Enhanced Electron Emission from Carbon Nanotube Paste after Firing

Sung Kee Kang, Jong Hyung Choi, Jae-Hee Han, Ji-Beom Yoo* and Chong-Yun Park

Center for Nanotubes and Nanostructured Composites,
Sungkyunkwan University, 300 Chunchun-Dong, Jangan-Gu, Suwon, 440-746, Korea

Joong-Woo Nam, J.E Jung and J. M. Kim
Technology Development 3, Corperate R&D Center, Samsung SDI
428-5, Gongse-Ri, Kiheung-Eup, Yongin, 449-902, Korea.
Phone : +82-31-288-4702 , E-mail : skeykang@samsung.com

Abstract

After multi-walled carbon nanotubes (MWNT) powder was crushed with ball milling process, it was mixed with organic vehicles. And then CNT paste was printed on ITO coated glass substrate. The field emission characteristics of CNT pastes fired in air atmosphere was better than that of CNT paste fired in Ar ambient due to less organic residues after firing.

Introduction

It has been believed that the vertically aligned carbon nanotubes (CNTs) with high aspect ratio, are the most ideally suited emitters for electron emission. [1-3]

Many research groups have reported the large electron emission from CNTs synthesized by conventional methods including CVD, arc discharge and laser ablation etc.. But it is reported that the large area cold cathode with CNTs emitter is very difficult to fabricate using these conventional methods because of problems such as controllability, complexity, and cost of the process. But, the screen print method using CNT pastes has received considerable attention as an alternative method to overcome such. Recently, screen-printing process using CNT paste was adopted to form the cathode layer due to low cost, simple process and mass production.[4-5] In screen printing method, several factors including paste composition, firing condition, and CNTs dispersion play a crucial role in determining the emission characteristics of CNTs paste. In this study, we investigate effects of the firing condition on the morphologies and the emission characteristics of CNT paste.

Experimental

Muti-walled carbon nanotubes (MWNT) powders were mechanically grinded with ball milling process, and were mixed with organic vehicles through 3-roll mill process. Powders are grinded and mixed by ball milling process more uniformly. 3-roll mill process shears the MWNT's paste very strongly. During the 3-roll

mill process CNTs were dispersed with organic vehicle. Then CNT paste was printed on ITO coated glass substrate by screen print process. The emission characteristics and surface morphologies of paste was measured **with a** parallel diode-type configuration Cathode area was 2 × 2 cm in a vacuum chamber (10^{-6} Torr) and by SEM, respectively.

Results and Discussion

We found that emission properties of CNT's paste have something to do with the firing ambient because of relationship between residues and emission.

Firing condition influence on removal of organic binder and surface morphology.

Fig.1 shows MWNTs paste after firing under air (a) and Ar (b) ambient. After firing especially under Ar ambient, residues still remains

Fig.2 shows emission properties of CNT paste fired under different conditions. Turn on field of paste fired under air and Ar ambient is 4.3 and 5.3V/um, respectively. And current density of paste fired under air and Ar at 8V/um are 81uA/cm^2 and 34uA/cm^2, respectively. Field emission property in air condition was better than in Ar gas condition.

Summary

MWNT paste has been prepared by 3-roll mill process and screen printed onto ITO coated glass. It was fired with air and Ar gas in the furnace. We measured emission properties of both samples in a vacuum chamber (10^{-6} Torr). When MWNTs paste under air condition, emission property is better than that in other firing conditions.

CNT paste fired under air condition remains less organic resides which may cover CNT and hinder the emission.

Acknowledgement

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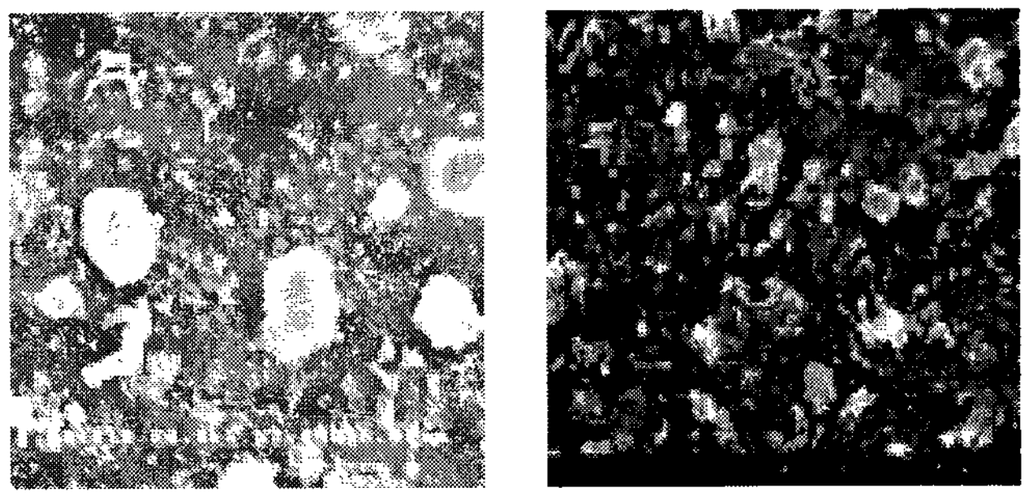

(a) (b)

Fig. 1 SEM images CNT pastes after firing nder air and (b) Ar ambient.

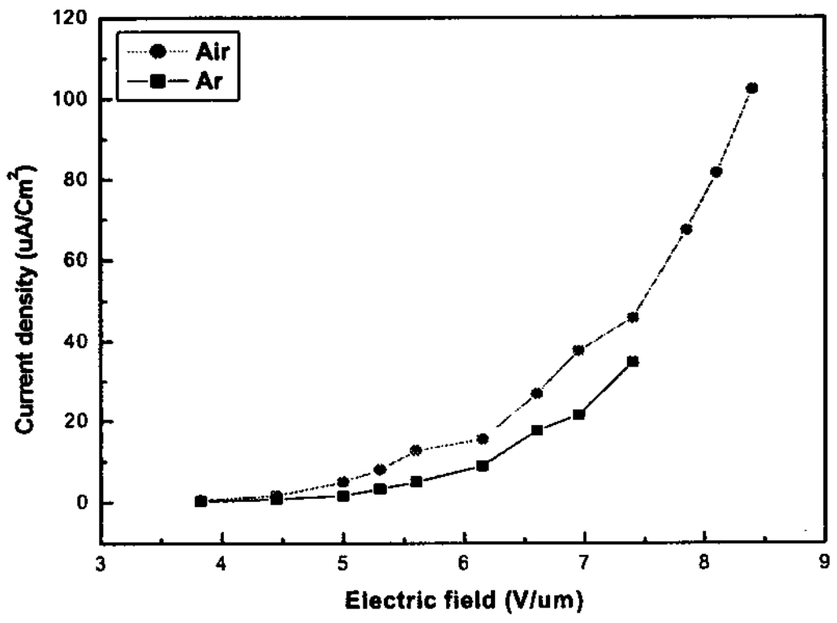

Fig. 2 Emission property of CNTs paste after firing under different conditions

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