



*
 - - -
 (// , //)

Ni-Mo

NaCl

(TEM)

(SEM)

:

[]

"

"

[]

[]

[]

[]

DC

[]

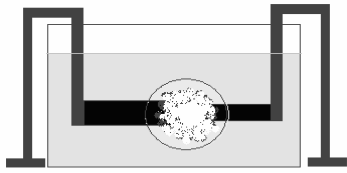
[]

[]

(DC)

()

()



[]

Ni-Mo

()

[]

Cl⁻ Na⁺

[]

°C

DC

/

(SEM)

()

()

)
 ((-)
 SEM ()
 Ni-Mo
 ()
 % : Ni:Mo

PECVD CVD

[]

(-)

figure	Catalyst	at%
-2	None	-
-2	Fe	2
-2	Co	2
-2	Ni	2
-2	Co:Mo	1:1
-2	Ni:Mo	1:1

(-)

(-)

: :

figure	atomic percent
-3	2:1%
-3	4:1%
-3	10:1%

/ - / at%

)

[]

(% /

SEM

(-) (-)

(Ni:Mo % :)

Ni

) H₂O₂ HNO₃

(

()

(-) (-)

SEM (-)

(-)

Ni-Mo Co-Mo

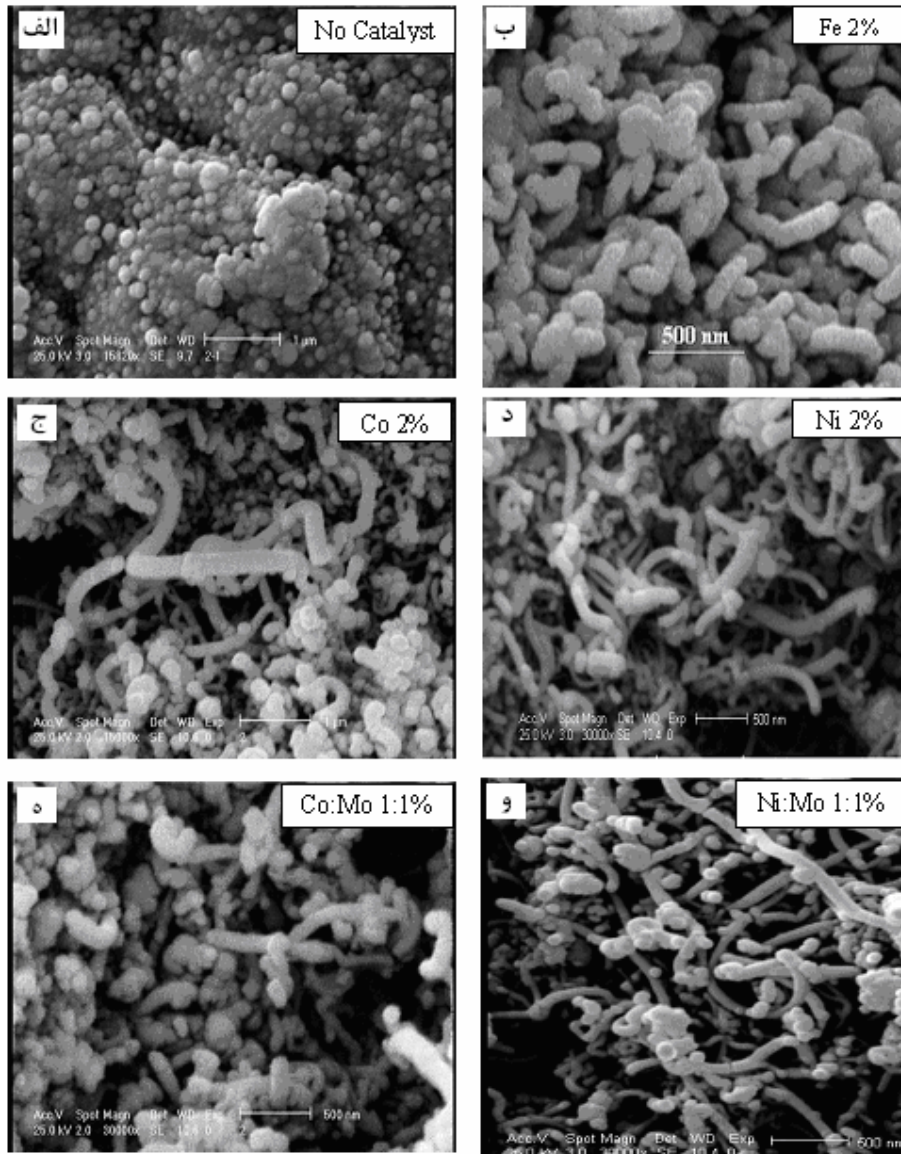
(-)

% : Ni-Mo

- nm

[-]

TEM



$$d = \frac{232}{\nu - 6.5} \quad ()$$

RBM ν
 CNT d cm^{-1}
 D G
 (-)
 % : Ni-Mo
 D G
 (G/D=)

(-) (-)
 (-)
 % : Ni:Mo
 RBM
 cm^{-1}
 ()
 ()
 [] RBM

(-)

cm⁻¹

RBM

(-)

C-C

)

% :

(% :

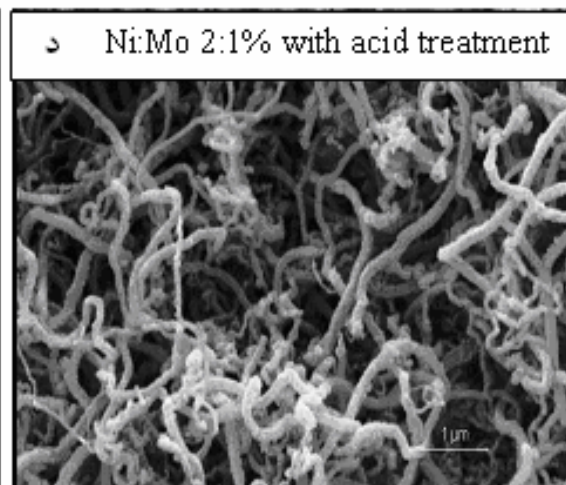
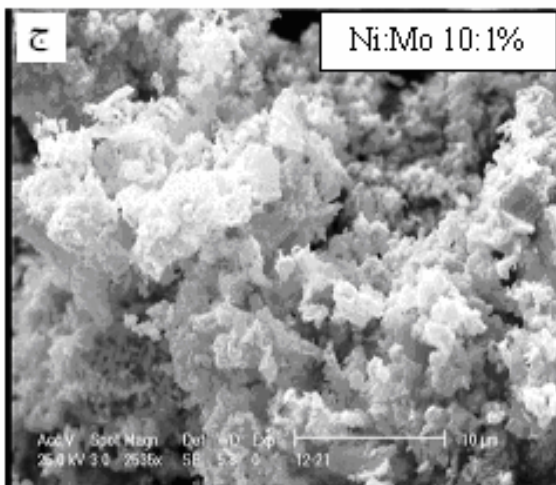
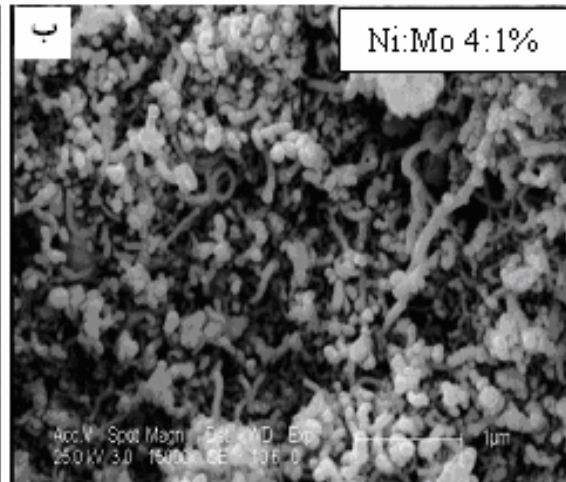
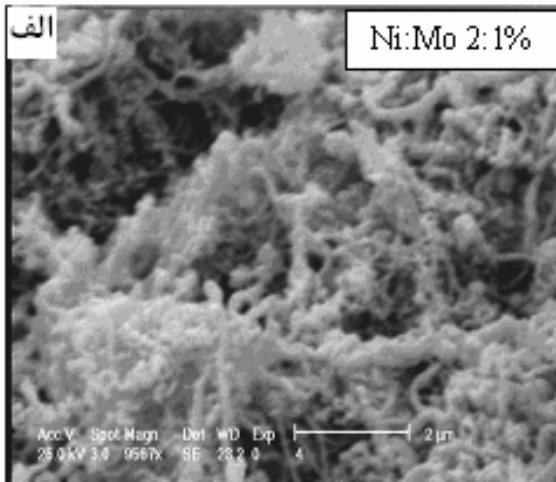
SEM

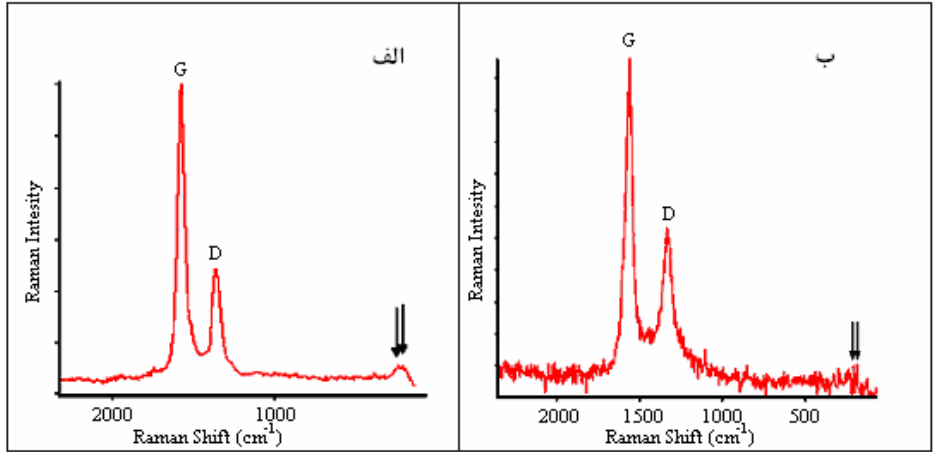
TEM

SEM

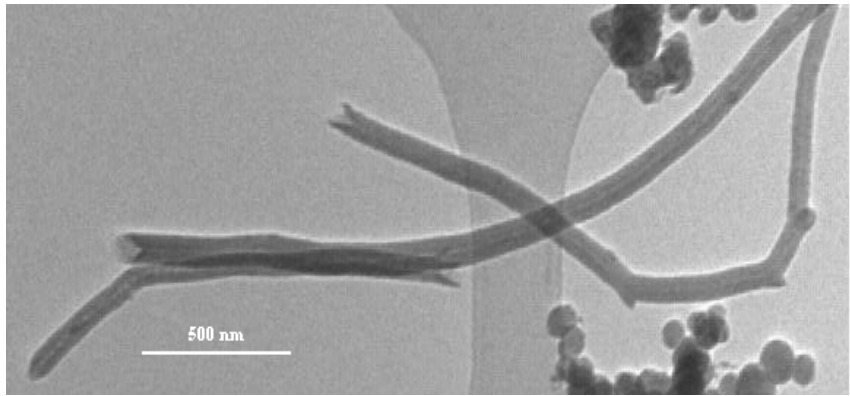
% :

Ni:Mo





.% : : % : :



. : % :

Co:Mo Ni:Mo

SEM Ni:Mo Ni Co:Mo

Ni:Mo

Ni Co Fe

SEM

Ni

Ni:Mo % :

- 1 - Iijima, S. (1991). *Helical Microtubules of Graphitic Carbon*, Nature, Vol. 354, PP. 56–58.
- 2 - V. Antisari, M., Marazzi, R. and Krsmanovic, R. (2003). “Synthesis of multiwall carbon nanotubes by electric arc discharge in liquid environment”, *Carbon*, Vol. 41, PP. 2393-2401.
- 3 – Zhu, H.W., Li, X.S., Jiang, B., Xu, C.L., Zhu, Y.F. and Wu, D.H. (2002). “Formation of carbon nanotubes in water by the electric-arc technique.” *Chemical Physics Letters*, Vol. 336, PP. 664-669.
- 4 - Zeng, H., Zhu, L., Hao, G. and Sheng, R. (1998). *Synthesis of Various Forms of Carbon Nanotubes by AC Arc Discharge*, Carbon, Vol. 36, PP. 259-261.
- 5 – Ishigami, M., Cummings, J., Zettl, A. and Chen S. (2000). “A simple method for the continuous production of carbon nanotubes.” *Chemical Physics Letters*, Vol. 319, PP. 457-459.
- 6 - Dar Wang, Sh. D., Chang, M. H., M. Der Lan, K., Wu, Ch. Ch., Cheng B, J. J. and Chang, H. K. (2005). “Synthesis of carbon nanotubes by arc discharge in sodium chloride solution.” *Carbon*, Vol. 43, Issue 8, PP. 1792-1795.
- 7 - Koohsorkhi, J., Hosseinzadegan, H., Mohajerzadeh, S., Asl. Soleimani, E. and Arzi, E. (2005). “PECVD-grown carbon nanotubes on silicon substrates suitable for realization of field-emission devices.” *Journal of Fullerenes, Nanotubes and Carbon Nanostructures*, Vol. 13, PP. 355-364.
- 8 - Sano N., Nakano J. and Kanki T. (2004). “Synthesis of single-walled carbon nanotubes with nanohorns by arc in liquid nitrogen.” *Carbon*, Vol. 42, PP. 667-691.
- 9 - Zhang, Zh., Dewan, Ch., Kothari, S., Mitra, S. and Teeters, D. (2005). “Carbon nanotube synthesis, characteristics, and microbattery applications.” *Materials Science and Engineering*, Vol. B 116, PP. 363–368.
- 10 - He, X., Jiang, L., Fan, Ch., Lei, J. and Zheng, M. (2007). “Chemical elimination of amorphous carbon on amorphous carbon nanotubes and its electrochemical performance.” *Chemical Physics*, Vol. 334, PP. 253–258.
- 11 - Rakesh, A., Afre, T., Soga, T. J., Kumar, M., Ando, Y. and Sharon, M. (2005). “Growth of vertically aligned carbon nanotubes on silicon and quartz substrate by spray pyrolysis of a natural precursor: Turpentine oil.” *Chemical Physics Letters*, Vol. 414, PP. 6–10.
- 12 - Gong, Q. J., Li, H. J., Wang, X., Fu, Q.G., Wang, Zh. W. and Li, K. Zh. (2007). “In situ catalytic growth of carbon nanotubes on the surface of carbon cloth.” *Composites Science and Technology*, Vol. 67, PP. 2986–2989.
- 13 - Huang, B., Huang, R., Jin, D. and Ye, D. (2007). “Low temperature SCR of NO with NH₃ over carbon nanotubes supported vanadium oxides.” *Catalysis Today*, Vol. 126, PP. 279–283.
- 14 - Wanliang, M.i., Jerry, Y.S.L., Li, Y. and Zhang, B. (2005). “Synthesis of vertically aligned carbon nanotube films on macroporous alumina substrates.” *Microporous and Mesoporous Materials*, Vol. 81, PP. 185–189.
- 15 - Belin, T. and Epron, F. (2005). “Characterization methods of carbon nanotubes: a review.” *Materials Science and Engineering*, Vol. B 119, PP. 105-118.

- 1 - Arc Discharge
- 2 - Laser Ablation
- 3 - Chemical Vapor Deposition
- 4 - Thermalize
- 5 - Radial Breathing Modes