URN etd-0407109-183704-219
Author Hsiang-Ching Chen
Author's Email Address No Public.
Statistics This thesis had been viewed 48 times. Download 0 times.
Department
Year 2007
Semester 1
Degree Master
Type of Document Master's Thesis
Language zh-TW.Big5 Chinese
Title The Study of Dielectrophoretic Force on Purification and Field Emission of Carbon Nanotubes
Date of Defense 0000-00-00
Page Count 70
Keyword
carbon nanotubes
dielectrophoresis
purification
field emission

Abstract
This study presents the design, fabrication and test of a field emission chip with carbon nanotubes (CNTs). The objective of this study was to utilize positive dielectrophoresis (DEP) to purify CNTs on parallel microelectrodes and then to perform a field emission test on the CNT film.
The study parameters include the electrode width/gap, the frequency of DEP and the duration of hot impressing. To understand the locations where the CNTs might be accumulated, a computer simulation was used to analyze the distribution of gradient of the square of electric field, E2, around the electrodes under the electric field. Three kinds of parallel microelectrodes, with various width and gap, were designed for the purification and field emission of CNTs. A test chip consisting of three parallel microelectrodes and a micro channel, formed by polydimethyl siloxane (PDMS), was manufactured by molding process. The medium, also served as cathode surfactant and dispersant, was prepared by sodium dodecyl sulfate (SDS), and the medium with CNTs was fulfilled into the micro channel by syringe pump. By applying different DEP frequencies on the electrodes, the experiment on trapping and purification of CNTs was observed and analyzed. The results showed the CNTs would be accumulated around the edges of electrodes where higher values of E2 existed. This trend was in good agreement with the simulation. After the CNTs were purified, Raman spectroscopy showed that the relative intensity ratio of G-band to D-band increased from 0.36 to 0.56 for the samples prepared at frequencies of 1 and 25 MHz, respectively, while the value of non-purified CNTs was 0.29. Therefore, higher frequency of DEP resulted in better purification of CNTs. Followed by the field emission test on the CNTs film. Results revealed that the CNTs film prepared at higher frequency of DEP had lower threshold of electric field for field emission. However, because the CNT film didn't adhere to the substrate very well, the CNTs bombarded to the anode and led to the jump of current. So, we further combined the purified CNT film by different DEP frequencies with the evaporated tin on the surface of SU-8 micro-column array to form micro-column array of CNTs. It mainly rose the temperature of tin to melting point and then combined with the CNTs by hot impressing. Array of CNTs made by hot impressing for 20 minutes would yield better field emission performance, with electric field threshold 1.7 V/μm, than those made for 1 and 10 minutes. Besides, the CNTs adhered with tin could result in steadier current in field emission tests.
Advisory Committee Ching-Hua Wei,Chin-Tu Lu - advisor

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Date of Submission 2008-08-05