Synthesis and Characterization of Tri-metallic Fe–Co–Ni Catalyst Supported on $CaCO_3CaCO_3$ for Multi-Walled Carbon Nanotubes Growth via Chemical Vapor Deposition Technique

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Abstract

In this study, multi-walled carbon nanotubes (MWCNTs) were developed via the decomposition of acetylene gas over tri-metallic (Fe/Co/Ni) catalyst supported on $CaCO_3CaCO_3$ in a vapor deposition (CVD) reactor. The effects of mass of $CaCO_3CaCO_3$ support, pre-calcination temperature and pre-calcination time on the yield of catalyst were investigated and optimized using $2_3 2_3$ factorial experimental design. The catalyst obtained at the optimal conditions was utilized for MWCNTs production using catalytic chemical vapor deposition method (CCVD). The effects of growing time and deposition temperatures on the yield of the MWCNTs were also studied. The as-synthesized catalyst and MWCNTs were characterized using the following analytical techniques: HRSEM, HRTEM, FTIR, TGA/DTA, EDS, XRD, and BET surface area. The results revealed that the optimal experimental conditions to obtain the maximum catalyst yield of 92.04% were: mass of $CaCO_3CaCO_3$ support of 8 g, pre-calcination temperature of 110 ∘C∘C, and pre-calcination time of 8 h. The TGA and BET analysis showed that the

catalyst developed at the optimal conditions were thermally stable with a high surface area of 224.68 m2/gm2/g and particle size distribution in the ranges of 0.1–60 nm. The HRSEM and HRSEM micrograph revealed that the produced CNTs were multi-walled carbon nanotubes in nature comprises homogeneous well-aligned woven-like structure. XRD patterns confirmed that the produced MWCNTs were highly graphitized with little structural defects. This present work indicated that MWCNTs of uniform strands and controlled structure can be produced from tri-metallic (Fe/Co/Ni) catalyst supported on CaCO3CaCO3 through CCVD technique.

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