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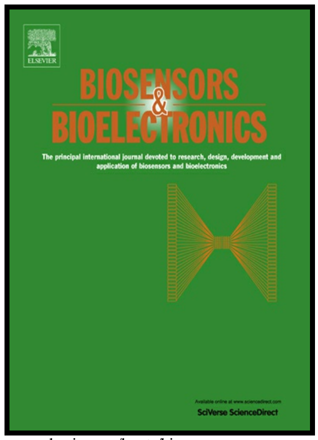

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Field-effect Transition Sensor for KI Detection Based on Self-assembled Calixtube Monolayers

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Abstract

A series of novel calixarene-based tubes comprising different numbers of silatrane anchoring groups was synthesized. For the first time, a self-assembled monolayer (SAM) derived from calixtubes was formed on a SiO_2 surface. The formation of the SAM was confirmed by X-ray photoelectron spectroscopy, scanning electron microscopy-energy dispersive X-ray analysis, and contact angle measurements. Modification of the sensitive surface of a conventional ion-selective field effect transistor (ISFET) with the afforded SAM resulted in the production of a KI-sensitive sensor. This sensor selectively determined KI compare to different alkali metal iodides: NaI, RbI, CsI; also investigation of different potassium salts (acetate, iodide, nitrate, chloride, dihydrophosphate, perchlorate) showed the highest response to KI. This sensor was successfully employed to determine the presence of KI in artificial saliva with a limit of detection of ~3×10^{-8} M. In addition, it was found that the detection limit of the sensor could be increased by combining the sensor with a microfluidic system. Due to the obtained sensor sensitivity and its ability to detect KI in artificial saliva, we could conclude that this sensor shows great potential for application in the determination of KI in different media, such as the human body and in biological liquids, such as saliva or urine.

Keywords: calixarene; thin film; host-guest system; ISFET; potassium iodide; self-assembled monolayer.

1. Introduction

The detection and identification of different compounds is a key issue in modern applied chemistry, with potassium iodide being of particular interest due to its role as a drug for treating dermatologic diseases. More specifically, potassium iodide is successfully employed in the treatment of inflammatory dermatoses, most notably erythema nodosum, subacute nodular migratory panniculitis, nodular vasculitis, erythema multiforme, and Sweet's syndrome (Sterling and Heymann, 2000). KI is usually administered in the form of a saturated solution at a dose of 0.3–6.0 g/day. As iodide concentrates in the salivary glands, the thyroid gland, the gastric mucosa, the mammary glands, the choroid plexus, and the placenta (Cavalieri, 1997), the use of KI with other potassium-containing drugs, potassium-sparing diuretics, and angiotensin-converting enzyme inhibitors can result in hyperkalemia and potassium toxicity (Medical Economics, 1998). In addition, the combination of KI with other iodide-containing drugs (e.g., amiodarone) and drugs that inhibit thyroid function (e.g., phenazone, lithium, and possibly sulfonamides) can cause hypothyroidism (Woeber, 1991). Indeed, patients taking KI frequently suffer from a number of side effects, including diarrhea, nausea, vomiting, and stomach pain (Medical Economics, 1998). These effects can be eliminated by decreasing the dosage, however patients may also experience symptoms of potassium toxicity or iodism over long-term use.

In contrast, iodine is a microelement that plays a vital role in the development of brain activity and cell growth (Yaqoob et al., 2006). As an iodine deficiency can lead to miscarriages during pregnancy, deaf-mutism, and paralysis (Hassanien et al., 2003), additional iodine intake from iodine-rich foods or supplements is recommended. One of the most common dietary supplements is KI (Ratanawimarnwong

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