UNIVERSITI TEKNOLOGI MARA

SYNTHESIS AND CHARACTERISATION OF CARBON NANOTUBE FROM CAMPHOR OIL USING TWO-STAGE FLOATED-CATALYTIC CHEMICAL VAPOUR DEPOSITION

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work as in author's profile. This thesis has not been submitted to any other academic institution or non-academic institution for any degree or qualification.

I, hereby acknowledge that I have been supplied with the Academic Rules and Regulations for Post Graduate, Universiti Teknologi MARA, regulating the conduct of my study and research.

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ABSTRACT

Nanomaterials have become an important part of the materials research and development. For the last couple of decades, emerging low-dimensional carbon materials, in particular, carbon nanotube (CNT) has received considerable attention in the literature in the broad field of nanoscience and nanotechnology. More recently, CNT appears to be a very appropriate candidate to become the advanced nanomaterial of the 21st century. Indeed, today, CNT has gained significant attention at the forefront of the carbon nanomaterial development, and has become one of the most widely investigated materials. In general, CNT is a cylindrically-shaped atom thin layer(s) of graphene or carbon crystal with an identical and high aspect ratio of its length over to diameter. In this thesis, the aim of this project was to explore the deposition/growth process using two-stage floated-catalytic chemical vapour deposition (CVD) technique and its intrinsic properties using advances nano-metrology analysis based on these CNTs. The current state of art on CNT growth by two-stage floated-catalytic CVD technique has been examined; emphasizing the fundamental processes that distinguish CNT growth from conventional crystal growth. The epitaxial iron-filled CNT growth from camphor oil precursor has attracted considerable interest because of its extraordinary characteristics and ability to grow by synthesised on the lab-scale. Although the quality of CNT over this technique has improved, there are still obstacles such as structural non-uniformity, that limit applications in a wide range of truly current technologies. The key elements of CNT growth using this technique are highlighted, and discussed with regard to impacts on structural uniformity, and physico-chemical properties. The parameters of specific components such as i) influence of synthesis temperature, ii) influence of synthesis time, iii) influence of catalyst to hydrocarbon ratio, iv) influence of thermal annealing atmosphere, and v) influence of post thermal annealing time were investigated in an effort to provide a pathway for future advancements in CNT synthesis. The CNTs were mainly characterised by field emission scanning electron microscopy, micro-Raman spectroscopy, and thermogravimetric analysis to determine physico-chemical properties of CNT. The findings of the study were supported by the highly resolution transmission electron microscopy. The iron-filled spherical-like graphene sheet to almost catalyst-free CNT nucleation-growth mechanism has been proposed for the CNT growth. Narrow diameter size distribution, low amorphous carbon content, defect-free, high thermal stability and low catalyst remained in CNT is observed for the optimised parameter of high quality of CNT. Finally, the major impact of CNT on materials science, challenging issues, and key future directions for research in CNT are briefly discussed.

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