Pis'ma v ZhETF, vol. 105, iss. 12, pp. 730 – 731

Synthesis and optical properties of ultralong ZnO microbushes

Y. E. Xu[+], *M. Luo*[*1)], *K. Yu*[×]

[+]*Department of Electronic Engineering, Shang Hai Jian Qiao College, 201306 Shanghai, China*

[*]*Department of Physics, Shanghai Second Polytechnic University, 201209 Shanghai, China*

[×]*Ministry of Education and Department of Electronic Engineering, East China Normal University, 200241 Shanghai, China*

Submitted 15 May 2017

DOI: 10.7868/S0370274X17120049

In recent years, ultralong carbon nanotubes (CNTs) have been successfully prepared and applied in many fields such as mechanics and electronics. Therefore, people have great interest in creating ultralong, continuous nanostructures for applications and their properties will promote new technological development. By now, several types of ZnO nanostructures with different macroscopic appearance such as ultralong ZnO nanobelts, hierarchical ZnO dendrites, ultralarge ZnO macroflower, centimeter-long ZnO nanocombs, have been successfully synthesized. But to our knowledge, the ultralong ZnO microbushes are the first time to be prepared by a simple carbon-thermal reduction method.

Ultralong ZnO microbushes have been synthesized using a simple thermal evaporation and condensation method by Cu catalysts. The lengths of the ZnO microbushes range from several millimeters to more than one centimeter and the diameters of the branches' teeth are about 300 nm. As shown in Fig. 1a, the ZnO brush is composed of a long central trunk and lots of highly ordered brush-teeth. The brush-teeth of the ZnO brush have the uniform length about 0.5 mm. It is interestingly that almost every brush-tooth has a crown on the top, which can be seen in Fig. 1b. The growth mechanism of the ultralong microbushes and the catalytic behavior of the copper can be interpreted by the Fig. 1c clearly. Room temperature photoluminescence spectra of the ultralong ZnO microbushes showed a UV emission band at about 388 nm and wide green emissions at around 525 nm in Fig. 1d. Owing to the implanting of Cu in the ZnO microstuctures, we obtain a high ratio of green to UV emission. It may be very attractive for commercial applications such as electrical devices, microelectromechanical systems and sensors.

Full text of the paper is published in JETP Letters journal. DOI: 10.1134/S0021364017120025

1)e-mail: mluo@gmail.com

1. J. Y. Lao, J. Y. Huang, D. Z. Wang, and Z. F. Ren, Nano Lett. **3**, 235 (2011).
2. R. Dalvand, S. Mahmud, J. Rouhi, and C. H. R. Ooi, Mater. Lett. **146**, 65 (2015).
3. K. N. Devi, W. J. Singh, and K. J. Singh, Mater Sci: Mater Electron **28**, 8211 (2017).
4. R. K. Sonker, S. R. Sabhajeet, S. Singh, and B. C. Yadav, Mater. Lett. **152**, 189 (2015).
5. R.Yousefi, Crystengcomm **17**, 2698 (2015).
6. W. L. Ong, S. Natarajan, B. Kloostra, and G. W. Ho, Nanoscale. **5**, 5568 (2013).
7. Q. Wan, T. H. Wang, and J. C. Zhao, Appl. Phys. Lett. **87**, 083105 (2005).
8. Y. Qiu, K. Yan, H. Deng, and S. Yang, Nano. Lett. **12**, 407 (2011).
9. J. Y. Park, S. W. Choi, K. Asokan, and S. K. Sang, J. Am. Ceram. Soc. **93**, 3190 (2010).
10. M. J. Bronikowski, Carbon **107**, 297 (2016).
11. Y. Lei, C. X. Prof, L. D. Dr, H. Guo, X. H. Su, J. L. Yao, Y. J. You, D. Tian, and X. M. Shang, Small **3**, 1889 (2007).
12. N. Zhang, K. Yu, Q. Li, C. Q. Song, L. Zhu, and Z. Q. Zhu, Mater. Lett. **121**, 231 (2014).
13. N. Zhang, K. Yu, Q. Li, Z. Q. Zhu, and Q. Wan, J. Appl. Phys. **103**, 104305 (2008).
14. S. Duo, Y. Li, Z. Liu, R. Zhong, and T. Liu, Mater. Sci. Semicond. Process **56**, 196 (2016).
15. K. Yu, Q. Zhang, J. Wu, L. Li, Y. Xu, S. Huang, and Z. Q. Zhu, Nano Res. **1**, 221 (2008).
16. H. Y. Hui and M. A. Filler, Nano Lett. **15**, 6939 (2015).
17. R. S. Wagner and W. C. Ellis, Appl. Phys. Lett. **4**, 89 (1964).
18. V. G. Dubrovskii, Cryst. Growth. Des. **15**, 5738 (2015).
19. Z. L. Wang, X. Y. Kong, and J. M. Zuo, Phys. Rev. Lett. **91**, 185502 (2003).
20. F. Q. He and Y. P. Zhao, Appl. Phys. Lett. **88**, 193113 (2006).
21. C. S. Lao, P. X. Gao, R. S. Yang, Y. Zhang, Y. Dai, and Z. L. Wang, Chem. Phys. Lett. **417**, 359 (2005).
22. G. Z. Shen, Y. Bando, D. Chen, B. D. Liu, C. Y. Zhi, and D. Golberg, J. Phys. Chem. B **110**, 3973 (2006).
23. Y. S. Lim, J. W. Park, S. T. Hong, and J. Kim, Mater. Sci. Eng. B **129**, 100 (2006).

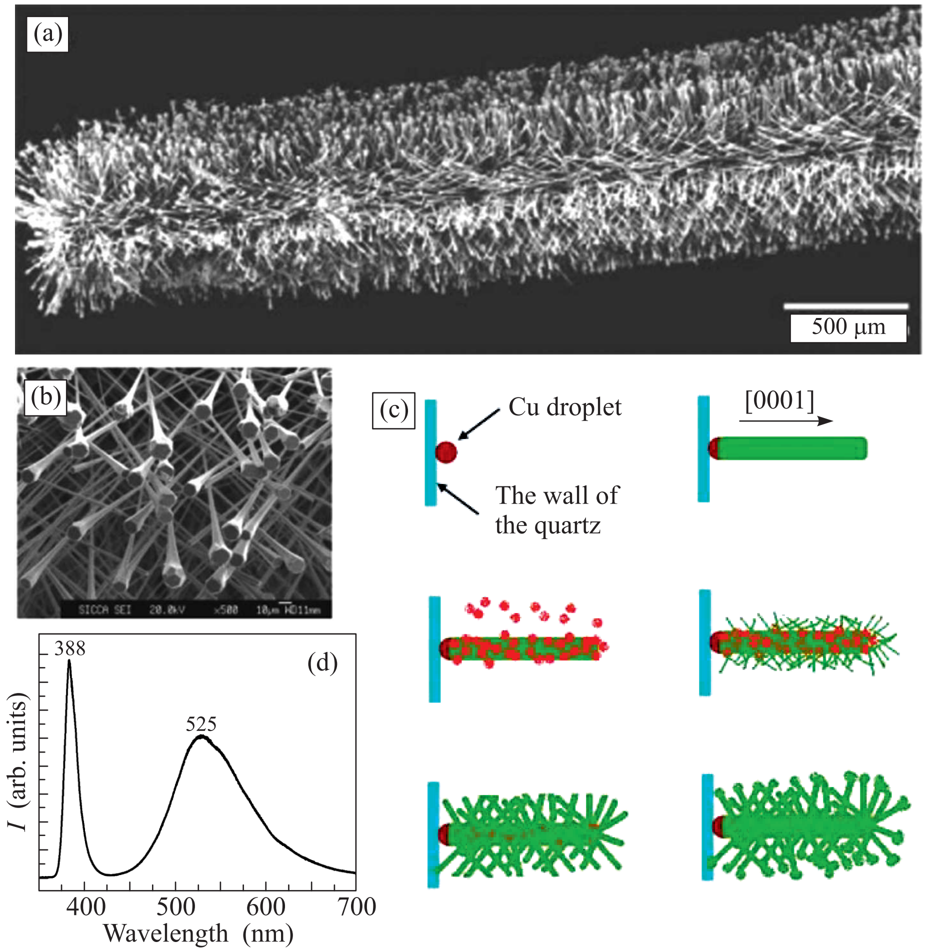

Fig. 1. (Color online) Low (a) and high (b) magnification SEM images of utralong ZnO microbushes. (c) – The growth mechanism of ZnO microbushes in various growth stages. (d) – Photoluminescence spectra measured at room temperature from the utralong ZnO microbush

24. W. Y. Yang, Z. P. Xie, H. Z. Miao, L. G. Zhang, and L. N. An, J. Phys. Chem. B. **110**, 3969 (2006).
25. R. L. Cui, Y. Zhang, J. Y. Wang, W. W. Zhou, and Y. Li, J. Phys. Chem. C **114**, 15547 (2010).
26. W. W. Zhou, Z. Y. Han, J. Y. Wang, Y. Zhang, Z. Jin, X. Sun, Y. W. Zhang, C. H. Yan, and Y. Li, Nano Lett. **6**, 2987 (2006).
27. F. F. Wang, L. Cao, A. L. Pan, R. B. Liu, X. Wang, X. Zhu, S. Q. Wang, and B. S. Zou, J. Phys. Chem. C **111**, 7655 (2007).
28. A. Cetin, R. Kibdr, and M. Avvdcikli, Nucl. Instrum. Methods. Phys. Res. Sect. B **249**, 474 (2006).
29. N. Y. Garces, L. Wang, L. Bai, N. C. Giles, and L. E. Halliburton, Appl. Phys. Lett. **81**, 622 (2002).