ORIGINAL LITERARY WORK DECLARATION

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Name of Degree : MASTER OF ENGINEERING

Title of Project Paper/ Research Report/ Dissertation/ Thesis (“this work”) :

SYNTHESIS AND CHARACTERIZATION OF AMORPHOUS CARBON NANOTUBES/ COPPER OXIDE HYBRID MATERIALS

Field of Study :

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ABSTRACT

Carbon nanotubes (CNTs) are designated as one of the most attractive material from researchers due to their unique properties and, wider range of applications. However, the synthesizing process of crystalline CNT is still a great issue because of their synthesizing process involving complicated process such as need higher operating temperature, catalyst support and expensive production cost. On the other hand, the synthesizing process of amorphous,carbon nanotubes (α-CNTs) offer a simple process. This will facilitate the producing of CNTs and open new doors to many potential applications. Therefore, we reported in this work a way of preparing α-CNT and hybridizing it with Cu_2O by a simple process using ferrocene and ammonium chloride at a low temperature (~250°C) in open atmosphere. The α-CNTs produced were purified with deionized for water and HCl for obtaining a high purity of CNTs. FESEM studies show that the morphology of the α-CNTs have changed after purification process. TEM studies revealed the diameter of the α-CNT and hybridized CNT. Raman studies revealed that the CNT is amorphous structure. EDX studies show the elements present in samples, and it is found that the major element is carbon. The X-ray diffraction pattern confirmed the amorphous nature of the sample and were also confirmed the presence of Cu_2O. The band gap of untreated, treated and hybridized samples were confirmed with UV-Vis studies.

ABSTRAK

Karbon nano tiub (CNTs) telah dikenalpasti sebagai salah satu bahan yang menarik dengan pelbagai sifat unik, dan sesuai untuk pelbagai aplikasi. Walau bagaimanapun, proses menghasilkan karbon nano tiub berstruktur hablur menjadi isu kerana proses penghasilannya adalah rumit seperti memerlukan suhu yang tinggi, memerlukan bantuan pemangkin, dan menelan kos yang tinggi. Walhal, proses penghasilan CNTs berstruktur amorfus (α-CNTs) hanya melalui proses yang ringkas. Perkara ini dapat memudahkan pemprosesan karbon nano tiub dan seterusnya membuka pintu baru kepada pelbagai aplikasi yang lebih baik. Oleh itu, kajian dijalankan untuk menghasilkan karbon nano tiub struktur jenis amorfus dan menghibridkannya dengan kuprum oksida (Cu_2O) melalui kaedah eksperimen yang ringkas menggunakan "ferrocene" dan ammonium klorida pada suhu yang rendah (~230°C). α-CNTs yang terhasil kemudiannya menjalani proses penulenan berasid untuk mendapatkan CNTs dengan ketulenan tinggi. Keputusan FE-SEM menunjukkan bahawa morfologi α-CNTs telah berubah setelah melalui proses penulenan. Diameter α-CNT telah diukur menggunakan TEM. Keputusan Raman telah mengesahkan bahawa karbon nano tiub yang dihasilkan adalah berstruktur amorfus. Analisis EDX telah menunjukkan jenis-jenis elemen yang terdapat di dalam sample dan didapati bahawa elemen utama adalah karbon. Kewujudan Cu_2O di dalam sampel telah dibuktikan melalui XRD, dan nilai "band gap" untuk semua sampel telah dikaji melalui eksperimen UV-Vis.

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LIST OF SYMBOLS AND ABBREVIATIONS

CNTs	Carbon nanotubes
α-CNTs	Amorphous carbon nanotubes
SWCNTs	Single-walled carbon nanotubes
DWCNTs	Double-walled carbon nanotubes
MWCNTs	Multi-walled carbon nanotubes
Cu_2O	Copper oxide
UV-Vis	Ultraviolet-visible
TEM	Transmission electron microscopy
FE-SEM	Field emission scanning electron microscopy
XRD	X-ray diffraction
EDX	Energy-dispersive X-ray
E_g	Bandgap energy
CVD	Chemical vapour deposition
PTFE	Polytetrafluoroethylene
AAO	Aluminium oxide templates
Co	Cobalt
Ni	Nickel
Fe	Iron
He	Helium
FeS	Ferrous sulphide
DC	Direct current

PEG	Polyethylene glycol
ml	Millilitre
Ni-Al	Nickel aluminium alloy
h	Hour
min	Minute
$Fe(C_5H_5)_2$	Ferrocene
Nm	Nanometer
cm	Centimetre
G	Giga
Pa	Pascal
NH_4Cl	Ammonium chloride
HCl	Hydrochloric acid
C_2H_5OH	Ethanol
M	Molarity
kV	Kilovolts
Cu-K α	Copper K-alpha
Å	Ångström
A	Ampere
α	Absorption coefficient
$h\nu$	Photon energy of the incident light
n	Type of optical transition
B	Constant