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ORIGINAL ARTICLE

Synthesis of carbon nanofibers on impregnated powdered activated carbon as cheap substrate

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Abstract The catalysis and characterization of carbon nanofibers (CNFs) composite are reported in this work. Carbon nanofibers were produced on oil palm shell powdered activated carbon (PAC), which was impregnated with nickel. Chemical Vapor Deposition (CVD) of C_2H_2 was used in the presence of hydrogen at ~650 °C. The flow rates of carbon source and hydrogen were fixed. The CNFs formed directly on the surface of the impregnated PAC. Variable weight percentages (1%, 3%, 5%, 7% and 9%) of the catalyst salt (Ni^{+2}) were used for the impregnation. However, the best catalysis was observed on the substrate with 3% Ni^{+2}. The product displayed a relatively high surface area, essentially constituted by the external surface. New functional groups also appeared compared to those in the PAC. Field Emission Scanning Microscopy (FESEM), Transmission Electron Microscopy (TEM), Fourier Transform Infrared (FTIR), BET surface area analysis and energy dispersive X-ray (EDX) were used for the characterization of the new carbon nano product, which was produced through a clean novel process.

1. Introduction

Carbon is an important support material used in many heterogeneous catalysis applications (Figueiredo and Pereira, 2010; Nhut et al., 2003; Coq et al., 1998; Rodriguez-Reinoso, 1998). Application of activated carbon produced from various sources and raw materials is well-known. Activated carbon (AC) is a form of carbon that has been treated either physically by steam and carbon dioxide, or chemically using an activating agent at elevated temperatures (Macias-Garcia et al., 2003; Molina-Sabio et al., 1996; Gómez-Serrano et al., 1991). Such treatment results in a carbonaceous material that has high surface area and pore volume (Stiles, 1987; Smisek and Cerny, 1970; Auer et al., 1998). A variety of metal catalysts, such as noble metals (Pt, Pd and Rh) and base metals (Sn, Fe, Mn, Co and Ni), have been used as active catalyst via dispersion on active carbon supports (Molina-Sabio et al., 1996; Stiles,

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1987; Harada et al., 2007; Li et al., 2004). The four primary methods of metal impregnation are: wet impregnation, ion exchange, precipitation, and chemical vapor deposition (Stiles, 1987).

Research on nano or micro-sized carbons has drawn much attention because of their potential uses in a wide range of fields (Hasan et al., 2007; Fu et al., 2007; Zhang et al., 2006; Yu et al., 2005; Qiu et al., 2004). It is possible to tailor the microstructures of CNFs by the selection of a preparation method, including catalyst, carbon source and operating conditions (Tang et al., 2000; Thess et al., 1996; Díaz et al., 2010; Zhou et al., 2006). Various methods can be used to produce CNFs such as arc-discharge, laser ablation, or chemical vapor deposition (CVD). However, synthesis of CNFs on impregnated PAC as a substrate is not reported yet. However, various impregnation techniques are reported to be used for several substrates (other than PAC) in projects related to nanotechnology (Rao et al., 2013; Atkinson et al., 2011; Thiele et al., 2009; Chong et al., 2009; Gallego et al., 2008; Barreca et al., 2007). On the other hand, the effect of temperature on the growth of CNFs was studied by others (Ichi-oka et al., 2007; Huang et al., 2009). Here, we present the modification of powdered activated carbon (PAC) having sizes ranged between 100 and 250 μm by the impregnation of nickel and growth of CNFs.

2. Material and methods

In this study, palm kernel shell PACs were impregnated by using nickel (II) catalyst dissolved in acetone. The powdered activated carbon was immersed into the nickel solution and sonicated for 30 min in ultrasonic bath (Model: JAC 2010P)

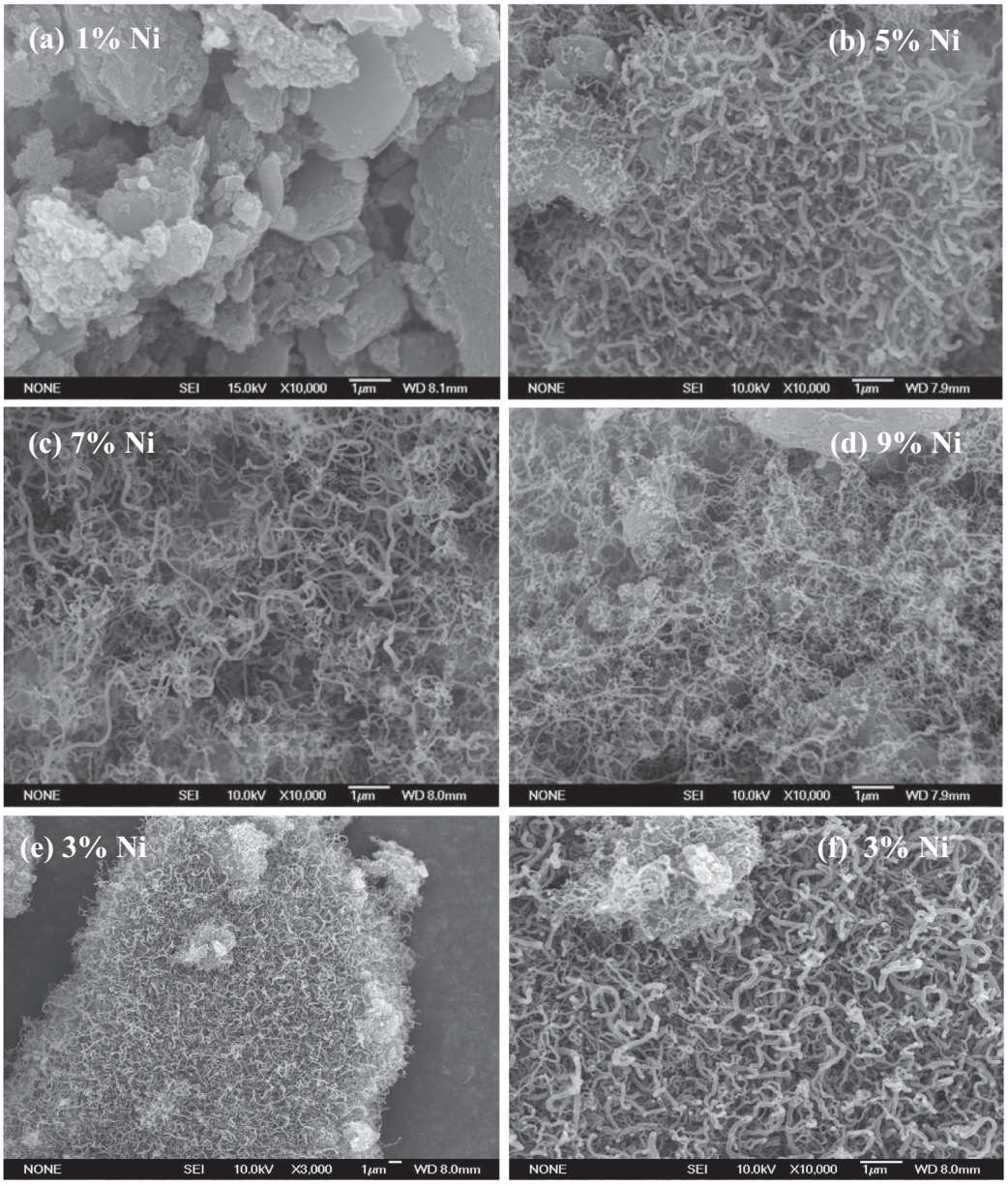

Figure 1 FESEM images of the CNFs.