Hindawi
Journal of Nanomaterials
Volume 2017, Article ID 5983106, 7 pages
https://doi.org/10.1155/2017/5983106

Research Article

The Composition-Tunable Polydiacetylenic Complex Films: Conformational Change upon Thermal Stimulation and Preferential Interaction with Specific Small Molecules

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Received 1 February 2017; Revised 17 April 2017; Accepted 27 April 2017; Published 24 May 2017

Academic Editor: Surinder Singh

Polydiacetylenic complex films were prepared using 10,12-pentacosadiynoic acid (PCDA) and para-xylenediamine (*p*XDA) upon acid-base interactions. The thermochromatic reversibility of the complex films was modulated by changing the mixed molar ratio (3 : 1, 2 : 1, and 1 : 1) of the two molecules. The corresponding conformational changes of the complex films were studied by ex situ FTIR analysis upon thermal stimulation for the first time. In addition, the binding specificities of α-, β-, and γ-cyclodextrins (CDs) with the films were studied, where the α-CDs can induce stronger red fluorescent emission of the films. These fundamental results may be useful for platforms that use these polydiacetylenic complex films as optoelectronic devices or chemical/biological sensors.

1. Introduction

Conjugated polymers are well-known sensing materials because of the changes in their electronic absorption and photon emission responding to environmental perturbations [1, 2]. Based on this property, a variety of conjugated polymers, such as polythiophene [3–5], polyaniline [6, 7], polypyrrole [8], polyacetylene [9], and polydiacetylene (PDA) [10–12], have been investigated as sensing materials. Though all of these conjugated polymers can be used as sensing materials, PDA is of significant interest due to its facile fabrication method for photopolymerization of well-ordered diacetylene (DA) monomers [13].

Another unique property of PDA materials is their color change from blue to red, where the red phase of the PDA is fluorescent while the blue phase is not [14, 15], in response to various stimuli, including temperature [16, 17], organic solvent [18, 19], mechanical stress [20, 21], and ligand-receptor interactions [22, 23]. The phase change from blue to red is due to the release of side-chain strain. The partial distortion of conjugated p-orbital arrays shortens the effective π-conjugated length, which changes the electronic states and the optical properties [24–26]. The blue-to-red color change of PDA is generally not reversed after removing the external stimuli, though a few examples of reversible chromism in specially designed PDA materials have been reported to date [16, 27]. Recently, we synthesized PDA complex films using two organic molecules at different ratios, 10,12-pentacosadiynoic acid (PCDA) and para-xylenediamine (*p*XDA) [28]. These complex films were formed by acid-base interactions between the carboxylic acid groups of PCDA and the amino groups of *p*XDA as well as proton transfer from the carboxylic