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Full Length Research Paper

Occurrence of carbon nanotube from banana peel activated carbon mixed with mineral oil

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Banana peel activated carbon and 2% mineral oil mixture was used as a precursor for carbon nanotube and nanocarbon. The process of synthesis involves pyrolysis of precursors at 1000 to 1200°C in a closed stainless-steel tube (ϕ 12.7 mm, 1.0 mm inches thick and lengths = 200 mm). The final products were analyzed using SEM, TEM and XRD. SEM and TEM investigation showed that the products consisted of a long straight carbon nanotube (outer diameter = 47 to 106 nm and inner diameter = 12 to 30 nm). The XRD studies revealed the presence of a graphitized carbon nanotube, which have Fe (metal) inside the hollow and the tip, in the pyrolytic products.

Key words: Carbon nanotube, banana peel, activated carbon, pyrolysis, mineral oil.

INTRODUCTION

Carbon nanotubes showed excellent mechanical and electronic properties with can be metallic or semiconducting, field effect transistors, single electron transister, rectifying diodes and have high-capacity hydrogen storage (Popov, 2004). The long conducting fibers may have many applications in biosensors, ion-activated molecular switches, and microelectrodes for medical uses. The irregular outer surface of the carbon nanotubes are expected to give a very large surface area for catalytic applications (Kumar et al., 1999). Production methods have been developed to produce carbon nanotubes including the arc method, electric arc discharge, laser ablation, high pressure carbon monoxide, and chemical vapor deposition (Paradise and Goswami, 2007). CO_2 laser pyrolysis has been used for carbon nanoparticle production where the produced particles have a spherical shape and a diameter of about 50 nm (Orlanducci et al., 2004). In another report, the nanotubes varied in diameter from tens to hundreds of micrometers. There were very few amorphous carbons visible in the deposits when thermally decomposed from liquid petroleum gas (Ndungu et al., 2008). Additionally, nanostructured carbon carbon composites have been made with vapour grown carbons. These composites bring about nanocrystalline anisotropic orientation at the interfaces, which increase the mechanical, thermal and electrical conductivity (Manocha, 2005). The mineral oil or mineral hydrocarbon is widely used for lubricating oils (Granella et al., 1995). It was used for carbon precursor. This work studied the synthesis of carbon nanotube from banana peel activated carbon and 2% mineral mixture using pyrolysis and simplicity of the process. The influence of thermal treatment on the morphology of nanostructure carbon was studied. The samples were pyrolysed at 1000 to 1200°C in a closed stainless steel tube. This method was modified from the chemical vapor deposition method (Mopoung et al., 2010). The final products were characterized, using SEM, TEM and XRD.

MATERIALS AND METHODS

Dried banana peel was carbonized at 400°C, and then activated using phosphoric acid (UNIVAR, AR) at a ratio of 0.5:1.0 by volume per weight (phosphoric: dried banana peel carbon) (Mopoung & Thongcharoen, 2009). Afterwards, the pyrolysis of the banana peel carbon was performed at 600°C. The carbon powder was then crunched in a ball mill grinder. The very fine powder was sieved through a 400-mesh screen**.** The activated carbon was mixed with 2% mineral oil. The 50 g of mixed powder was placed in a stainless-steel which was 12.7 mm in diameter, 1.0 mm thick and 200 mm in length. Both ends of the tube were closed by welding. The samples in the closed tube were pyrolyzed at 1000 to 1200°C for 1 h. After that, the temperature was cooled to room temperature. The final products were characterized by scanning electron microscopy

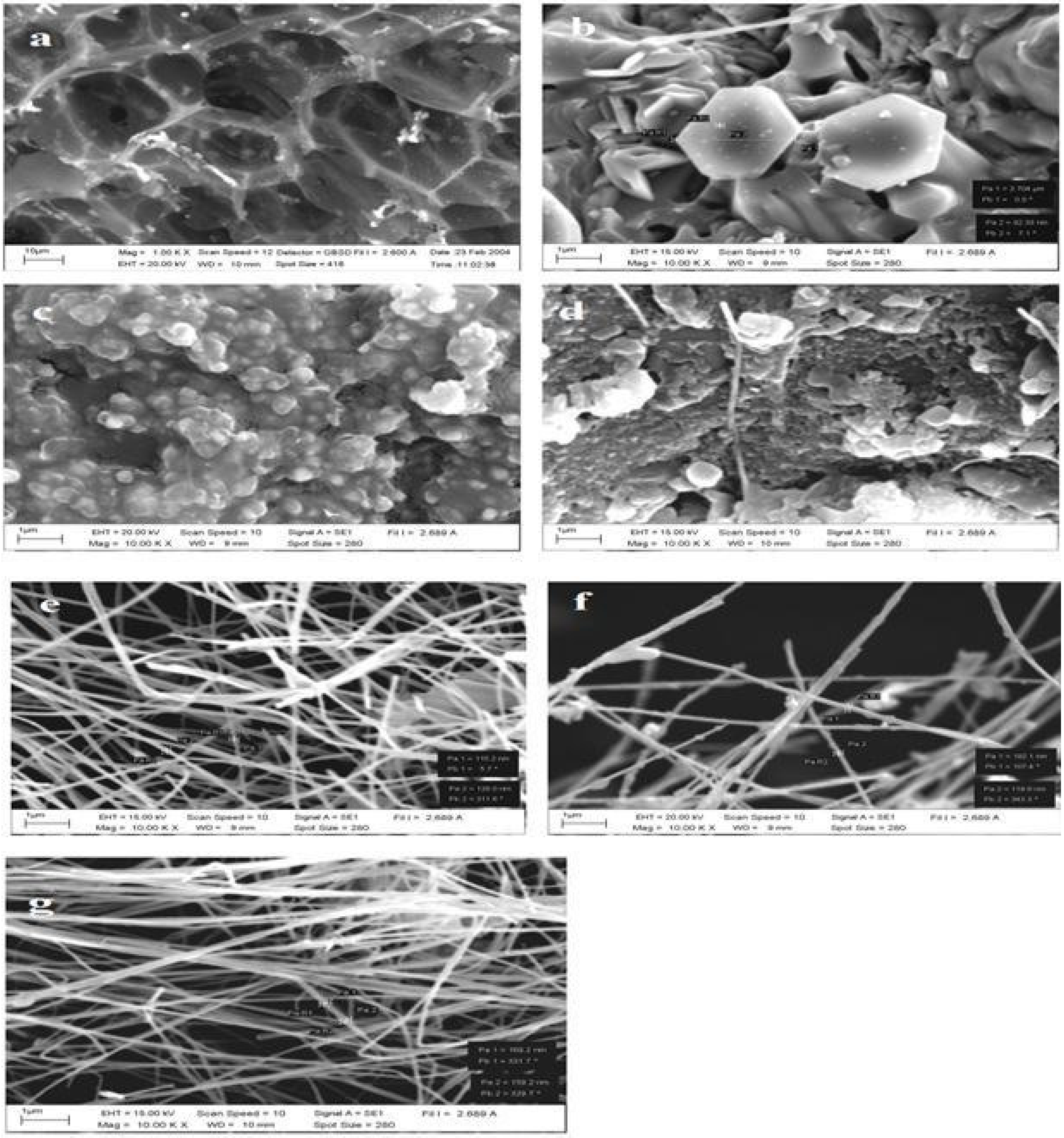

Figure 1. SEM micrograph of; (a) activated banana peel carbon at 600°C; (b) activated banana peel carbon at 1000°C; (c) activated banana peel carbon at 1100°C; (d) activated banana peel carbon at 1200°C; (e) carbon nanotube from pyrolysed banana peel activated carbon and 2% mineral oil mixture at 1000°C, (f) carbon nanotube from pyrolysed banana peel activated carbon and 2% mineral oil mixture at 1100°C and (g) carbon nanotube from pyrolysed banana peel activated carbon and 2% mineral oil mixture at 1200°C.

(SEM, LEO 1455 VP), transmission electron microscopy (TEM, Phillips, Tecnai12) (The sample was sonically dispersed in a toluene during 15 min and a drop of the solution was deposited onto a copper grid) and X-ray diffraction (XRD, PW 3040/60, X' Pert Pro MPD).

RESULTS AND DISCUSSION

The SEM images of the products are shown in Figure 1. It is shown that the pyrolytic products consists mainly of

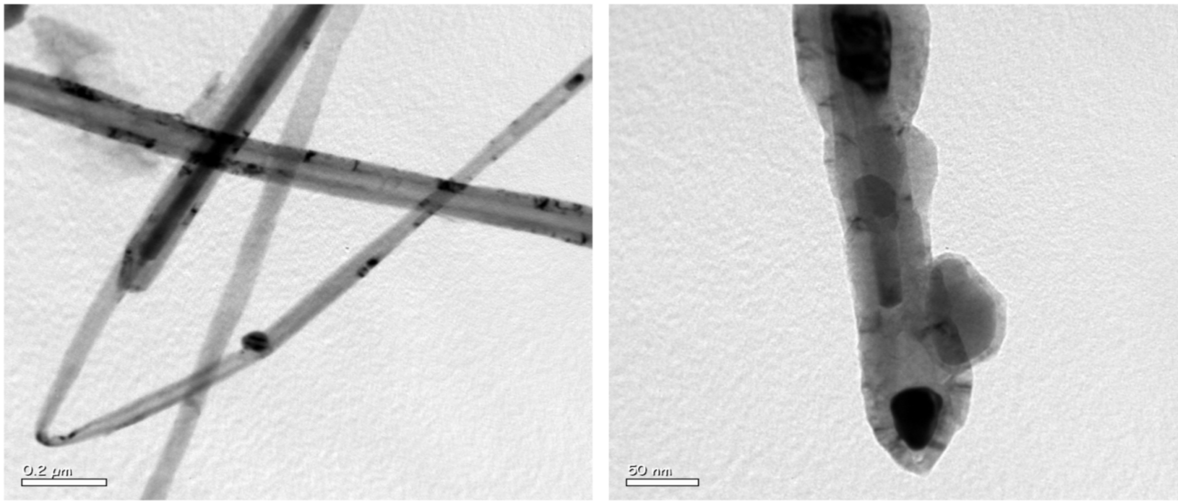

Figure 2. TEM micrograph of carbon nanotube from pyrolysed banana peel activated carbon and 2% mineral oil mixture.

straight nanotube with thickness of about 115 to 138 nm at 1000°C, 120 to 192 nm at 1100°C and 159.2 to 169.2 nm at 1200°C. The SEM image for all pyrolytic samples showed nanotubes with nodular interconnections (Figure 1e to g). The quality and quantity of the nanotubes in the samples which were synthesized at different temperatures were not significantly different. As compared with activated banana peel, carbon which pyrolysed at 600°C (Figure 1a) and 1000 to 1200°C (Figure 1, b to d), showed that nanotube did not appear in the pyrolytic products. From the TEM images of the pyrolyzed products shown in Figure 2, it was confirmed that the products are carbon nanotubes, with a straight shape, which is similar to the carbon nanotubes from liquid petroleum (Ndungu et al., 2008), with outer diameters of 47 to 106 nm and inner diameter = 12 to 30 nm, respectively. The lengths of the nanotubes are very long.

Furthermore, TEM studies revealed the presence of multi walled carbon nanotubes and Fe (metal) inside the hollow and the tip of the carbon nanotube (Figure 2). These morphologies indicate that Fe (metal) was thermally decomposed from the stainless steel tube and encapsulated by precipitated carbon, which corresponded to the nodular form in the SEM image. The Fe crystal was further confirmed by XRD patterns with peaks at 50.2° (Figure 3). It is suggested that the carbon nanotubes grew with their tips open during their growth process. Mahanandia et al. (2008) have also reported of similar carbon nanotubes formed by this method. From this research, it is expected that the stainless steel tube is acting as a catalyst too. This case describes how carbon growth involves surface carbon decomposition, carbon dissolution and diffusion, and when carbon super saturation is reached, carbon precipitates in the form of graphene layers (de Lucas et al., 2006). The powder X-ray diffraction pattern of the banana peel activated carbon and pyrolytic products which were produced from banana peel activated carbon and 2% mineral oil mixtures at 1000 to 1200°C pyrolysis are shown in Figure 3. The XRD profiles for the pyrolytic products exhibited sharp peaks, which indicate changes in the structure of the activated carbon. It was confirmed that the pyrolysis temperature at 1000 to 120°C of activated banana peel carbon and mineral oil mixtures were thermally decomposed to a crystalline, graphitic form of carbon (including; carbon nanotube, peaks at 26, 28.5, 43 and 54.5°; fullerene, peaks at 11, 19, 21.5, 31.5, 41.5 and 56.5°; and chaoite, peaks at 24.5, 29.5, 30.5, 34, 39.5 and 48.5°). The XRD pattern implied that the pyrolytic products are not pure and have some impurity. The impurities include some carbon amorphous (peaks at 45 and 58.5°), Fe_3C (peaks at 38 and 41°), Fe_2O_3 (peaks at 34.5 and 53°) and K_2O (peak at 46°). It suggests that the pyrolysis reaction is not completed and the carbon amorphous still existed. For Fe_3C and Fe_2O_3, it was expected that, Fe (metal) was dissociated from the stainless steel tube and reacted with some of C and O in the stainless steel tube system. In the case of K_2O, K probably remained in the banana peel formed during oxidation reaction. In general, the banana peel had high content of K.

Conclusions

Carbon nanotubes can be obtained from activated banana carbon and 2% mineral oil mixture by pyrolysis in the stainless steel tube at 1000 to 1200°C. The pyrolytic

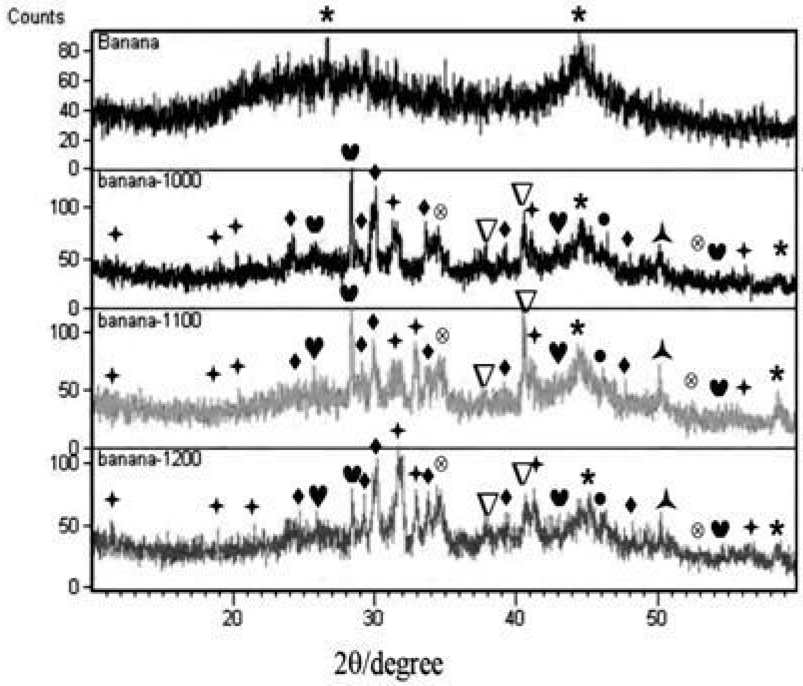

Figure 3. XRD patterns of activated banana peel carbon at 600°C, carbon nano tube from pyrolysis at 1000°C, carbon nanotube from pyrolysis at 1100°C and carbon nanotube from pyrolysis at 1200°C. (* carbon amorphous, ♥ carbon nanotube, ∇ Fe_3C, ⊗ Fe_2O_3, • KO_2, ♦ chaoite, ⅄ Fcc Fe, and ✦ Fullerene).

products consisted mainly of straight nanotubes with an outer diameter of 47 to 106 nm and an inner diameter = 12 to 30 nm, respectively. The nanotubes showed nodular Fe (metal) inside the hollow and the tip interconnections. The pyrolytic products consist mainly of carbon nanotubes and a small amount of carbon amorphous, fullerene, and carbon in chaoite form, Fe_3C, Fe_2O_3, and K_2O.

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REFERENCES

De-Lucas A, Garcia PB, Garrido A, Romero A, Valverde JL (2006). Catalytic synthesis of carbon nanotubes with different graphene plane alignments using Ni deposited on iron pillared clays. Appl. Catal. A: Gen., 301: 123-132.

Granella M, Ballarin C, Nardini B, Marchioro M, Clonfero E (1995). Mutagenicity and contents of polycyclic aromatic hydrocarbons in new high-viscosity naphthenic oils and used and recycled mineral oils. Mut. Res., 343: 145-150.

Kumar M, Kichambare PD, Sharon M, Ando Y, Zhao X (1999). Synthesis of conducting fibers, nanotubes, and thin films of carbon from commercial kerosene. Mater. Res. Bull., 34(5): 791-801.

Mahanandia P, Nanda KK, Prasad V, Subramanyam SV (2008). Synthesis and characterization of carbon nanoribbons and single crystal iron filled carbon nanotubes. Mater. Res. Bull., 43: 3252-3262.

Manocha LM (2005). Introduction of nanostructures in carbon-carbon composites. Mater. Sci. Eng. A., 412: 27-30.

Mopoung S, Liamsombut T, Thepsuya N (2010). Production of composite sodium-nanocarbon from mixtures of banana peel charcoal and sodium hydroxide by pyrolysis process. Continental J. Appl. Sci., 5: 61-68.

Mopoung S, Thongcharoen P (2009). Coloured intensity enhancement of latent fingerprint powder obtained from banana peel activated carbon with methylene blue. Sci. Res. Essays, 4(1): 008-012.

Ndungu P, Godongwana ZG, Petrik LF, Nechaev A, Liao S, Linkov V, (2008). Synthesis of carbon nanostructured materials using LPG. Microporous Mesoporous Mater., 116: 593-600.

Orlanducci S, Valentini F, Piccirillo S, Terranova ML, Botti S, Ciardi R, Rossi M, Palleschi G (2004). Chemical/structural characterization of carbon nanoparticles produced by laser pyrolysis and used for nanotube growth. Mater. Chem. Phys., 87: 190-195.

Paradise M, Goswami T (2007). Carbon nanotubes-production and industrial applications. Mater. Des., 28: 1477-1489.

Popov VN (2004). Carbon nanotubes: Properties and application. Mater. Sci. Eng. R., 42: 61-102.