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**Main Research Interest: Nanowires and nanotubes: architecture and properties, Nano Ferroelectrics, Template-based nanofabrication.**

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**Nanowires and nanotubes: synthesis and size/morphology dependent properties**

Ordered nanowire arrays of mainly semiconducting materials (ZnO, TiO<sub>2</sub>, CuO, etc.) will be synthesized using cost-effective template methods. Depending on application requirements, their size, orientation and distribution will be controlled to different levels. This is because the optical and/or electric property of a nanowire might be strongly dependent on its size and architecture. Such a relationship allows a tune of their optoelectronic performance for the application as light source and detectors.

Using nanowire as a further template, we can fabricate ternary oxide nanostructures (such as spinels, perovskites) based on the conventional solid-state reactions. Of interest are some multi-color luminescent nanotubes, and magnetic nanoparticles. We study the interface reaction and diffusion mechanism.

We are also interested in the direct observation of the nanowire growth using in-situ TEM, which gives us hints the thermodynamics and kinetics of the growth process. Moreover, interaction between metal nanoparticle and the oxide nanowire surface is also of importance to the understanding of the photocatalytic effect and gas sensing properties of such hybrid system.

**Nano Ferroelectrics**

We study the fundamental physics as well as their memory applications of nanoscale ferroelectric materials (e.g., PZT). Main interests include (i) fabrication of single-crystalline ferroelectric nanorods/tubes, (ii) their assembly into 3-D capacitors, and (iii) ferroelectric-gated, semiconducting metal-oxide nanowire channel FET devices.

**Selected Publications**

L. Liao, H. J. Fan, B. Yan, Z. Zhang, L. L. Chen, et al., "Ferroelectric Transistors with Nanowire Channel: Toward Nonvolatile Memory Applications", ACS Nano, (2009) Online published.

H.J. Fan, Y. Yang, M. Zacharias, "ZnO-based ternary oxide nanotubes and nanowires" J. Mater. Chem. 19, 885-900 (2009).

J.F. Scott, H.J. Fan, S. Kawasaki, J. Banys, et al., "THz emission from tubular Pb(Zr,Ti)O<sub>3</sub> nanostructures", Nano Lett. 8, 4404-4409 (2008)

H.J. Fan, U. Gösele, M. Zacharias, "Formation of nanotubes and hollow nanoparticles based on Kirkendall and diffusion process: A review", Small 3, 1660-1671 (2007) (Invited review)

H.J. Fan, A. S. Barnard, M. Zacharias, "ZnO nanowires and nanobelts: shape selection and thermodynamic modeling", Appl.

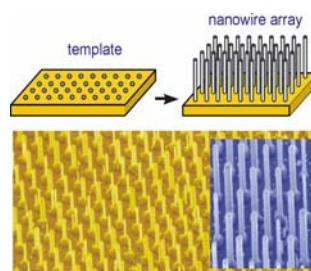
Phys. Lett. 90, 143116 (2007).

H.J. Fan, M. Knez, R. Scholz, D. Hesse, K. Nielsch, M. Zacharias, and U. Gösele, "Influence of surface diffusion on the void formation induced by the Kirkendall effect: the basic concept", Nano Lett. 7, 993-997 (2007)

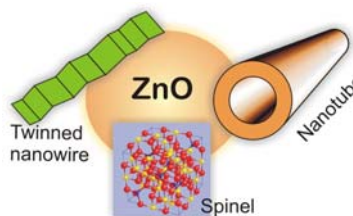
H.J. Fan, P. Werner and M. Zacharias, "Semiconductor nanowires: from self organization to patterned growth" Small 2, 700-717 (2006) (Invited review)

H.J. Fan, M. Knez, R. Scholz, K. Nielsch, E. Pippel, D. Hesse, M. Zacharias, and U. Gösele, "Monocrystalline spinel nanotube fabrication based on the Kirkendall effect", Nature Materials 5, 627-631 (2006)

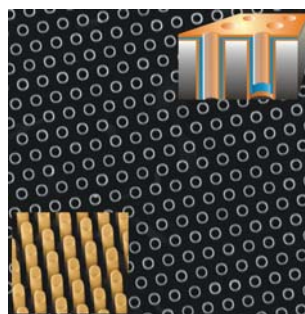
H.J. Fan, W. Lee, R. Hauschild, M. Alexe, R. Scholz, A. Dadgar, K. Nielsch, H. Kalt, A. Krost, M. Zacharias, and U. Gösele, "Templated-assisted ordered arrays of ZnO pillars for optical and piezoelectric applications" Small 2, 561-568 (2006)



Template-based fabrication towards ordered nanowire arrays



ZnO-based ternary nanowires or tubes through nanoscale solid-state reactions



Background: Topview of ferroelectric PZT submicron tubes array. Top: Schematics of the concentric tri-layered tubes. Bottom: inclined view.