Low-Temperature Growth of Multiwalled Carbon Nanotubes and Their Field-Emission Properties

吳俊儀、葉競榮 ; 姚品全 ; 陳雍宗

E-mail: 9511365@mail.dyu.edu.tw

ABSTRACT

A highly active Fe-film prepared by electrodeposition over ITO glass substrate were employed to conduct atmospheric thermal chemical vapor deposition at low temperature(600 ° C) in C2H2 flow to form multi-walled carbon nanotubes. Experimental results indicate that the Fe catalysts under reducing ambient of NH3 were very effective for the growth of multi-walled carbon nanotubes with average tube diameter of 20~40 nm. The as-deposited carbon nanotubes films was tested for its filed emission properties. The two-electrodes electron emitting device was tested by a Keithley 236 high-voltage measuring unit under vacuum chamber of 10-5 Pa. The turn-on voltage was 5.5 V/ μm and the threshold voltage was around 9.2 V/ μm with an maximum emission current density of 14.3 mA/cm2. The Fowler-Nordheim plot showed a good linear fit, indicating that the emission current of the as-fabricated carbon nanotubes emitter follows the Fowler-Nordheim behavior. The calculated field enhancement factor was 2225 calculated from the slope of FN. This value shows a typical multi-walled carbon nanotubes field emission behavior.

Keywords : Thermal CVD ; Electroplated ; Multi-walled carbon nanotubes ; Field-emission

Table of Contents

REFERENCES

1] S. Iijima, Nature, 354,（1991）56.
[2] Dresselhaus, M.S.; Dresselhaus, G.; Eklund, P.C. Fullerenes and Carbon Nanotubes, Academic,San Diego, 1996.
[3] MR Falvo, GJ Clary, RM II Taylor, V Chi, FP Brooks, S Washburn,RSuperfine, Nature 389(1997) 582 [4] M treacy, TW Ebesen , JM Gibson, Nature 381 (1996) 678 [5] S. B. Sinnott, R. Andrews., D. Qian., A. M. Rao., Mao Z, E. C. Dickey and F. Derbyshire,“ Model of carbon nanotube growth through chemical vapor deposition ”, Chemical Physics Letters, 315, 25-30(1999).
[6] D. S. Bethune, C. H. Kiang, M. S. de Vries, G. Gorman, R. Savoy, J.vazquez, R. Beyers, Nature,363, 605-609 (1993).
[7] A. C. Dillon, P. A. Parilla, J. L. Alleman, J. D. Perkins and M. J. Heben,“ Controlling single-wall nanotube diameters with variation in laser pulse power ”, Chemical Physics Letters, 316, 13-18 (2000).
[8] Jiao, S. Seraphin, Journal of Physics and Chemistry of Solids, 61, 1055-1067 (2000).
[9] A. Rao,“ Nanostuctured From of Carbon-An Overview ”, International School of Solid State Physics-18th course: the three faucets Nanostructured Carbon for Advanced Applications (NATO-ASI),2000, Italy.
[10] ”Carbon Nanotubes – preparation and properties ”,ed. By Thomas W. Ebbesen, CRC Press, Boca Raton, New York, London, Tokyo, 1997.
[11] T. W. Ebbesen and P. M. Ajayan, Nature, 358（1992）220.
[12] 林景正，工業技術研究院 工業材料研究所 精細金屬實驗室。
[13] Ivanov, V. ,Nagy, J. B. et al. Chem. Phys. Lett. 223 （1994） 329.
[14] R. Sen, A. Govindaraj and C. N. R. Rao, Chem. Phys. Lett. 267 （1997）276.
[15] 黃建良，”奈米碳管的合成”，奈米科技專刊，工業技術研究院化學工業研究所，2002 年11月，51-61 頁。
[16] H.M. Cheng, F. Li, G. Su, H.Y. Pan, L.L. He, X. Sun ans S. Dresselhaus, Appl. Phys. Lett., 72,(1998)3282.
[17] I.W. Chiang, B.E. Brinson, A.Y. Huang, etc.,“ Purification and Characterization of Single-wall Nanotubes (SWNTs) Obtained from the Gas-phase Decomposition of CO (HiPco Process) ”, J. Phys.Chem. B, 105 (2001) 8297-8301.
[18] Z. P. Huang, J. W. Xu, Z. F. Ren, J. H. Wang, M. P. Siegal and P. N.. Provencio, "Growth of highly oriented carbon nanotubes by plasma-enhanced hot filament chemical vapor deposition", Appl. Phys.Lett., 73, 3845 (1998) [19] 林兆君，工業技術研究院 工業材料研究所 精密蝕刻實驗室。
[20] R. Saito, G. Dresselhaus, M. S. Dresselhaus, "Physical Properties of Carbon Nanotubes ", Imperial College Press, 1998, p75.
[21] C. Journet, P. Bernier, Appl. Phys. A, 67（1998）1.
[22] M. Yudasaka etc., "Mechanism of the effect of NiCo, Ni and Co catalysts on the yield of single-wallcarbon nanotubes fored by pulsed Nd:YAG laser ablation", J. Phys. Chem. B, l03, (1999) 6224 [23] F. Kokai etc., "Synthesis of single-wall carbon nanotubes by millisecond-pulsed CO2 laser vaporization at room temperature",Chemical Physics Letters, 332, (2000) 449.
[24] A.C. Dillon etc., "Controlling single-wall nanotube diameters witli variation in laser pulse power".Chemical Physics Letters, 316, (2000) 13.