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Immobilization of polydiacetylene vesicles on cellulose acetate butyrate (CAB)-coated substrates for self-assembled supramolecular sensor arrays

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Abstract

Polydiacetylene (PDA) sensor arrays were successfully fabricated on cellulose acetate butyrate (CAB)-coated glass substrates. Immobilization of amine, carboxylic acid and hydroxy terminated PDA vesicles on CAB can be achieved without the need for covalent bonding between PDAs and the glass substrates. The immobilized PDA supramolecules fluoresce when subjected to thermal stress or in response to specific molecular recognition.

Keywords: Polydiacetylene; Cellulose acetate butyrate; Microarray; Immobilization

1. Introduction

Amphiphilic diacetylene lipids have been actively investigated as supramolecular sensor scaffolds due to the intriguing properties associated with the photopolymerizable diacetylene moieties as well as the stress-induced color and fluorescence changes of the resulting conjugated polymers [1–17]. The majority of PDA-based chemosensors described thus far have relied on visible spectroscopy since a characteristic blue-to-red color change takes place in response to specific ligand–receptor interactions.

Until recently, PDA sensors based on fluorescence signaling features have gained less attention even though it has been known for some time that "blue-phase" PDAs are nonfluorescent while their "red-phase" counterparts fluoresce [18]. Jelinek et al. have shown that catecholamines can be detected by using PDA-based fluorescence [19]. Very recently, we outlined a new strategy for fluorescence-based PDA sensor systems [17]. In this system, PDA microarrays are created on surface-modified glass substrates by using a conventional microarray spotter. Importantly, the immobilized PDAs were found to emit red fluorescence upon heating or by specific molecular recognition.

The microarray formattable and stress-induced fluorescence properties of PDA are important in terms of sensor development since they enable the fabrication of label-free sensor chips that do not contain additional fluorescence probe molecules. In contrast, conventional fluorescence-based sensor chips generally require additional fluorescence probe molecules such as Cy3, Cy5, rhodamine, or fluorescein.

In recent investigations of PDA-based label-free sensor chips, we have sought to uncover a commercially available, spin-castable, and efficient polymer matrix that can be used to efficiently bind immobilized PDA supramolecules on glass substrates. In addition, a matrix polymer that does not require specific functional groups to immobilize PDAs sensors would be most versatile. For example, aldehyde-modified glass substrates were needed for the immobilization of amine terminated PDAs in our earlier studies [17]. In this communication, we describe the results of an exploratory investigation in which we have observed that cellulose acetate butyrate (CAB) is an efficient matrix polymer for the immobilization of PDA sensors.

2. Experiment

2.1. Chemicals

10,12-Pentacosadiynoic acid (PCDA) was purchased from GFS Chemicals. 2,2′-(Ethylenedioxy)bis-(ethylamine)

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