Novel Chemical Sensors Using Boronic Acids for Glucose Detection

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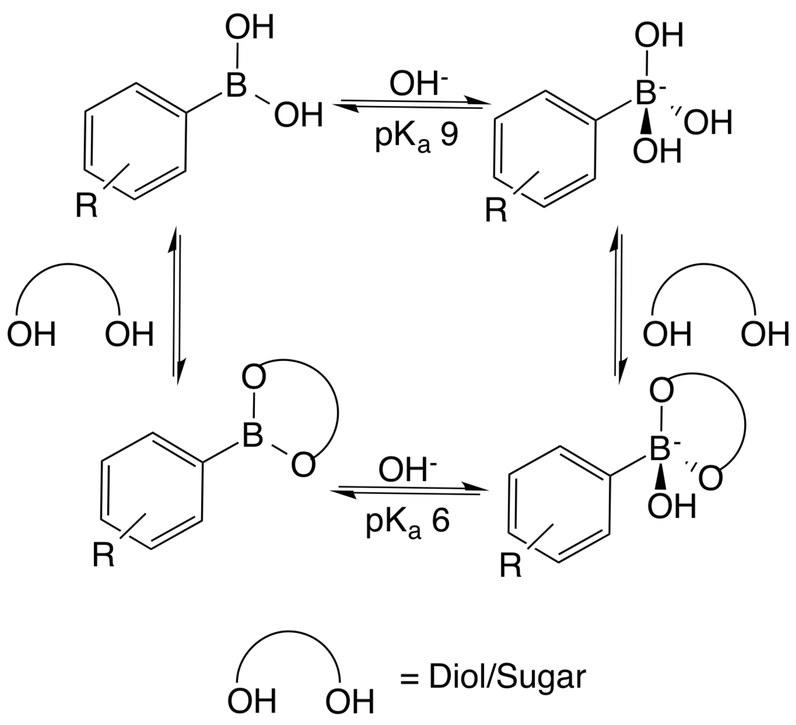
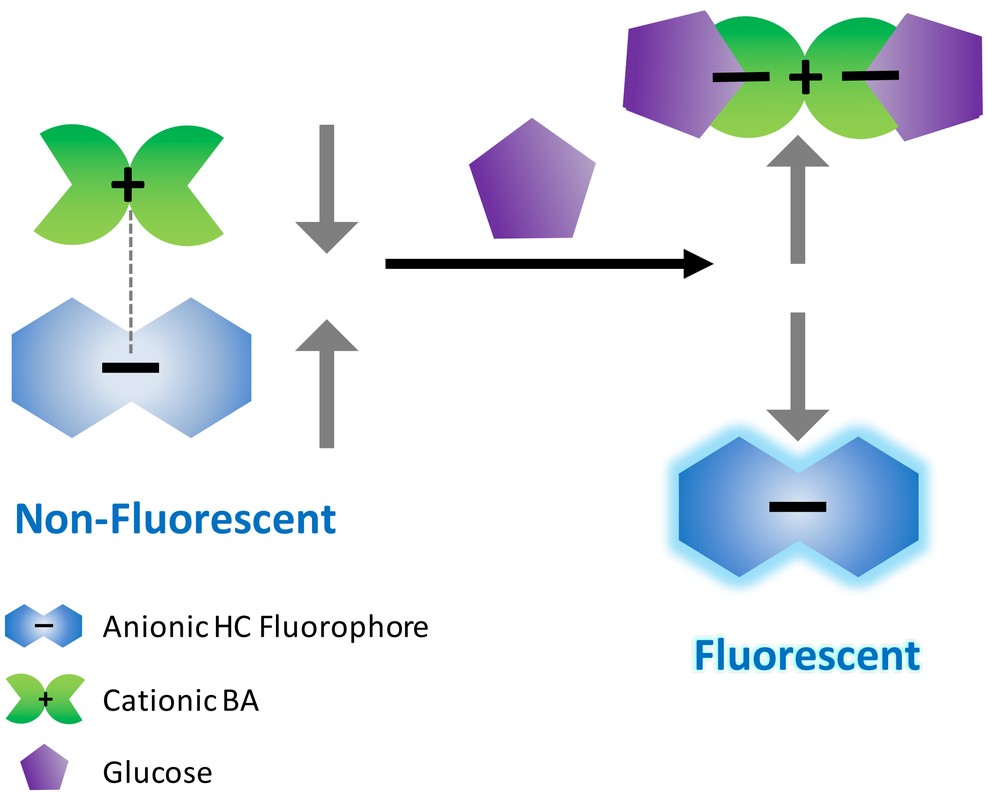
Introduction

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 glucose sensing in a two-component sensing system. Cationic BAs have shown to quench the fluorescence of anionic fluorophores, such as 7-hydroxycoumarin (7HC). Subsequent incremental additions of glucose can restore the fluorescence of 7HC. This approach aims to develop non-enzymatic optical glucose sensors through which people suffering from diabetes can track their condition.

Equilibria between BA and diols in aqueous media

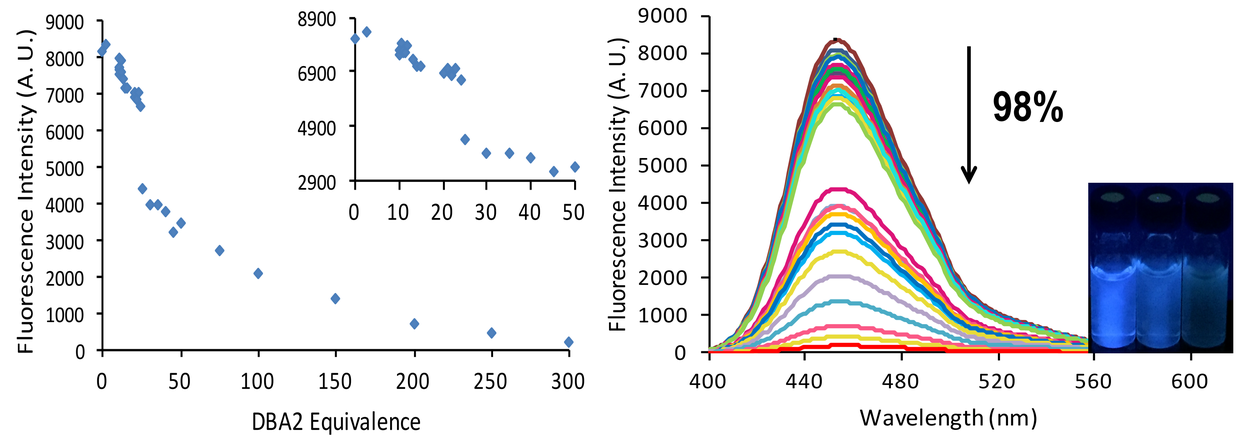


Two-Component Sensing Mechanism

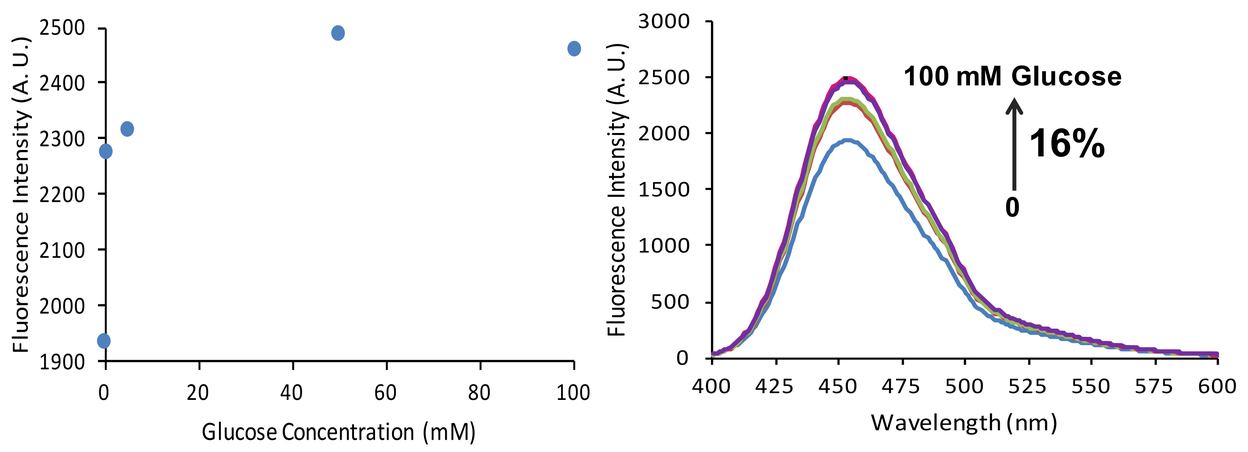


Glucose Sensing

A novel *bis*-BA sensor (DBA2) was synthesized and used in a two-component system with the 7HC fluorophore. 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.



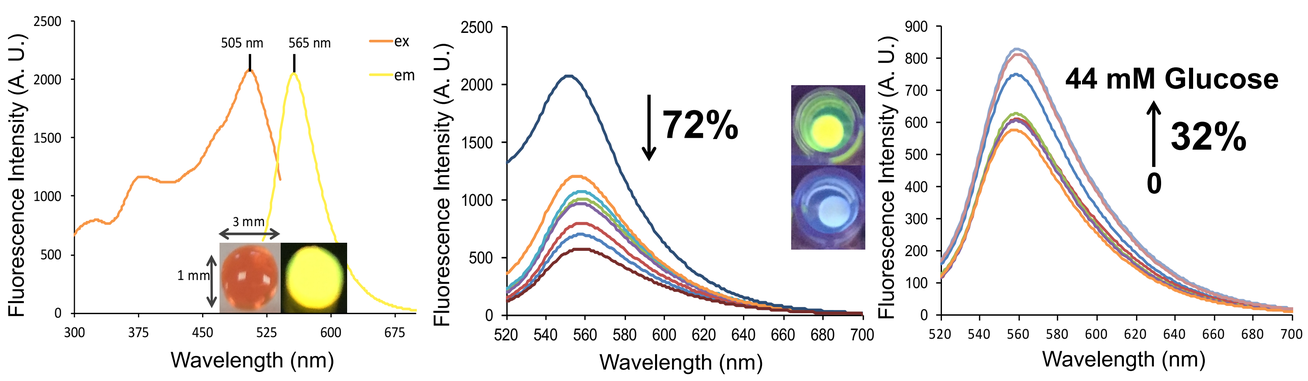
Fluorescence quenching of 7HC with increased concentrations of DBA2 in MeOH:pH 7.4 Phosphate Buffer (1:1) with overall pH 8.6. Excitation wavelength 370nm, emission wavelength 453nm.



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.

Future Work

This two-component glucose sensing switch can also be incorporated in to a gel matrix, when the sensing groups contain polymerisable units. On immobilising this sensing system in to a gel matrix, the system can be quickly optimised on interchanging the sensing components, as well as providing convenient integration in to a device.



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 incorporation of this sensing system in to gel matrices could provide convenient integration in to wearable sensing platforms, such as smart-patches or contact lens devices.

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