Synthesis of Carbon Nanotubes Using Plant Source and Study their Properties

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Abstract

In this study the normal and activated charcoal were used to prepare normal and activated multi walled carbon nanotubes (MWCNTs) from same plant (Citrus aurantium) which is a source of carbon by Chemical Flame Deposition method (CFDM). The obtained products were analyzed using FESEM, FTIR, XRD, and Raman spectroscopy. The FESEM image of normal charcoal revealed that it has much less nanopores than activated charcoal. The ratios of ID/IG for the normal and activated MWCNTs were 0.85 and 0.91 respectively, which shows that use activated charcoal as a source enhance the disorder and the defects on the carbon nanotubes. The results demonstrate and confirmed that a carbon nanotubes which were prepared from normal and activated charcoal have some disfigurements and have converging diameter nearly (31-88 nm) and (37-70nm) for normal and activated MWCNTs with length about (1-2) μm respectively.

Key Words: Plant, Charcoal, Active Charcoal, Carbon Nanotubes.

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Introduction

Normal charcoal and their activated were prepared from plant refer to a wide-ranging of carbonized materials of substance of elevated degree of porosity and surface area. Active charcoal has many uses in the life and manufacture for the eviction and amendment of different compounds(Kosheleva et al., 2019) (Samsuri et al., 2014) (Yousefi et al., 2019). In other hand, important discovery of carbon nanotubes (CNTs) attracts several scientists because of its significant characteristics(Iijima, 1991). The Carbon nanotubes are a kind of carbon for thin cylinder and different composition(H Khan et al., 2010). The tensile power of the CNT is better than those of the different material such as metals (Varshney, 2014). The CNT is categorized into many types such as single, few and multi walled nanotubes which have three different forms (Armchair, Chiral and Zigzag form), this design depends on the way the graphene is wrapped into a cylinder, multi walled carbon nanotubes have two model Russian Doll model and Parchment model (Pandey and Dahiya, 2016). MWCNTs and FWCNTs have greater properties than SWCNTs due to the existence of abundant layers of graphene; this structure helps in application in the area of complex matters (Samal and Bal, 2008). In many applicationsthe MWCNT can usage (Jones et al., 2013), due to its absorbing property of different gases under ambient conditions, the CNT also has its usage in the storage of hydrogen (Froudakis, 2011). To synthesis carbon nanotubes there are many chemical and physical ways such as laser ablation, arc discharge and chemical vapour deposition (CVD) processes. Arc discharge method was utilized in the production of all CNTs types (Rafique and Iqbal, 2011).

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CVD method is the more diffuse in the production of CNT (Szabó et al., 2010). The main merit of the chemical deposition method (CVD) is that it allows CNT outgrowth in an variable shapes (Arunkumar et al., 2020) (Eatemadi et al., 2014). Chemical flame deposition (CFD) method provides good advantage over above methods, the CNTs outgrowth ability controlled with low heat about (90-140 °C) (Yassin et al., 2019). In this study, the carbon nanotubes (MWCNTs) was synthesized from plant source by CFDM, for use in several applications, and study the properties of the product by different physical methods as well.

Experimental Part

1. Preparation of charcoal and activated charcoal

The earth used as a shield against oxygen and to insulate the carbonising wood against excessive loss of heat to make more charcoal than any other method, which obviously keeps its place because of het low cost. The charcoal was obtained from the Sinsil Al-Tayeh village - Diyala - Iraq by burning the stalk of the Citrus aurantium using primitive methods as shown in the scheme 1. Excavate a pit, put in the charge of wood and cover the pit with excavated earth to seal up the chamber. The earth forms the necessary gas-tight insulating barrier behind the carbonization can take place without leakage of air; this would allow the charcoal to burn away to ashes and give a charcoal, see Scheme 1.

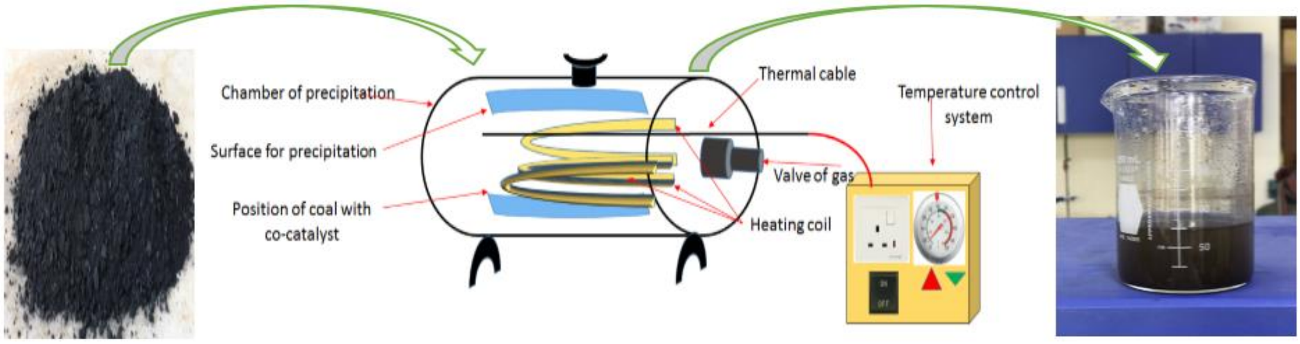
Activated carbon, also called activated charcoal to have small low-volume pores that increase the surface area available for adsorption or chemical reactions. The Citrus aurantium charcoal (100g) was grinded well to become a powder. Drying the charcoal powder with air for 24 hours, after that, add 50 mL of the lemon juice to the charcoal powder with stirring to get a cohesive paste. The paste was covered and left for 24 hours, and it was placed in an oven (150°C) for 3 hours to obtain activated carbon or activated charcoal, scheme 2.

Scheme 1. The stages of preparation charcoal and activated charcoal in Sinsil Al-Tayeh village - Diyala – Iraq

Scheme 2. The stages of production the activated charcoal

2. Preparation of carbon nanotubes

Multi walled Carbon nanotubes (MWCNTs) were produced by using Citrus Aurantium charcoal (normal and activated charcoal) as a source of carbon at 120 °C under limit atmospheric oxygen. By chemical flame deposition CFD method were done *via* homemade reactor as shown in scheme 3.



Scheme 3. Reactor of chemical flame method (CFM) (Yassin and Abdulrazzak, 2019)

Results and Discussion

The infrared spectra of the samples for normal charcoal, activated charcoal, normal carbon nanotube and activated carbon nanotube are shown in figures (1,2) respectively. The FTIR spectrum of normal charcoal (Fig. 1. green spectrum) showed many main bands at 3417–3441 cm^{-1} assigned to O–H stretching and 1643 cm^{-1} refer to C=C stretching (Krishnan and Anirudhan, 2002). Similarly, the activated charcoal (Fig. 1. red spectrum) show at wavenumber of 3429 cm^{-1} weak broad bands belong to O–H stretching, C–H bonds of the aromatic ring moderate intensity at 2927–2981 cm^{-1}. Band at 1643cm−1 and 1427 refer to C=O /C=C bonds, while 1049 cm−1 for the C–O bonds of the aromatic ring compound type (Wibowo et al., 2015).

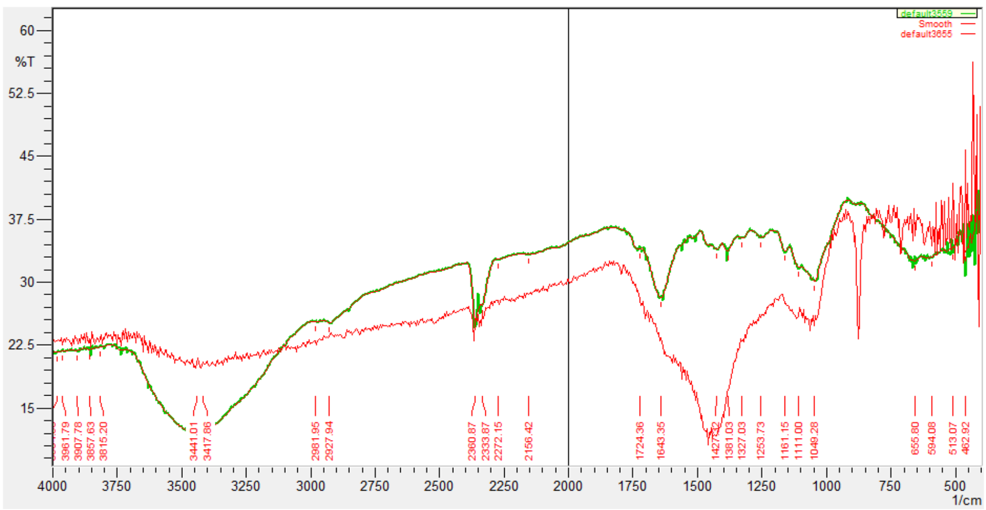


Fig. 1. FTIR spectra of normal charcoal (green spectrum) before and after activated (red spectrum)

The FTIR spectra of normal and activated MWCNTs are shown in Figure (2). FTIR of normal MWCNTs (Fig. 2. red spectrum) shows dominant peaks at 3180 – 3477 cm^{-1}, 1622, 1402 and 1122 cm^{-1} corresponds to O–H, C=O/C= C and C–O, respectively. While the FT-IR spectrum of activated MWCNTs are shown in (Fig. 2. blue spectrum) different peaks at 3392, 2924, 1620 and 1071cm^{-1} indicates the presence of a hydroxyl group O–H, aliphatic–CH, C=O and C–O stretching vibrations in alcohols, phenols, ether or ester groups.

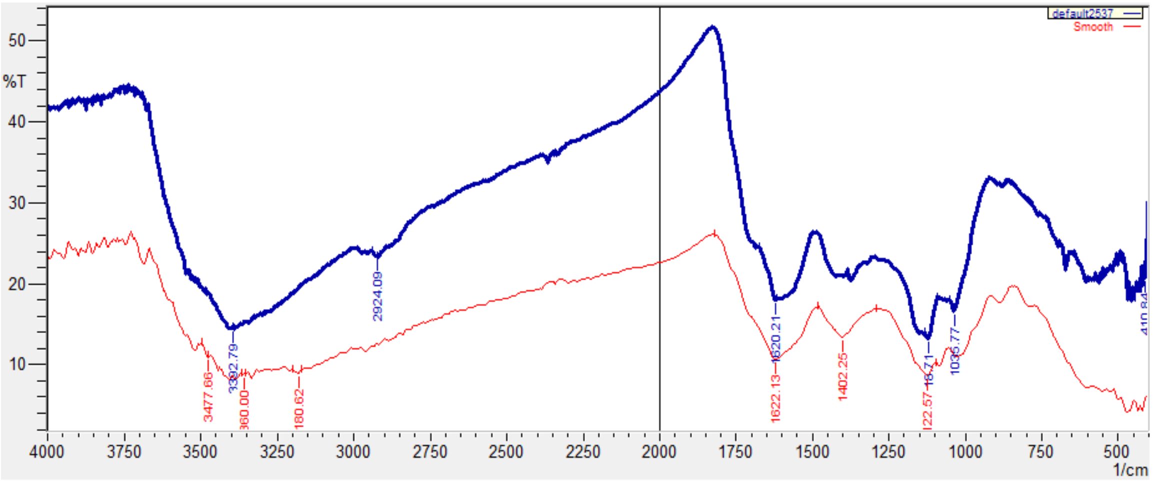


Fig. 2. FTIR spectra of normal MWCNTs (red spectrum) and activated MWCNTs (blue spectrum)

Raman spectra of normal and active MWCNTs is presented in Figure 3. There are two peaks observed on all MWCNTs samples. In case the normal MWCNTs the D band corresponding to the degree of nanotubes structure disorder observed at 1359 cm^{-1}, 1444 cm^{-1} and the G band corresponding to the degree of nanotubes graphitisation appeared at 1588cm^{-1}, while in case of active MWCNTs the D band observed at 1436 cm^{-1} and G band at 1582cm^{-1}. As well as 2D band corresponding to stresses at 2972 and 3027 cm^{-1} were observed, which refer to normal and activated MWCNTs respectively. And clearly shows that use of activated charcoal as a source enhanced the disorder and the defects on the sidewall of tubes (Mohammadian et al., 2018), in which a larger D to G ratio indicates a higher defect density. The ratio of I_D/I_G of the normal MWCNTs (0.85) less than activated MWCNTs (0.91) was around 0.6.

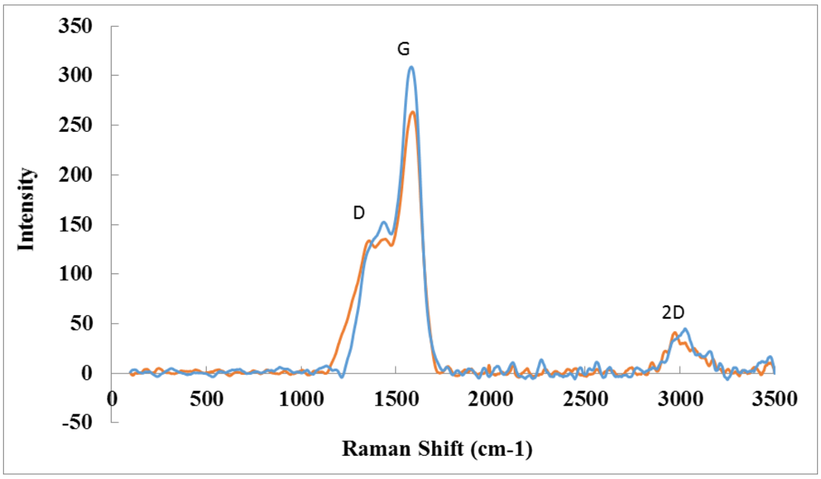


Fig. 3. Raman spectra of normal MWCNTs (blue spectrum) and activated MWCNTs (red spectrum)

The XRD results obtained for the normal MWCNTs were compared with activated MWCNTs and it showed that the peaks point values has a different values of around ± 1.1 (Fig. 4 a,b).

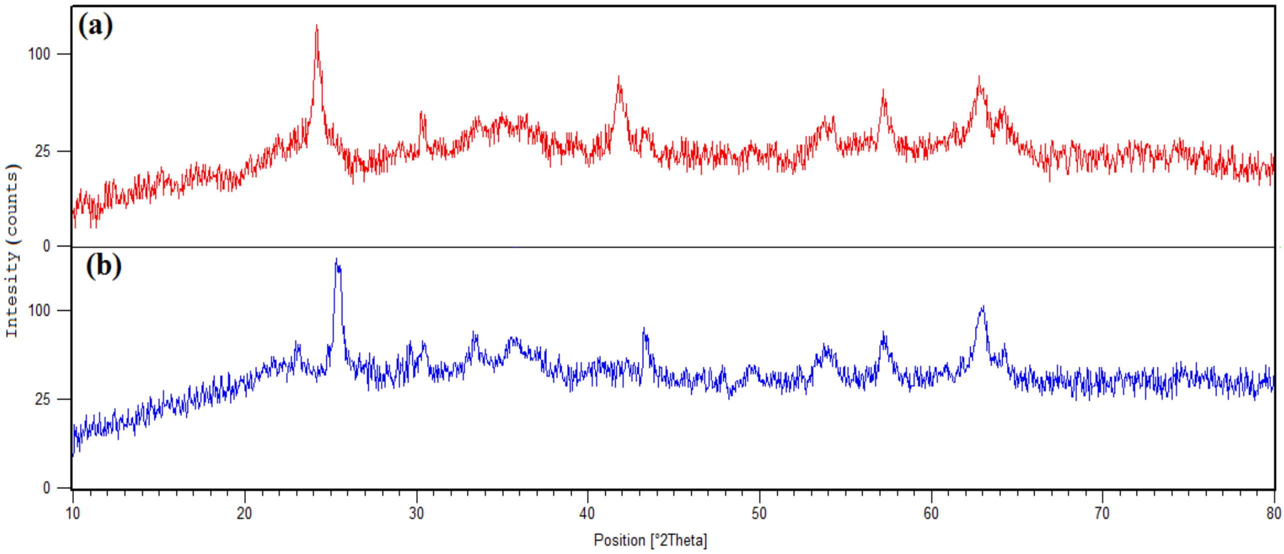


Fig. 4. XRD Pattern of (a) normal MWCNTs and (b) activated MWCNTs

The FESEM images of normal charcoal (Fig. 5a) revealed that it has a less nanopores than activated charcoal (Fig. 5 b) (Kadirvelu et al., 2000).

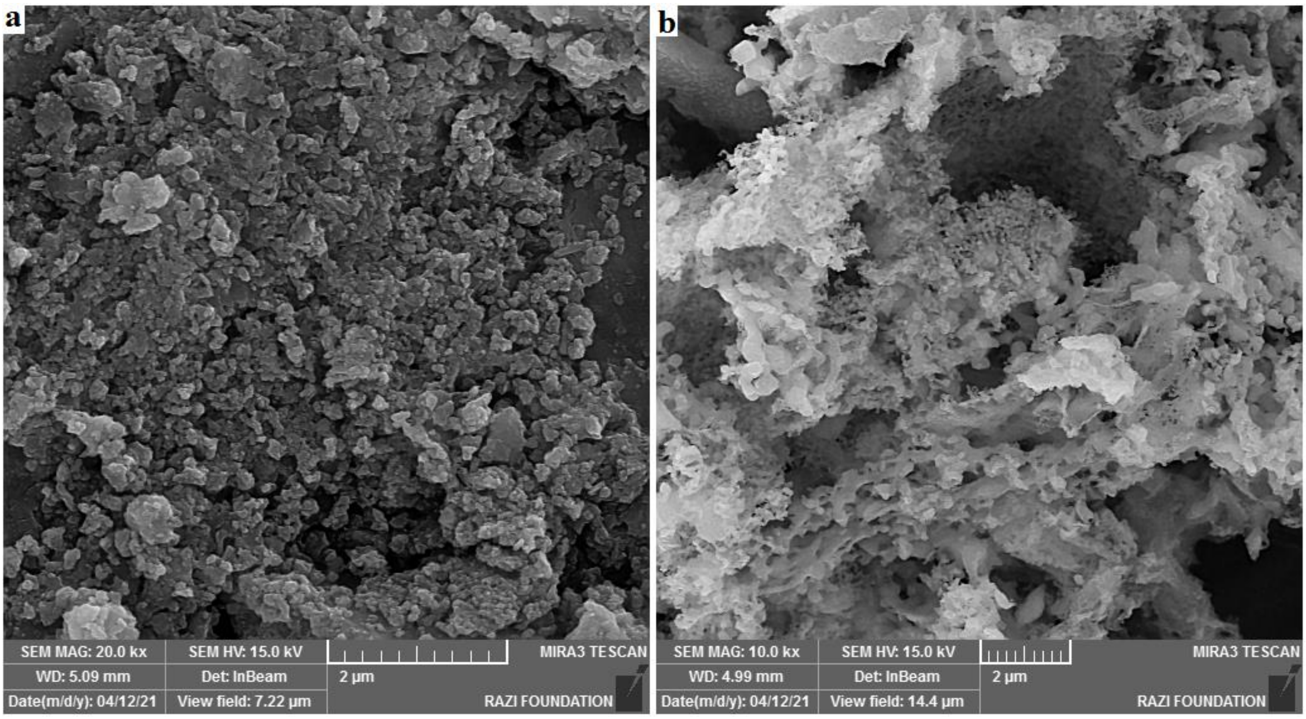


Fig. 5. FESEM images of (a) normal charcoal and (b) activated charcoal

On the other hand, the FESEM images (Fig. 6a,b) of the normal and activated MWCNTs, shows the outer surface of the tubes of the normal MWCNTs were rough, while the outer surface of the tubes of the activated MWCNTs were smooth with some disfigurements. Moreover, it is clearly indicates that the diameter of the normal MWCNTs was a bit smaller than the activated MWCNTs. The activation process damaged some outer surface of the tubes of the MWCNTs which lead to some disfigurements on the outer layers of the activated MWCNTs.

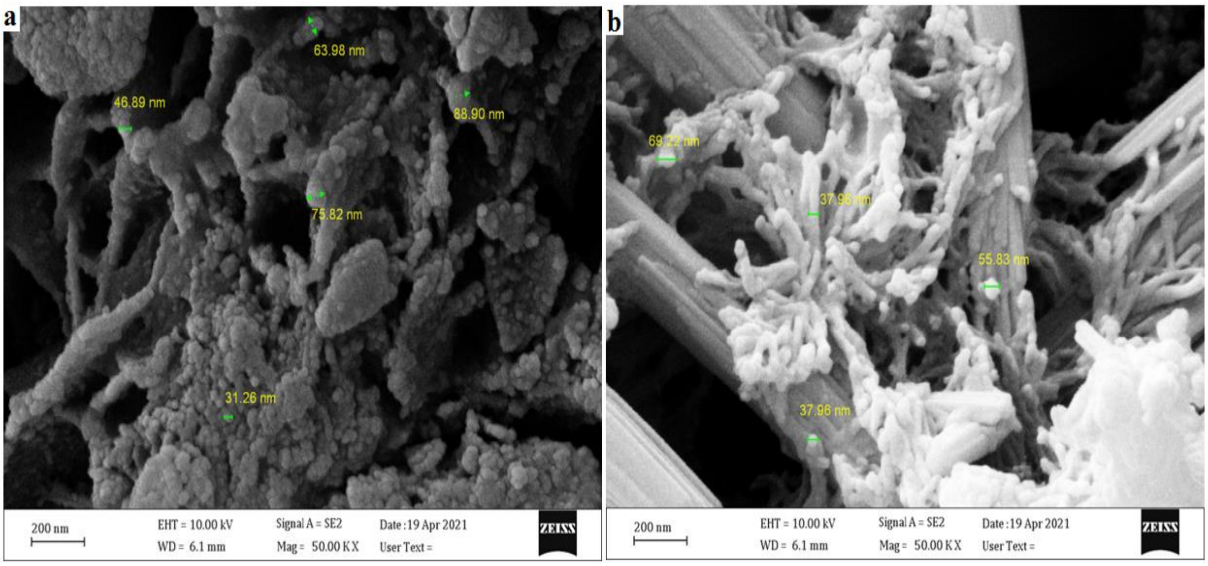


Fig. 6. FESEM images of (a) normal MWCNTs and (b) activated MWCNTs

Conclusions

Normal and activated MWCNTs were prepared from same local plant source and have their same structures, own merits and demerits. The FESEM image of normal charcoal revealed that it has much less nanopores than activated charcoal. Two types of MWCNTs were prepared by chemical flame deposition method (CFDM) from normal and activated charcoal. The shape of the outer tubes of the normal MWCNTs was rough, while the outer tubes of the activated MWCNTs was smooth and there were some disfigurements on it. Moreover, comparing the two images carefully, we could also see that the diameter of the normal MWCNTs was a bit smaller than that of the activated MWCNTs. The ratio of I_D/I_G of the normal MWCNTs (0.85) is less than activated MWCNTs (0.91) and was around 0.6. The XRD confirmed the synthesis of the normal and activated multi walled carbon nanotubes (MWCNTs).

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