Contact Lenses for Real-Time Colorimetric Sensing of Glucose

Danielle Bruen1, Rami Albatal2, Larisa Florea1 and Dermot Diamond1

1Insight Centre for Data Analytics, National Centre for Sensor Research, School of Chemical Sciences, Dublin City University, Dublin 9, Ireland.
2Insight Centre for Data Analytics, Dublin City University, Dublin 9, Ireland.

Introduction

Boronic acids (BA) are well-known for their interactions with diol-containing compounds like glucose. Fluorescent moieties are commonly incorporated into a BA derivative’s framework to monitor the effect of increased glucose concentrations in a given environment. In this study, a novel carboxylic acid BA derivative, o-COOHBA, has been synthesized and investigated for glucose sensing, in solution and when immobilised onto a polydimethylsiloxane (PDMS) “lens”-like surface. In both cases on increased glucose concentrations, a decrease in fluorescence intensity was observed in the range of 0-10mM in solution and similarly, in the range of 0-5mM when anchored to a PDMS surface, corresponding to the ocular-glucose concentrations for diabetics (~500µM – 5mM). This approach aims to develop smart contact lenses that will allow people suffering from diabetes to track their condition non-invasively.

Sensing Mechanism

Glucose Sensing

The fluorescence of o-COOHBA has been studied in solution and when anchored to a PDMS surface. o-COOHBA has shown to respond to glucose in the dynamic range of 0-10mM, which corresponds to the ocular-glucose concentration range in diabetics (~500µM – 5mM).

Synthesis of BA Sensor

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

PDMS Lens Fabrication

Conclusions

In both solution studies and when anchored on to the PDMS surface, a decrease in fluorescence intensity was observed on increased glucose concentrations. The excitation wavelength of 380 nm is advantageous, as it lies close to the visible-region of the electromagnetic spectrum, which allows for the use of cheap, readily available LEDs as excitation sources. The large Stokes shift of 100 nm is also ideal for a sensing application. The carboxylic acid substituent was also desirable for immobilizing the BA sensor onto a wide variety of polymeric substrates.