FORMATION OF NOVEL OXIDE NANOSTRUCTURES

Zhong Lin (ZL) Wang

School of Materials Science and Engineering
Georgia Institute of Technology, Atlanta 30332-0245
e-mail: zhong.wang@mse.gatech.edu

Quasi-one-dimensional (1D) nanostructures (nanowires, nanobelts and nanorods) are the forefront nanomateirals for nanotechnology. Oxide nanostructures have been synthesized for a wide range of semiconducting oxides [1] that are potential building blocks for constructing numerous nanodevices. Using the technique demonstrated for measuring the mechanical properties of nanotubes [2,3], the mechanical and field emission properties of the oxide nanobelts have been characterized. Field effect transistors [4], ultra-sensitive nano-size gas sensors [5], nanoresonators and nanocantilevers [6] have been fabricated using nanobelts.

Among all of the oxide nanostructures we have investigated, ZnO is very unusual. The two important characteristics of the wurtzite structured ZnO are the non-central symmetry and the polar surfaces. The structure of ZnO can be described as a number of alternating planes composed of tetrahedrally coordinated O^{2-} and Zn^{2+} ions, stacked alternatively along the *c*-axis. The oppositely charged ions produce positively charged (0001)-Zn and negatively charged (000-1)-O polar surfaces, resulting in a normal dipole moment and spontaneous polarization along the *c*-axis. The polar surfaces give raise a few interesting growth features, such as the formations of nanosprings [7], nanorings [8], nanobows [9] and nanohelices [10]. These nanostructure are semiconductive and piezoelectric and have potential applications as nano-scale sensors, traducers, and actuators. This presentation will be about the synthesis, characterization and potential applications of these novel nanostructures [11].

[1] Z.W. Pan, Z.R. Dai and Z.L. Wang, *Science*, 209 (2001) 1947.
[2] P. Poncharal, Z.L. Wang, D. Ugarte and W.A. de Heer, *Science*, 283 (1999) 1513.
[3] R.P. Gao, Z.L. Wang, Z.G. Bai, W. de Heer, L. Dai and M. Gao, *Phys. Rev. Letts.*, 85 (2000) 622.
[4] M. Arnold, P. Avouris, Z.L. Wang,. *Phys. Chem. B*, 107 (2002) 659.
[5] E. Comini, G. Faglia, G. Sberveglieri, Zhengwei Pan, Z. L. Wang *Applied Physics Letters*, 81 (2002) 1869.
[6] W. Hughes and Z.L. Wang, *Appl. Phys. Letts*., 82 (2003) 2886.
[7] X.Y. Kong and Z.L. Wang, *Nano Letters*, 2 (2003) 1625 + cover.
[8] X.Y. Kong, Y. Ding, R.S. Yang, Z.L. Wang, *Science*, 303 (2004) 1348.
[9] W.L. Hughes and Z.L. Wang, *J. Am. Chem. Soc*., 126 (2004) 670
[10] P.X. Gao, Y. Ding, W.J. Mai, W.L. Hughes, C.S. Lao and Z.L. Wang, *Science*, 309 (2005) 1700.
[11] Thanks the support from NSF, DARPA, NASA and Airforce.
[12] for details see: http://www.nanoscience.gatech.edu/zlwang/