Penerbit Akademia Baru

Journal of Advanced Research in Materials Science

Journal homepage: www.akademiabaru.com/arms.html
ISSN: 2289-7992

Modelling of Water-Assisted Flame Synthesis of Carbon Nanotube using Counterflow Diffusion

Open Access

Muhammad 'Abid Ira Irawan[1], Mohd Fairus Mohd Yasin[1,*], Khairul Fikri Tamrin[2]

[1] School of Mechanical Engineering, Faculty of Engineering, Universiti Teknologi Malaysia, 81310 UTM Johor Bahru, Johor Bahru, Malaysia
[2] Department of Mechanical and Manufacturing Engineering, Universiti Malaysia Sarawak, Kota Samarahan, Sarawak, Malaysia

ABSTRACT

Research on carbon nanotubes (CNTs) has been performed extensively. On top of that, water-assisted synthesis of CNT has started to emerge with captivating effect towards growth of CNT. The present study investigates a baseline inlet condition for water assisted case utilizing diffusion flame that imitates the temperature distribution and growth region of CNT without water vapor, on the basis of experimental data of non-water assisted high yield CNTs. To affirm the effect of water vapor, 35% to 70% of water vapor has been added replacing the fuel side nitrogen content. The results prove that water vapor suppresses the flame where the maximum temperature drops with increasing concentration. Consequently, this affects the length and growth region of CNTs. The region width has been reduced for about 7.4% to 18.5% with water vapor. This shows that excessive water poorly affects the growth of CNTs. On the other hand, the region has also shifted for about 0.64 mm to the fuel side (5.7%) from the origin when 70% of water vapor was added. Following this, the impact of catalyst towards CNT growth is subsequently presented whereby a comparison is made between Fe and Co to synthesize CNT using flame synthesis. Based on the result, Fe possess better activation for the CNTs to grow as compared to Co. A significant difference between the predicted CNT length for Fe (147 μm) and Co (56 μm) is attributed to their diffusivity values.

Keywords:
Carbon nanotubes; flame synthesis; water-assisted; counterflow

Copyright © 2020 PENERBIT AKADEMIA BARU - All rights reserved

1. Introduction

Carbon is undoubtedly an abundant element in nature which exists either in the form of solid, liquid or gaseous. In 1991, Iijima successfully discovered carbon nanotubes (CNTs) [1]. With notable captivating CNTs' characteristics, a broad range of researches has been ongoing to explore the synthesis, growth mechanism and applications of CNT.

The growth process of CNTs is often accompanied by undesirable amount of carbonaceous materials and impurities due to chemical reagents and solvent contamination including the ones from gas precursor. This unintentionally would degrade quality as well as purity of the produced CNTs. For long, this issue has always been the challenge in attaining a long, pure and high quality CNTs. Hu *et al*., [2] stated that instigating weak oxidizer may help to enhance their growth. In particular, water vapor tends to be the excellent choice for this mild oxidizing agent as in situ

*Corresponding author.
E-mail address: mohdfairus@mail.fkm.utm.my (Mohd Fairus Mohd Yasin)

https://doi.org/10.37934/arms.66.1.17