Template-Assisted Growth of ZnO Nanorod Arrays

Tao-Hua Lee[1], Hung-Jue Sue[2,3] and Xing Cheng[1,2]

[1]Department of Electrical and Computer Engineering, Texas A&M University, College station, TX 77843

[2]Polymer Technology Center, Texas A&M University, College station, TX 77843

[3]Department of Mechanical Engineering, Texas A&M University, College station, TX 77843

As a direct and wide bandgap semiconducting material, ZnO draws a lot of interests as the candidate for electronic and short wavelength optoelectronic applications. It has potential applications as light-emitting diodes,[1] laser diodes,[2] solar cells,[3] and many others. The large field of applications has led to the demand to synthesize ZnO nanostructures through low consumption bottom-up process to reduce the wasting of raw materials and energy. More importantly, the low processing temperature in the bottom-up process makes it simple to integrate ZnO with other materials and substrates for broader applications. In this work, a new template method which involves electrophoresis and nanoimprint is demonstrated for large-scale fabrication of vertically aligned ZnO nanorod arrays at predetermined locations.

Prior to the growth of ZnO nanorod arrays, 5 nm ZnO nanoparticles were first prepared from zinc acetate, potassium hydroxide, and methanol.[4] ZnO nanoparticles were then dispersed in methanol and deposited on Si substrate by electrophoresis (Figure 1) for the positively charged ZnO nanoparticle surface from oxygen vacancies. Poly(methyl methacrylate) (PMMA) was then spin-coated onto the substrate and nanoimprint was performed with 700 nm period mold. Following reactive-ion etching to remove the residue layer, a portion of the nanoparticles were exposed as seeds for hydrothermal ZnO nanorod growth.[5] Figure 2 shows the template-assisted growth of nanorod arrays. Nanorods only grew at the locations where PMMA was removed. More results will be reported in detail and the optimization of the synthesis process will also be presented. This template-assisted growth of nanorod arrays demonstrates the feasibility to precisely direct the growth of inorganic nanocrystals from solutions at predetermined locations.

---

[1] C. Liu, S. T. Lee, et al., Adv. Mater., 15 (2003) 838.

[2] R. F. Service, Science, 276 (1997) 895.

[3] M. Law, L. E. Greene, J. C. Johnson, R. Saykally, and P. D. Yang, Nature Materials, 4 (2005) 455.

[4] D. Sun, M. Wong, L. Sun, Y. Li, N. Miyatake and H.-J. Sue, J. Sol-Gel Sci. Tech., 43 (2005) 237.

[5] M. Guo, P. Diao, and S. Cai, J. of Solid State Chemistry, 178 (2005) 1864-1873.

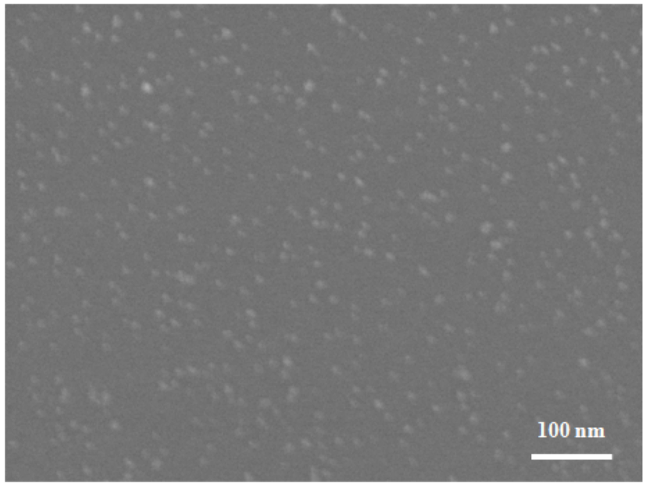

Figure 1. ZnO nanoparticles with 5 nm in diameter were deposited on Si substrate by electrophoresis from a colloidal suspension.

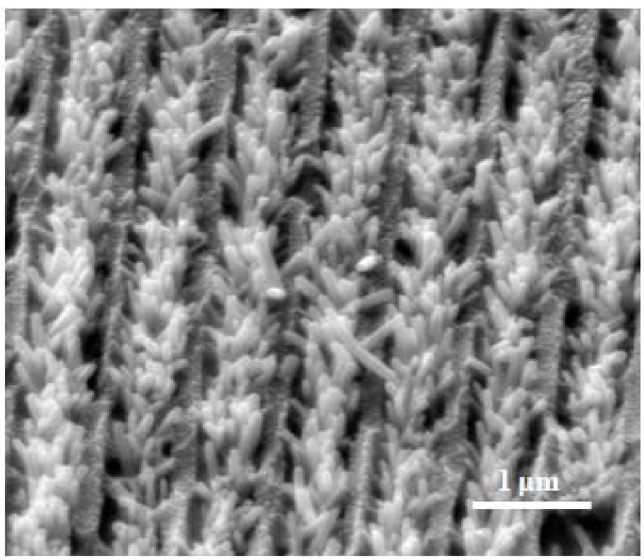

Figure 2. Scanning electron microscopy image of ZnO nanorod arrays grown on polymer templates. Nanorods only grew at the locations where PMMA was removed.