Hindawi
Journal of Nanotechnology
Volume 2019, Article ID 3424915, 11 pages
https://doi.org/10.1155/2019/3424915

Research Article

Growth of MWCNTs on Plasma Ion-Bombarded Thin Gold Films and Their Enhancements of Ammonia-Sensing Properties Using Inkjet Printing

Udomdej Pakdee[1] **and Ananya Thaibunnak**[2]

[1]*Division of Physics, Faculty of Science and Technology, Rajamangala University of Technology Krungthep, Bangkok 10120, Thailand*
[2]*Division of Printing Technology, Faculty of Science and Technology, Rajamangala University of Technology Krungthep, Bangkok 10120, Thailand*

Correspondence should be addressed to Udomdej Pakdee; udomdej.p@mail.rmutk.ac.th

Received 19 January 2019; Revised 11 April 2019; Accepted 23 April 2019; Published 2 June 2019

Academic Editor: Enkeleda Dervishi

Multiwalled carbon nanotubes (MWCNTs) have been synthesized on thin gold (Au) films using thermal chemical vapor deposition (CVD). The films were evolved to catalytic Au nanoparticles (Au NPs) by plasma argon (Ar) ion bombardment with a direct current (DC) power of 216 W. The characteristics of the MWCNTs grown on Au catalysts are strongly dependent on the growth temperature in thermal CVD process. The MWCNTs were then purified by oxidation (550°C) and acid treatments (3 : 1 H_2SO_4/HNO_3). After purifying the MWCNTs, they were dispersed in deionized water (DI water) under continuous sonication. The MWCNT solution was then ultrasonically dissolved in a conducting polymer mixture of poly(3,4-ethylenedioxythiophene):poly(styrenesulfonate) (PEDOT:PSS) to prepare for an electronic ink. The ink was deposited onto the flexible and transparent plastic substrates such as polyethylene terephthalate (PET) with fabricated silver interdigitated electrode using two methods such as drop-casting and inkjet printing to compare in the detection of ammonia (NH_3) and other volatile organic compounds (VOCs) at room temperature. Based on the results, the gas response, sensitivity, and selectivity properties of MWCNT-PEDOT:PSS gas sensor for NH_3 detection are significantly enhanced by using inkjet printing technique. The sensing mechanism of fabricated gas sensor exposed to NH_3 has been also proposed based on the swelling behaviour of polymer due to the diffusion of NH_3 molecules into the polymer matrix. For the MWCNTs, they were mentioned as the conductive pathways for the enhancement of gas-sensing signals.

1. Introduction

Carbon nanotubes (CNTs) and their composites have attracted increasing attention in various applications for several years [1–5]. Many techniques have been presented to synthesize the multiwalled carbon nanotubes (MWCNTs) and single-walled carbon nanotubes (SWCNTs) [6–9]. Chemical vapor deposition (CVD) is one of the most popular techniques for growing the CNTs. In this technique, metal catalyst particles or islands were presented as an important factor for growing the MWCNTs [10]. Recently, there have been extensive reports to demonstrate the growth of CNTs by using gold nanoparticles (Au NPs) as catalysts [11–14]. The catalyst behaviour of Au NPs can be presented when its particle size is reduced into nanoscale caused by size effects [14]. Because of the resistance to oxidation and good electric conductivity, the Au catalysts would be an ideal selection for the fabrication of CNT-based devices. The evolution of thin Au films to nanoparticles using thermal annealing and plasma ion bombardment was successfully reported for growing the CNTs [13]. For gas-sensing applications, the CNTs can be promoted as a good material due to its excellent properties such as high specific surface area, good electric conductivity, and high carrier mobility [15, 16]. The publications involving the gas-sensing devices have been focused on the high sensitivity and good selectivity at room temperature [16–19]. The CNTs decorated with some metal nanoparticles as a sensing film were reported to improve the