



A facile fabrication of polydiacetylene nanowires and their response to aqueous solutions with basicity



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ARTICLE INFO

Article history:

Received 7 December 2015

Received in revised form 28 December 2015

Accepted 28 December 2015

Available online xxx

Keywords:

Nanowires

Conductive polymer

Photo-active polydiacetylene

ABSTRACT

Polydiacetylene nanowires composed of 10, 12-docosadiynedioic acid (DCDDA) were fabricated simply by solution reprecipitation method with diameter of 50–150 nm and length of several micrometers. As the DCDDA nanowires are exposed to aqueous solutions of pH less than 7, there is no fluorescence emission observed. In contrast, we observed the a red-fluoresce response of the nanowires as they exposed to solutions of pH ranging 8–10, reflecting the degree of ionization of carboxylate head groups.

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1. Introduction

In recent years, one-dimensional nanostructures such as wires, rods, belts, and tubes are attracting considerable interest due to potential applications in electronic devices [1–3], chemical sensors [4–7], and biosensors [7–9]. In particular, one-dimensional nano-materials have been described as a good candidate for a sensitive sensing system owing to the high surface-to-volume ratio of the nanostructures. For example, since carbon nanotubes (CNTs) were discovered by Iijima in 1991 [10], the CNTs-based gas sensors have attracted intensive research interest because of they have high sensitivity towards gas molecules, fast response time, and relatively low operating temperature. Kong et al. demonstrated the first gas sensors based on single-walled carbon nanotubes (SWNTs) [4]. Since then, many techniques have been developed to improve the performance of CNT gas sensors [5,11].

In addition, many researchers have studied chemical sensors based on semiconductor nanowires, such as silicon nanowires, SnO₂ nanowires, ZnO nanowires, and In₂O₃ nanowires. These sensors usually work via a change in the surface charge of the nanowires in the presence or absence of target molecules [6,8]. In

this system, target molecules are detected only by a change in the electronic conductance. Nevertheless, the control of doping concentrations in semiconducting nanostructures remains a challenge.

Conjugated polymers (CPs) that are characterized by a delocalized electronic structure have attracted much attention due to their potential in chemical and biological sensing applications [12]. In comparison to small molecule-based sensors, π -conjugated polymer-based sensors show enhanced detection capability due to a transferring signal along the backbone of the CPs [13]. Of the various CPs, polydiacetylenes (PDA) have been studied as an active platform for chemical and biological sensing because they undergo a visible color change from blue to red and a fluorescent change from non-fluorescent to red-fluorescent in response to a variety of external stimuli, such as temperature [14–16], pH [16,17], chemical solvent [18], and ligand-receptor interaction [19–23]. This phase transition occurs when external stimuli impose stresses that altering the delocalization length of π -electrons along the backbones of PDA. Various one-dimensional PDA nanostructures have been fabricated by self-assembly of highly ordered diacetylene monomers [24,25]. In addition, a number of researchers have suggested that hydrogen bonding, hydrophobic interactions, and π - π stacking act as the driving force of the self-assembly [24,26].

In this paper, PDA nanowires with a highly organized state were fabricated by the reprecipitation method. A bolaamphiphilic diacetylene monomer was adopted in order to facilitate the formation of nanowires. The nanowires were treated with various pH

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