The Development of a Generic Bioanalytical Matrix Using Polydiacetylenes**

By *Sang Wook Lee*, *Chang Duk Kang*, *Doo Ho Yang*, *Ji-Seok Lee*, *Jong Man Kim*, *Dong June Ahn*,* and *Sang Jun Sim**

In order to develop more user-viable formats for polydiacetylene (PDA) biosensors, it is necessary to control the biochemical and physical properties of the PDA matrix. In this study, we prepare polydiacetylene liposomes from controlled mixtures of 10,12-pentacosadiynoic acid (PCDA) and PCDA–MI, a PCDA derivative with a maleimide headgroup. Both the chemical and physical properties of the liposome are easily manipulated by controlling the molar ratio of PCDA to PCDA–MI during liposome preparation. After preparing the liposomes, the activity of the maleimide headgroups increases linearly with the PCDA–MI content for concentrations in the range of 0–30 %. As a result, the antibody-binding characteristics of the PDA liposomes increase with PCDA–MI content. It is also possible to modulate the physical properties of the liposome. Differential scanning calorimetry measurements show that the phase organization of the liposome is progressively lost with increasing PCDA–MI content. Furthermore, the liposomes show an increased color change in response to temperature that is also dependent on PCDA–MI content, indicating increased membrane fluidity. When PCDA:PCDA–MI liposomes are conjugated with a cell-specific antibody the response to the antigen induces a color change that is dependent on the PCDA–MI content. Consequently, it is deduced that the increased sensitivity of the liposomes containing higher PCDA-MI content is due to increased antibody binding and membrane fluidity. From these experiments, we identify the factors controlling the colorimetric properties of the PDA matrix and demonstrate that it is possible to modulate the sensitivity and stability of PDA biosensors by controlling the ratio of constituent monomers.

1. Introduction

Polydiacetylene (PDA)-based biosensors have been attracting steady interest by virtue of their unique, intense colorimetric properties. When diacetylene monomers are self-assembled and polymerized by UV light they generally produce a blue color that changes to red under different stimuli such as temperature, pH, mechanical force, solvent, and most interest-ingly, ligand–receptor interactions occurring at the polydiacetylene matrix interface.[1–2] Various sensor applications for polydiacetylene, such as the detection of influenza virus, cholera toxin, *Escherichia coli*, glucose, cyclodextrin, protein–lipid interactions, and protein and enzymatic reactions incorporate different synthetic receptors in a PDA matrix.[2g,3]

The majority of studies concerning polydiacetylene-based sensors have shown the great promise of these materials as sensory platforms in proof-of-concept experiments. However, it is still necessary to improve PDA-based systems to a more user-viable format. One fundamental aspect of PDA-based systems that has not been given much attention is how to manipulate the properties of PDA matrices. Most PDA bioanalytical platforms have not been characterized in sufficient detail to allow consideration of how manipulation of their properties may be achieved. There is also interest in how to diversify and simplify the application of PDA bioanalytical platforms. The widely used method of synthesizing diacetylene or lipid moieties with a receptor headgroup is clearly limited in terms of applicability, because receptor-bearing compounds must be synthesized for new target molecules. One logical approach for bypassing this requirement is to build a PDA matrix that allows the immobilization of diverse receptors.

Developing a matrix that allows both the manipulation of its properties and the immobilization of diverse receptors would contribute to an understanding of how PDA biosensors work, and may lead to the development of a so-called standardized PDA matrix that could be used for many bioanalytical applica-

[*] Prof. D. J. Ahn, D. H. Yang
Department of Chemical & Biological Engineering
Korea University
Seoul 136-701 (Korea)
E-mail: ahn@korea.ac.kr
Prof. S. J. Sim, S. W. Lee
Department of Chemical Engineering
Sungkyunkwan University
Suwon 440-746 (Korea)
E-mail: simsj@skku.edu
C. D. Kang
School of Chemical and Biological Engineering
Seoul National University
Seoul 151-744 (Korea)
J.-S. Lee, Prof. J. M. Kim
Department of Chemical Engineering
Hanyang University
Seoul 133-791 (Korea)