奈米碳管、氧化鋅奈米線及其相關元件之特性及應用研究

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摘　　要

本論文中將針對氧化鋅奈米線的研製、材料特性鑑別、元件製備、光學與電學等的特性研究，做一完整而詳細的分析與研究，期能尋求出一穩定的奈米儲能、光電元件應用製程。利用奈米碳管的高比表面積配合氧化錳製備之超電容複合式電極可有效的提升其電容特性；經過成長於可撓式高分子基版，鎂離子添加控制其直接能隙，利用磷離子改變其導電性質，光學激發特性分析以及場發射性質的研究，可以對現階段的氧化鋅一維奈米結構的成長機制與結晶過程給予一個較為明確的探討，同時也針對未來的儲能與場發射平面顯示元件的基礎性研究提供了清楚的模型，運用其特異奈米結構微型化的相輔相成而早日達到實際應用的領域。

Characterizations and Applications of Carbon Nanotubes, Zinc Oxide Nanowires and Related Devices

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Abstract

Characterizations and applications of carbon nanotubes (CNTs), zinc oxide nanowires (ZnO NWs) and related devices were discussed in this study. The MnO_x-CNTs composite supercapacitor electrode exhibits good capacitor abilities for the high active area of carbon nanotubes. ZnO NWs were synthesized on the flexible polymer substrate by hydrothermal method, the band gap of zinc oxide nanowires was modulated by the dopant of magnesium, and the field emission ability was enhanced by the phosphorus incorporation. The growth mechanism, optical and electric characterizations were also carrying out in this study. The present study provides a new fabrication of energy storage device and a simple process to synthesize the field emission devices based on low temperature synthesized ZnO NWs.

Acknowledgement

To my family.

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Figure Captions

corresponding F-N plot under anode electric field of 2.2 V/μm. (b) The relation of transconductance versus gate voltage of the under-gate field emission device.

Table Captions

List of Notations

m^* : the effective mass

$\hbar$: the Planck's constant divided 2π

$\vec{r}$: the electron position vector

$V(\vec{r})$: the confinement potential

$\psi_{\vec{k}}(\vec{r})$: the wave function (or eigenfunction)

$E(\vec{r})$: the electron energy(or engenstate)

V : the crystal volume

A : the area of the quantum well

L_z : the well width

$H(x)$: the Heaviside step function

L : the length of the quantum wire

L_y : the y-direction length of the wire cross-section

N_{WR} : the density of quantum wires

N_D : the volume density of quantum dots

J : the FN current density

ϕ : the work function

E : the applied electric field

$t(y), v(y)$: the correction factors related to the electric field

β : the field enhancement factor

V_g : the voltage applied to the gate and emitter electrodes

I : the current

n : the number of emitters

A : the emission area per tip

σ_{LV} : the liquid-vapor surface free energy

V_L : the molar volume of liquid

s : the vapor-phase supersaturation

h_G : the mass-transfer coefficient

C_G : the concentration of the reactants in the bulk gas

C_S : the concentration of the reactants next to the droplet surface

H : the Henry's Law constant

P_s : the partial pressure of reactant next to the droplet surface

P_G : the partial pressure in the bulk of the gas

h : the gas-phase mass-transfer coefficient in terms of concentration in the droplet

D : the diffusivity of reactants in the bulk gas, and δ is thickness of the boundary layer

μ : the viscosity of the bulk gas

ρ : the density of the bulk gas

ν : the flow rate of the bulk gas

k_s : the chemical reaction rate constant

C_{Sat} : the saturating concentration of the reactants in the droplet

A_1 : the adsorption area of the droplet

A_2 : the reaction area of the droplet-nanowire interface

R : the growth rate of these nanowires

N : : the number of atoms incorporated into a unit volume of these nanowires