The Fluorescent Polydiacetylene Liposome

Eun-Kyung Ji, Dong June Ahn,[†,*] and Jong-Man Kim[*]

Department of Chemical Engineering, College of Engineering, Hanyang University, 17 Haengdang-dong, Seongdong-gu, Seoul 133-791, Korea

[†]Department of Chemical and Biochemical Engineering, Korea University, Anam-dong, Sungbuk-gu, Seoul 136-701, Korea

Received February 11, 2003

Key Words : Polydiacetylene, Biosensor, Liposome, Color change, Fluorescent monomer

Development of efficient sensors utilizing conjugated polymer as sensing matrices has gained much attention among many research scientists.[1-11] Especially, polydiacetylene (PDA)-based sensors for the detection of biologically important species have been intensively investigated due to the unique color changing properties upon stimulation.[12-27] Closely packed and properly designed certain diacetylenes can undergo polymerization via 1,4-addition reaction to form an ene-yne alternated polymer chain upon UV irradiation with 254 nm as shown in Figure 1.[28-35] The resulting polydiacetylenes, if obtained under optimized conditions, appear to be intense blue color to the naked eyes. The blue-colored polydiacetylenes can be prepared in the form of liposomes in aqueous solutions or as thin films using Langmuir-Blodgett or Langmuir-Schaefer methods. The advantage of the nanostructured polydiacetylenes as biosensors comes from the fact that visible color change from blue to red occur in response to a variety of environmental perturbations, such as temperature,[36-39] pH,[40] and ligand-receptor interactions.[12-14,27] Many researchers have tried to understand the mechanism of the color transition. Although it is not clear, it has widely been accepted that color change is associated with a conformational change of polydiacetylene backbone. Accordingly, the polydiacetylenes in the blue form have extended conjugation of *p*-orbital in the main chain of the polymers. The conjugated *p*-orbitals undergo distortion by environmental stimuli, leading to partial twist of the *p*-orbitals. Thus, the dark blue color of the polymers gradually shifts to the red color depending on the amount of the stress.

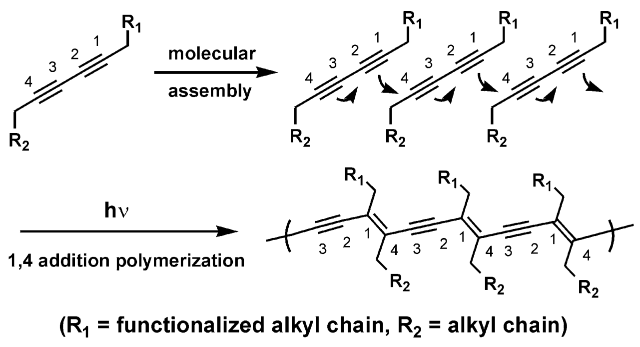

Figure 1. Schematic representation of polymerization of assembled functional diacetylenes by irradiation with UV light.

One of the most commonly used matrix lipid monomer for polydiacetylene-based biosensor is 10,12-pentacosadiynoic acid (PCDA **1**) (Figure 2). The PCDA lipid monomer can readily be assembled in aqueous media in the form of polymerized liposome vesicles after UV irradiation. When indicating the lipid concentration in a liposome solution, one calculates it based on the total lipid monomers used, assuming all of the monomers are transformed into the liposome. Since it is practically impossible to directly measure the lipid concentration of polymerized diacetylene liposomes, the nominal concentration has been widely used as a standard measure, even without rigorous proof. However, in order to use such nominal concentration for the purpose of calibration of PDA-based sensors, we will need to prove most of, if not all, the PCDA molecules assembled to bilayered liposomes in aqueous solution. This could be done by using a fluorescent lipid monomer which is newly derived from PCDA. If a liposome solution is prepared with

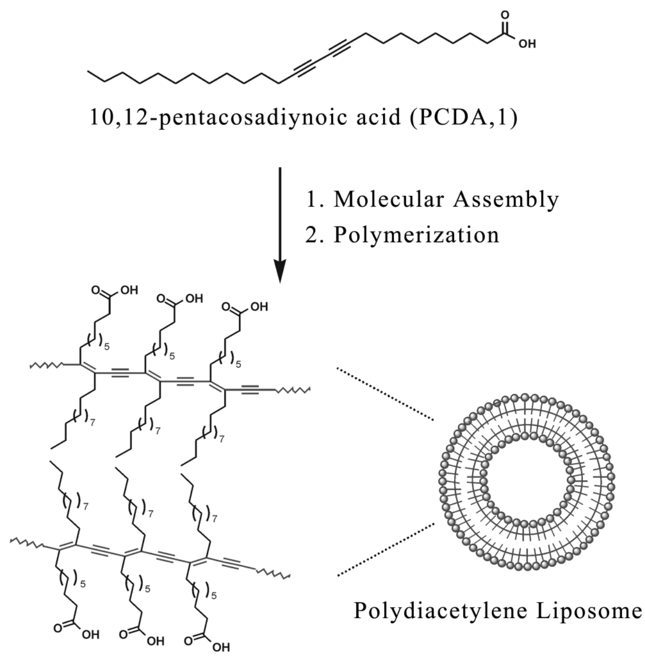

Figure 2. Schematic representation of the liposome prepared with 10,12-pentacosadiynoic acid (PCDA, **1**).

[*]Co-Corresponding authors. Dong June Ahn (Fax: +82-2-926-6101; e-mail: ahn@korea.ac.kr); Jong Man Kim (Fax: +82-2-2298-4101; e-mail: jmk@hanyang.ac.kr)