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Comparison of Supported and Unsupported Co/Pd Nano Particles Catalysts to Synthesize CNT

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Abstract

In this paper the Co/Pd bi metallic catalyst have been prepared by sol gel method, one of them without using support and the other one by using MgO support, the articles have been characterized through FTIR, XRD, SEM and it has been concluded that the bi metallic catalyst using the support will lead to production of CNT (Carbon Nano Tube) with the higher yield, while the unsupported catalyst jus leads to the production of CNF (Carbon Nano Fibers)

Keywords: Supported catalyst, Un-supported catalyst, Co/Pd bi metallic nano particles, Nano carbon tubes, Nano carbon fibers.

1. Introduction

The discovery of CNT was in 1991 [1] since their discovery by Ijima, the CNT and the other structures of Carbon has attracted many researches for their research topic. Carbon can have various structures such as Graphite, Diamond, Fullerenes, Carbon Nano Tubes in form of Single wall, Multi wall and double wall, Graphene and also Carbon Nano fibers. [2]

CNT has many superior properties such as mechanical, electronics, optoelectronic and chemical, and that's the reason it has attracted many researches in industry and as well as academic purposes. They have so many superior applications in electronics , sensors , hydrogen storage, mechanical and field emission ,[3] super capacitates, semi conductors [4] and so many other commercial and industrial application review recently by Volder et al [5] .CNT can be produced by Arc discharge, laser ablation, electrolysis, from bulk polymer, low temperature solid pyrolysis, vertical/horizontal furnace, CVD (Chemical Vapor Deposition), PECVD (Plasma Enhanced Chemical Vapor Deposition) [6] .In the present paper the experiments are carried out in a CVD method since this method is better from the aspects of product purity and its large scale production [7]

2. Methodology

In the literature there are so many reports of using metallic catalysts and Co and Pd have always been proven to be among active catalysts. Bethune et al used bi metallic catalysts with cobalt and they could grow SWCNTs and they concluded that cobalt plays an important role in formation of SWCNTs [8]. Rasesco et al also produced SWNTs by Co-Mo bi metallic catalysts. [9] We have used Co because

Fe, Co, Ni have high solubility of carbon in these metals at high temperature and also high diffusion rate [10] They also have stronger adhesion with growing CNT [9] In addition to transition metals, the metals of other groups such as Au, Ag, Pt, Pd have been used to produce the CNT efficiently and with high yields. [11] Therefore because of these reasons the combination of Co and Pd have been used as a bi metallic catalyst in this paper. In the case of the support the Mgo has been used among other supports such as Al_2O_3, SiO_2, Zeolite etc, because it has been reported that MgO is easily dissolvable and easier to purify in CNT. [12]

3. Experiments

There are many reports on production of Co-Pd bi metallic catalysts [13, 14, 15, 16, 17]. In this experiment $Co(No_3)_3.9H_2O$, $Pd(Br)_2(MeCN)_2$ which was heated were dissolved in distilled water , they were stirred while heating at 100 C, then they were sonificated for 1 hr, The metal contents was kept at 6 wt% and the molar ratio of co-pd was 1:2. They were dried at 100 C and calcined at 500 C. The Co-Pd catalysts then were impregnated at MgO with an aqueous solution. They were stirred followed by drying in oven at 100 C and Calcination at 600 C. The 200 mg of the catalysts were placed in a reactor, heated in Ar up to 50 C when purged and then up to 800 C and after the temperature was stabilized the methane was introduced with a flow rate of 100 cm/m3 for 6 hrs.

4. Results and Discussion

As shown in Figure 1 , the particle size were determined by XRD and by an analysis of line broading at 2θ for the supported catalysts at 25,43,68, 75 and for the unsupported catalysts at 2θ= 26, 36,43, 53, 67.It is found that the smaller uniform and more uniform Carbon Nano tubes have been grown from the MgO supported catalysts in contrast to the supported catalysts the un-supported ones have a broader diameter and the Fibers are gown in different structures and only few of these fibers are regular in shape.

The SEM result of the supported Co-Pd catalyst shows that multi wall carbon nano tubes are presence and the size distribution is homogenous however for unsupported the structure is Carbon Nano Fibers and Graphite like shape and there exists a different size distribution.

The FTIR results also show that when the support isn't used the band shifts and it's as if there is a mono metallic catalyst such as Co and the band for Pd almost has disappeared. On the activity of the catalyst, this fact can be mentioned that Co-Pd/MgO catalysts are more assisting in growing of CNT; however the Co-Pd unsupported catalyst has a very small yield producing CNF. This fact shows the carbon deposition rate which the support increases and consequently the steady state rate which increases the yield but the unsupported catalyst is not assisting the deposition rate and it deactivates the catalyst finally.

Figure-1. SEM result of (a) Co/Pd supported on MgO and (b) Co/Pd unsupported Catalyst

(a) (b)

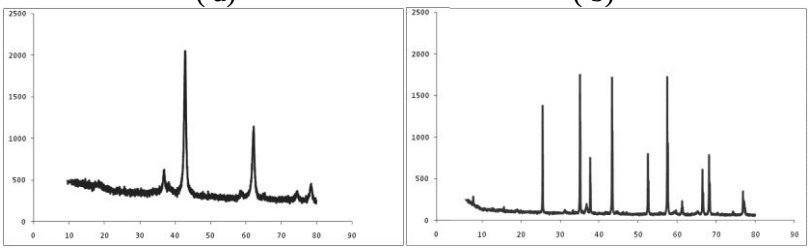


Figure-2. FTIR result of (a) Co/Pd supported on MgO and (b) Co/Pd unsupported Catalyst

(a) (b)

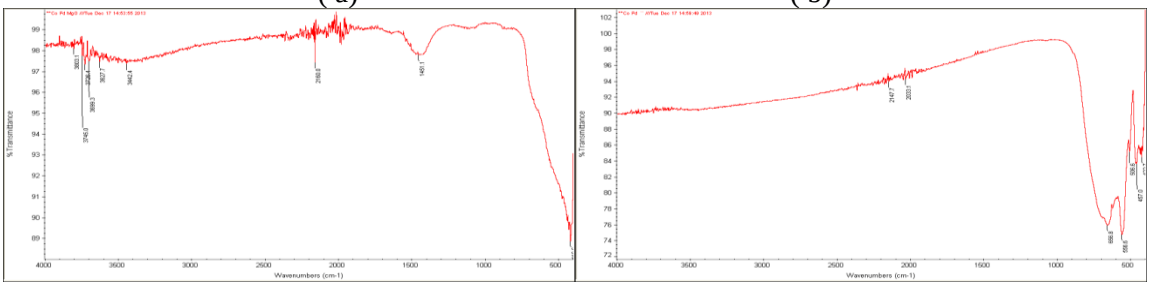
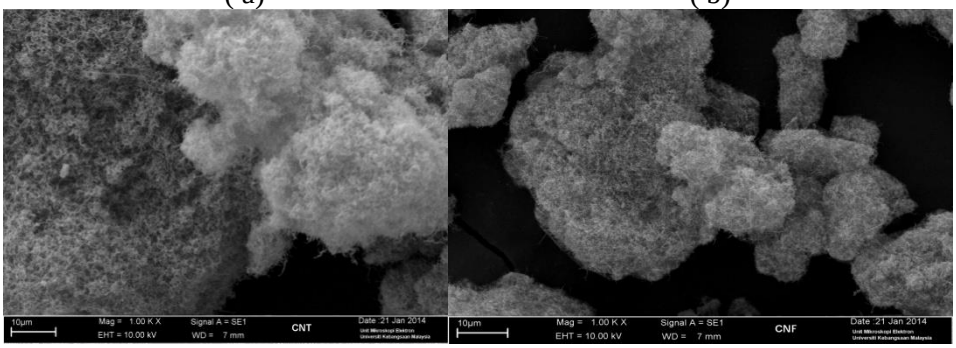


Figure-3. SEM result of (a) Co/Pd MgO supported resulted in CNT and (b) Co/Pd unsupported resulted in CNF

(a) (b)



5. Conclusion

Generally the unsupported Co-Pd was inactive. This unsupported bi metallic catalyst just acted as mono metallic catalyst which was inactive without support and produced CNF which wasn't homogenous in shape and structure. The CNF on an unsupported catalysts are heterogeneous in diameter and size and the yield is so low .The bi metallic supported Co-Pd catalyst supported on MgO leads to the higher yield of CNT with a desired shape and structure and these facts are in accordance with the other researches done on the comparison of using support and unsupported catalyst in synthesis of CNTs. [18-27]

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