Indirect Optical Glucose Detection using a Two-Component Sensing System

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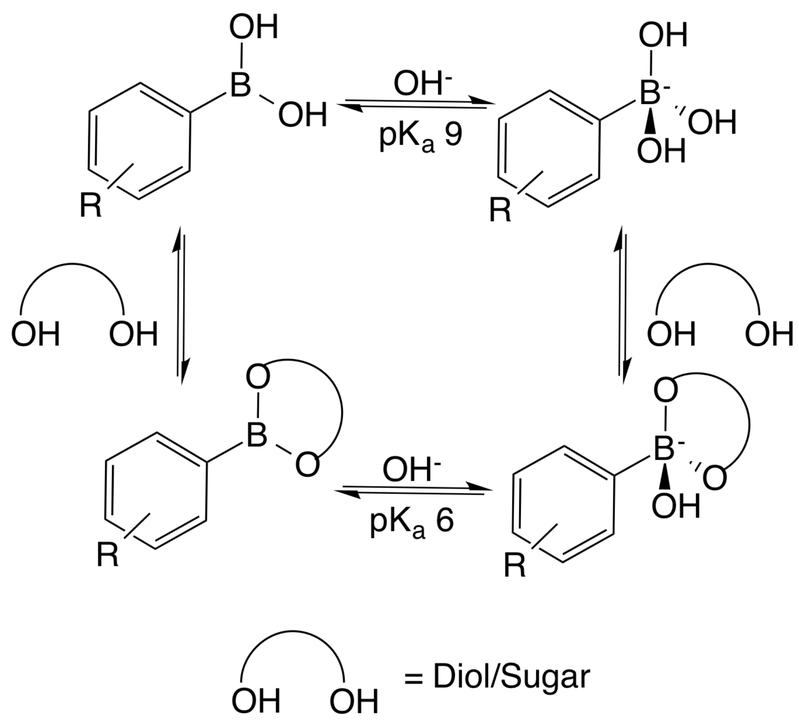
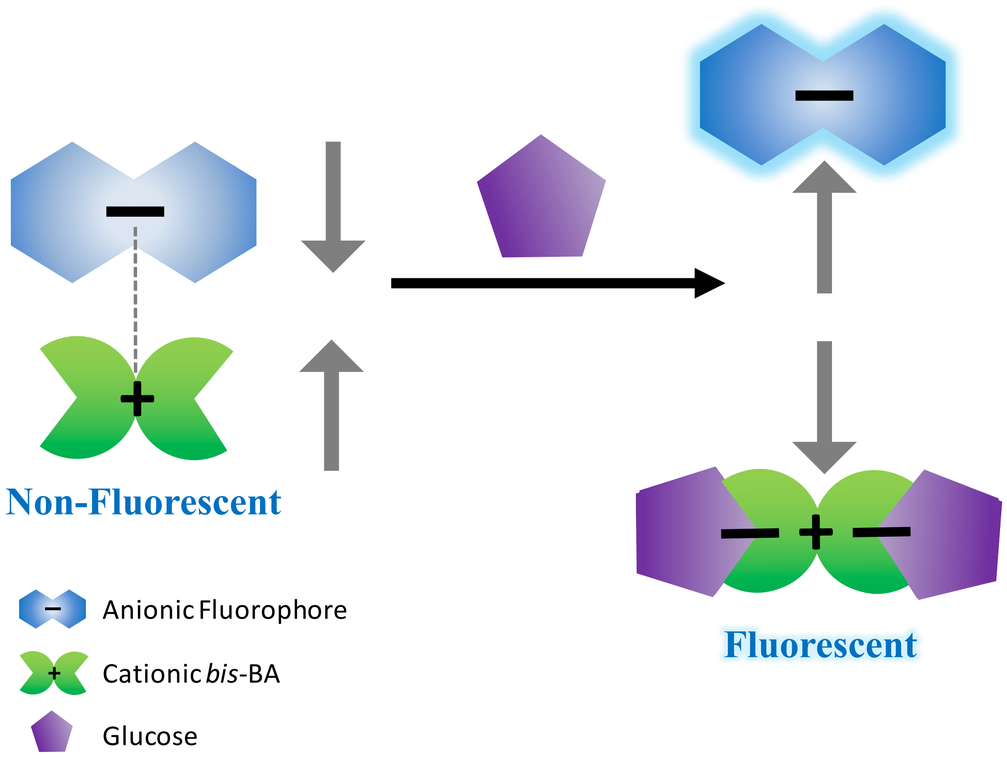
Introduction

Diabetes is a worldwide incurable disease known to have acute and chronic health effects, such as blindness, heart or kidney failure. Monitoring physiological glucose concentrations is a means of managing diabetes, however no continuous non-invasive monitoring method currently exists. The use of boronic acids (BAs) for sensing sugars is well-known, as these Lewis acids have a high affinity for diol-containing compounds. In this context, cationic BA derivatives have been investigated for potential use in sensing-devices as a two-component sensing system, as they have shown to quench the fluorescence of known fluorophores, such as 7-hydroxycoumarin (7HC) and on incremental additions of glucose, the fluorescence of 7HC can be restored. This approach aims to develop non-enzymatic optical glucose sensors through which people suffering from diabetes can track their condition.

BA Sensing Mechanism

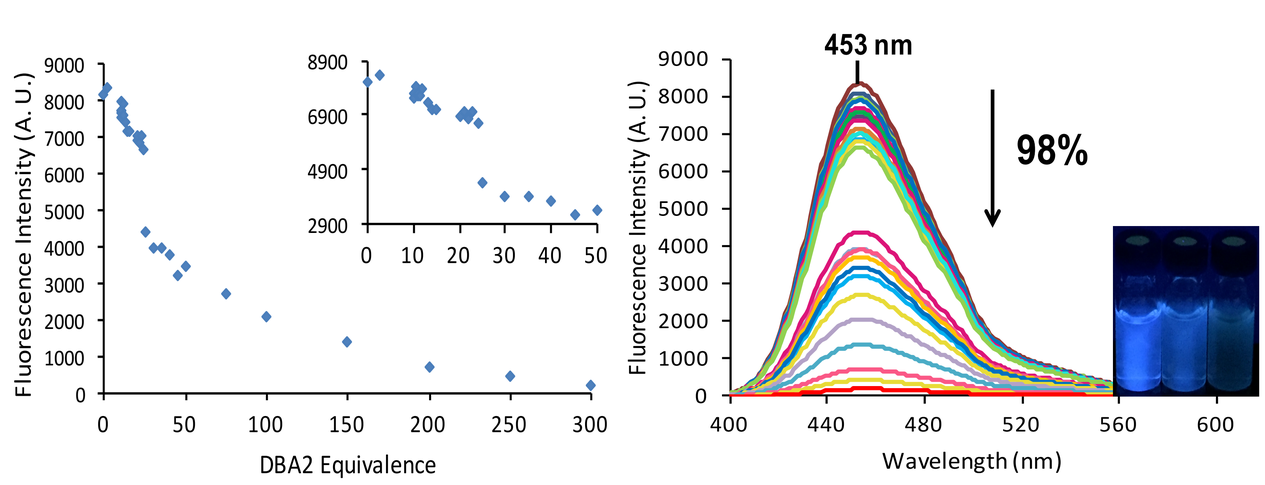


Two-Component Sensing Mechanism

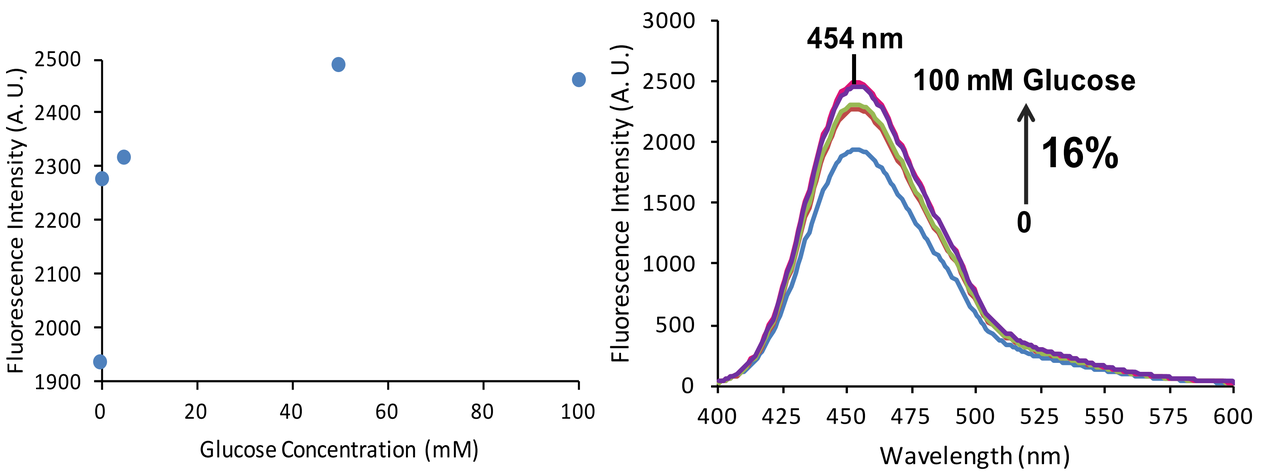


Glucose Sensing

A novel *bis*-BA sensor (DBA2) was synthesized and used in a two-component system with the fluorophore 7-hydroxycoumarin (7HC). The fluorescence of 7HC was monitored at pH 8.6. It was observed that the fluorescence of 7HC became quenched with increasing concentrations of DBA2 and on sequential additions of glucose, the fluorescence could be restored.



Fluorescence quenching of 7HC with increased concentrations of DBA2 in MeOH:pH 7.4 Phosphate Buffer (1:1) with overall pH 8.6. Excitation wavelength 370nm, emission wavelength 453nm.



Fluorescence recovery of 7HC with increased concentrations of glucose (100mM) in MeOH:pH 7.4 Phosphate Buffer (1:1) with overall pH 8.6. Excitation wavelength 370nm, emission wavelength 454nm.

Conclusions

7HC demonstrated a decrease in fluorescence intensity on increased DBA2 concentrations by 98%. On sequential additions of glucose up to 100mM, the fluorescence could be recovered by 16% and in particular, the sensor was most sensitive to glucose in the range of 0-5mM, which corresponds to the ocular glucose range in diabetic patients, 0.5-5mM. The higher excitation wavelength of 370 nm is also advantageous, as it lies close towards the visible-region of the electromagnetic spectrum, which allows for the use of low cost, readily available LEDs as excitation sources.

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