Synthesis of carbon nanotubes using Microwave Plasma Enhanced Chemical Vapor Deposition under the Influence of Magnetic Fields

Cyril Benedict Lugod, Dr. Joseph Auresenia*

De La Salle University – Manila, Manila, 1004, Philippines

**corresponding author: joseph.auresenia@dlsu.edu.ph*

Abstract

Carbon nanotubes (CNTs) are allotropes of carbon characterized by a tube-like structure with diameters ranging in the nanometer scale and having very high aspect ratio, which is the ratio of its length to its diameter. Carbon nanotubes have unique properties that are useful in various practical applications such as in electronics particularly in plasma TV, drug delivery and in reinforcing composite nanomaterials. Recently, it has gained significant interest among the research community. Commercial production of CNTs are limited because of some issues on CNT growth and morphology particularly its tortuosity. This study will evaluate the effects of the presence of magnetic field during CNT synthesis in a Microwave Enhanced Plasma Chemical Vapor Deposition (MPECVD) process using a Whirlpool AVM585 conventional microwave oven. It evaluates the effect of magnetic field supplied by an electromagnet coil on CNT morphology. Previous studies used permanent magnets to align the CNT but this is not applicable in MPECVD since the microwave electromagnetic fields inside the microwave oven chamber demagnetized the permanent magnets. Based on intensive literature search, so far this is the first study that used electromagnet to produce magnetic field to align the CNT inside the microwave chamber. This study will also determine the effects of hydrogen catalyst pretreatment on CNT growth. The experimental design will be based on a Taguchi orthogonal array design which is $L_9 3^4$ orthogonal array. This experimental array has four factors with three levels and a total of 9 runs. The effects of the experimental factors such as the magnetic field strength (3 levels), microwave power (3 levels), catalyst pretreatment time (3), and hydrogen gas flow rate (3 levels) on the responses such as the yield, purity, diameter, and tortuosity was investigated. It was found the in the presence of magnetic field constantly supplied by an electromagnet coil placed near the plasma reactor inside the microwave chamber had significant effect on the morphology of the produced CNTs. The CNTs produced in the presence of magnetic fields have more aligned configuration based on tortuosity, have smaller diameter and are purer in terms of graphitic carbon contents as compared to the CNTs produced without the presence of electromagnetic waves.

Keywords: Carbon nanotubes; MPECVD; Magnetic field; Microwave; Nanotechnology.