UMSAEP UM-UWC Interim Report

Visit to Columbia, Missouri, 11 April – 27 June 2019

Multi-component electrochemical sensors based on cucurbit [8] uril and their boronic acid substituted bis-

1. Overview

The research exchange visit to the University of Missouri (Columbia) represented the first steps towards a mutually beneficial research collaboration between the electrochemistry driven research focus of SensorLab (UWC) and the Organic Chemistry synthetic expertise offered by the Chemistry department (Columbia, Missouri). SensorLab researchers introduced the electrochemical approach to analytical reporting extensively studied in their laboratories (UWC) as a suitable protocol for sensitivie reporting of glucose. The Glass organic synthesis group provided the host-ligand system comprised of cucurbit[8]uril and various boronic acid ligands as the active components of a solution system for titration with glycolipids and fluorescence reporting of the binding efficiency. In this collaborative project we evaluated the feasibility of a parallel electro-analytical protocol proposed by Baker for evaluation of the binding efficiency of the Glass analytical protocol for glucose detection.

2. Proposed Objectives (abbreviated)

We proposed the design of a multi-component electrochemical sensor system which binds to glucose which would have advantages such as lower cost, potential for repeat usage and improved durability compared to enzyme-based systems currently in use. The sensor system was based on two boronic-acid containing receptors which are bound together non-covalently by a cucurbituril macrocycle first reported by the Glass group (see Figure 1).

Figure 1: Flourescence sensing protocol for glucose detection (Ming Xu et al, 2018, Angewandte Chemie)

The receptors have a viologen (dication) base because cucurbiturils (CBs) are well known to bind to cation guests. Binding to glucose causes the receptors to rearrange in the macrocycle. Boronic acids are well known to become negatively charged (boronate), therefore we expect significant changes in the electrochemistry of the sensor upon binding glucose. Following a parallel approach to the fluorescence sensing an electrochemical layer by layer approach was designed using $K_3Fe_3(CN)_6$ as the internal reporting redox molecule (similar to the dye in Glass concept). The redox compound is fully dissociated in aqueous systems and the oxidation and reduction of the Fe^{2+}/Fe^{3+} system forms a highly efficient redox indicator for binding as the charge within the CB host changes.

So, we would like to see if a change in redox potential correlates with the addition of glucose. If significant changes are observed, it may be interesting to coat simple electrodes with our sensor to see if a model 'test strip' can be developed. It would also be important to check for a response upon

Objective 1: CB as host agent

(a) (b)

Figure 2: (a) Experimental set up for the evaluation of ligands and (b) Cyclic voltammetry response of G1, G5 and G6 ligands

(a) (b)

Figure 3: (a) Cyclic voltammetry redox probe current response to ligand binding and (b) associated binding curve for each ligand (n=3) h (v)-50 .15 Td [(b)-50 (i)-72 (nd)-50 (i)-16.9 ( )]TJ 0.006 Tc -[(p (s)a (et)346