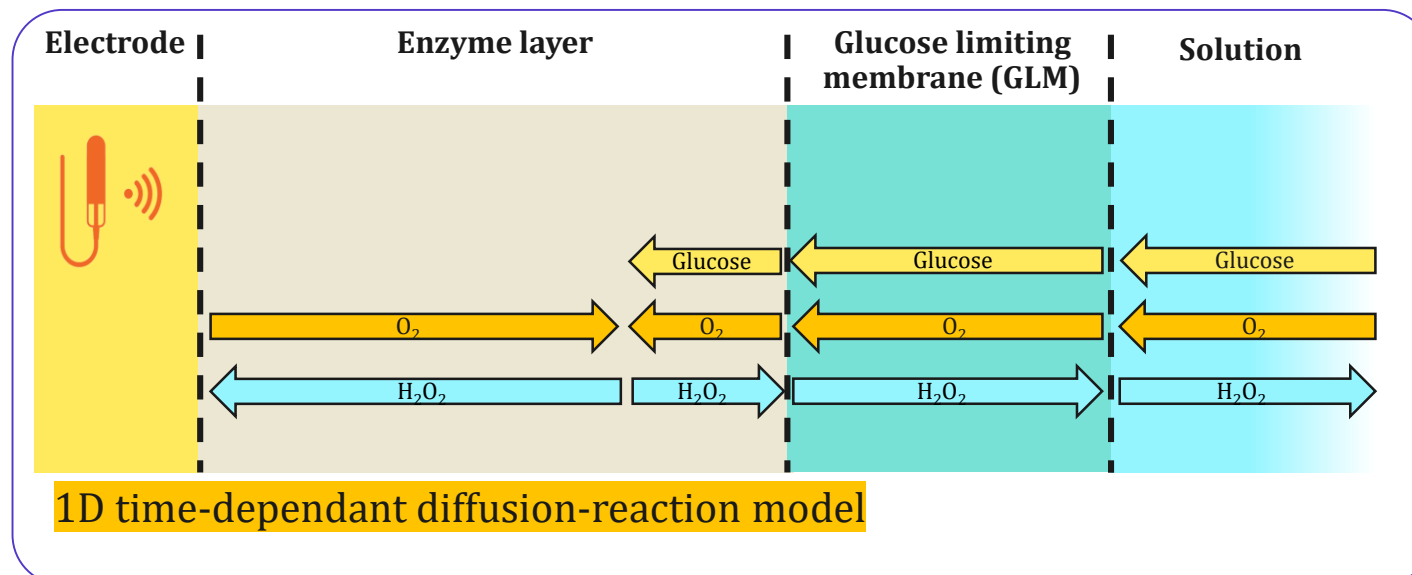
- 1D time-dependent simulation of reaction and diffusion, including enzyme deactivation [1].



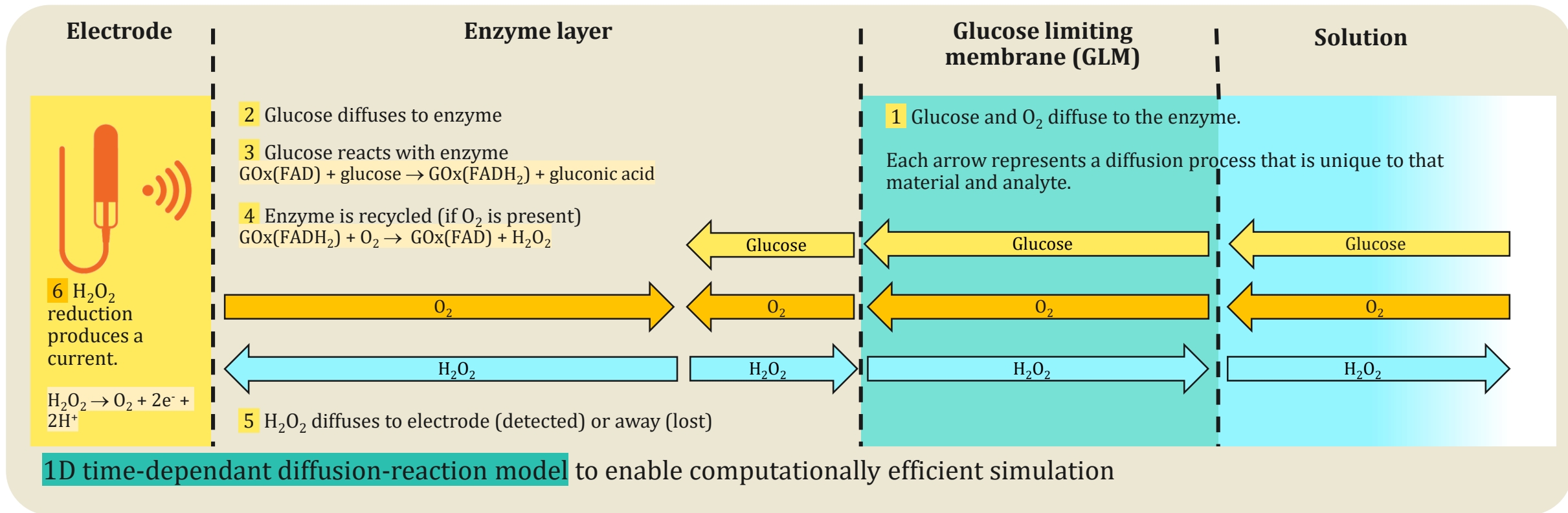
Flow model

- Axisymmetric convection-diffusion model to derive boundary conditions for the 1D model to represent depletion zones near the sensor surface.

1. Year-Long Measurement of Glucose Oxidase Deactivation in electrochemical Glucose Sensors, IEEE SENSORS JOURNAL, VOL. 26, NO. 10, 15 MAY 2026



Reaction-diffusion model



Determining model inputs

The model inputs are determined using a “bottom up” approach

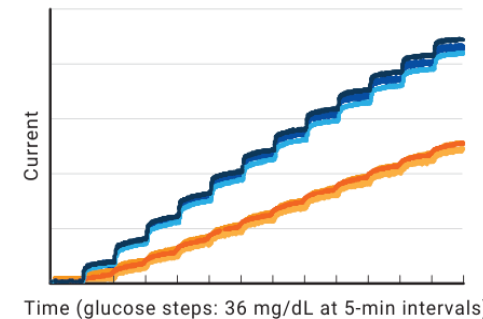
- independently measure or analyse each process
- combine processes to predict emergent behaviour.

Model inputs:

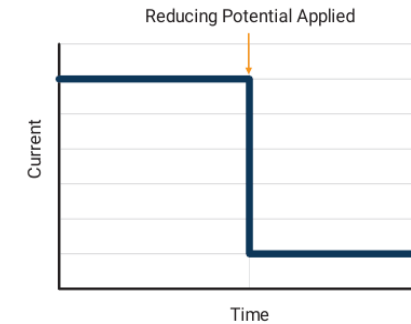
- transport properties for each species and layer (diffusion & partition coef.)
- depletion layer thickness in solution
- reaction rate constants.

These were derived from:

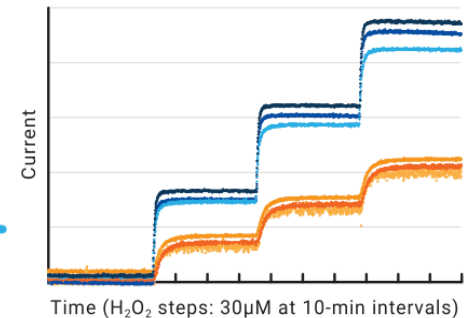
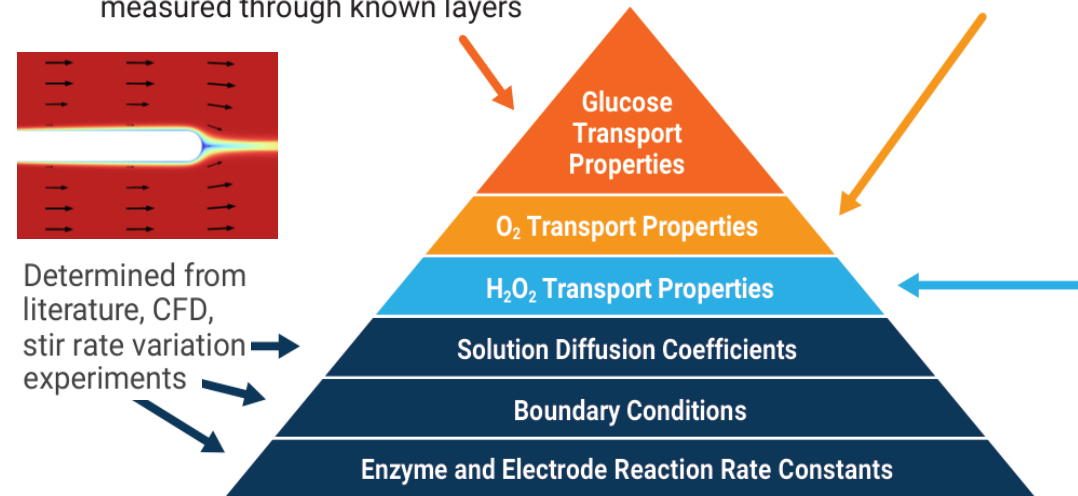
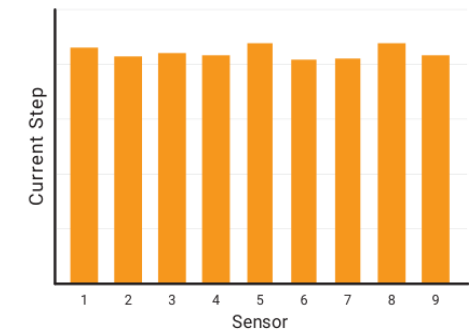
- experimental tests
- CFD simulations
- literature.



Determined from glucose oxidation measured through known layers



Determined from O₂ reduction measured through known layers



Determined from H₂O₂ oxidation measured through known layers

Model use and key results

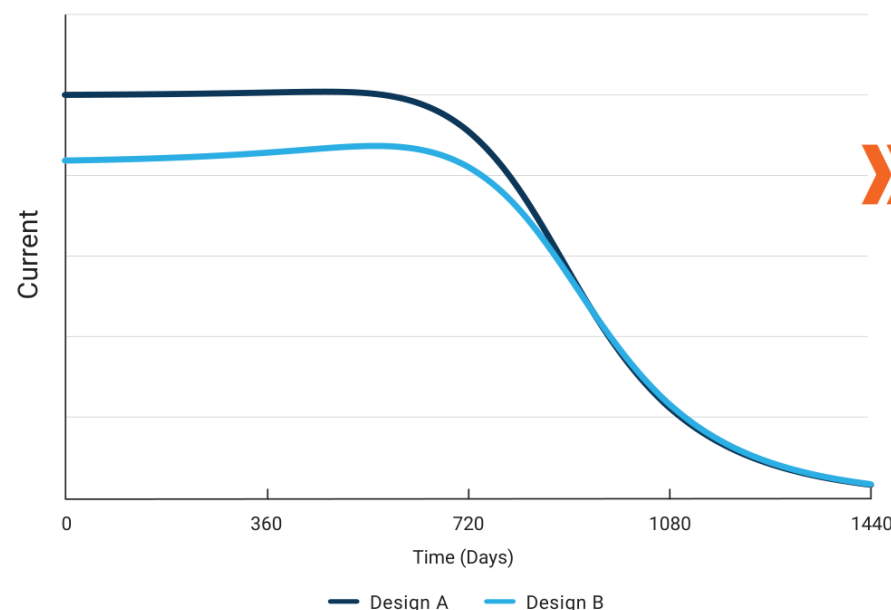
Model use

- **Linearity** and **response time** were derived from simulated glucose step-response tests
- **Sensitivity** was monitored with long periods at constant glucose concentration
- Layer thickness and composition were varied to **explore the sensor design space and improve lifetime**.

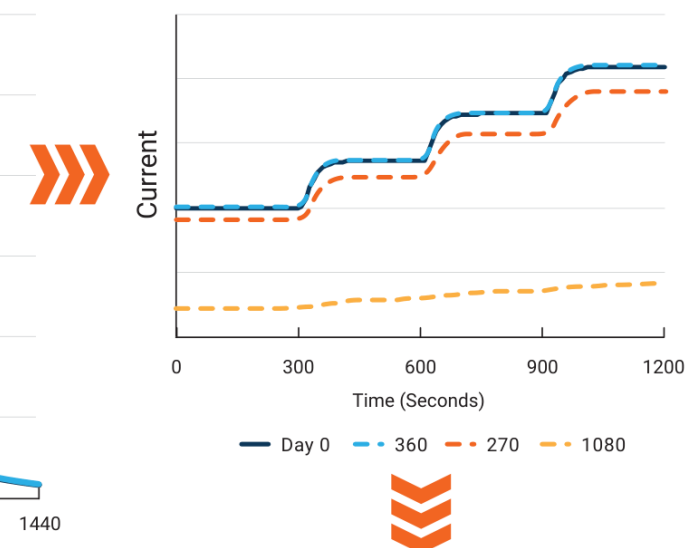
Key results

- The preferred sensor design meets key performance requirements
 - Lifetime: >3 years
 - Response time: <180 seconds
 - Linearity: close to linear response, managed by 2-point calibration

Simulated Sensor Lifetime



Glucose Step Response Over Lifetime

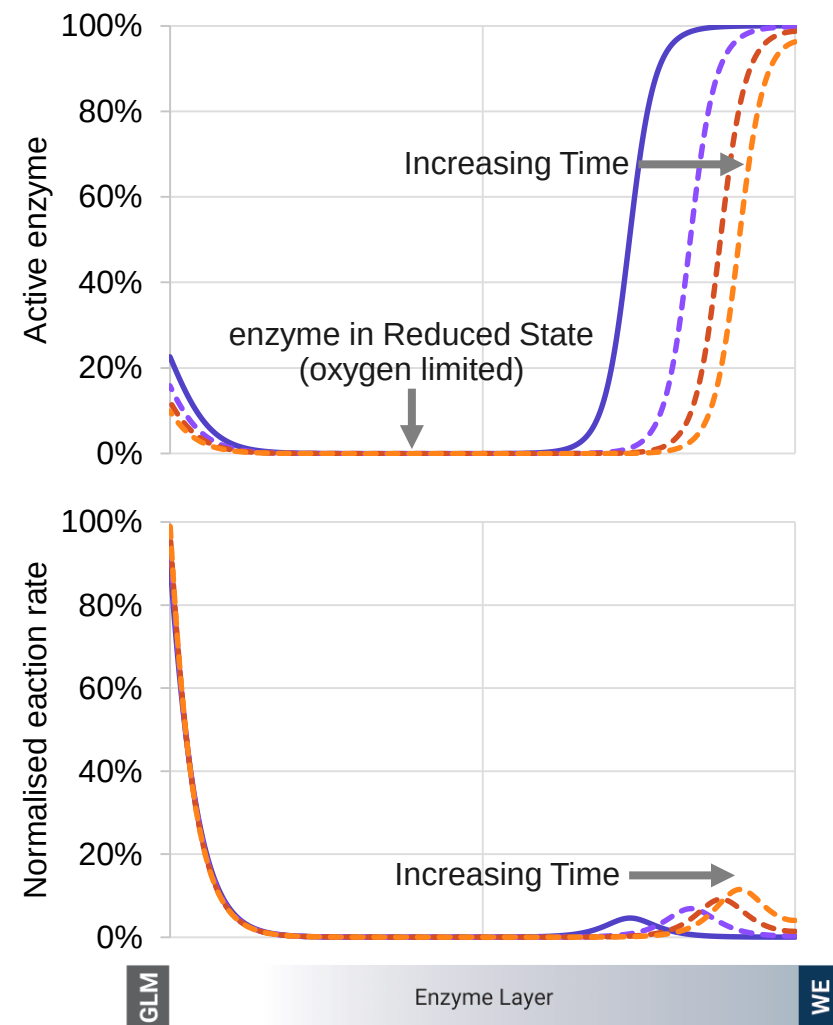


Sensitivity, Response Time, Linearity

Conclusions

TTP's modelling work enabled rapid development of Glucotrack's implantable continuous blood glucose monitor, and built confidence in the sensor lifetime before proceeding with animal and first-in-human trials.

- The model provides valuable insights into implantable CBGM sensor longevity.
- Reaction dynamics and critical analyte concentrations for sensors with different layer thicknesses are understood.
- In particular, modelling results suggested significant design improvements to improve sensitivity, stability, and linearity.



The model reveals complex behaviour within the enzyme layer, informing design improvements



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Redefine possible