Semiconductor nanowires

M. Law, J. Goldberger, and P. Yang, Semiconducor nanotubes and nanowires, *Annu. Rev. Mater. Res.* **34** (2004) 83.

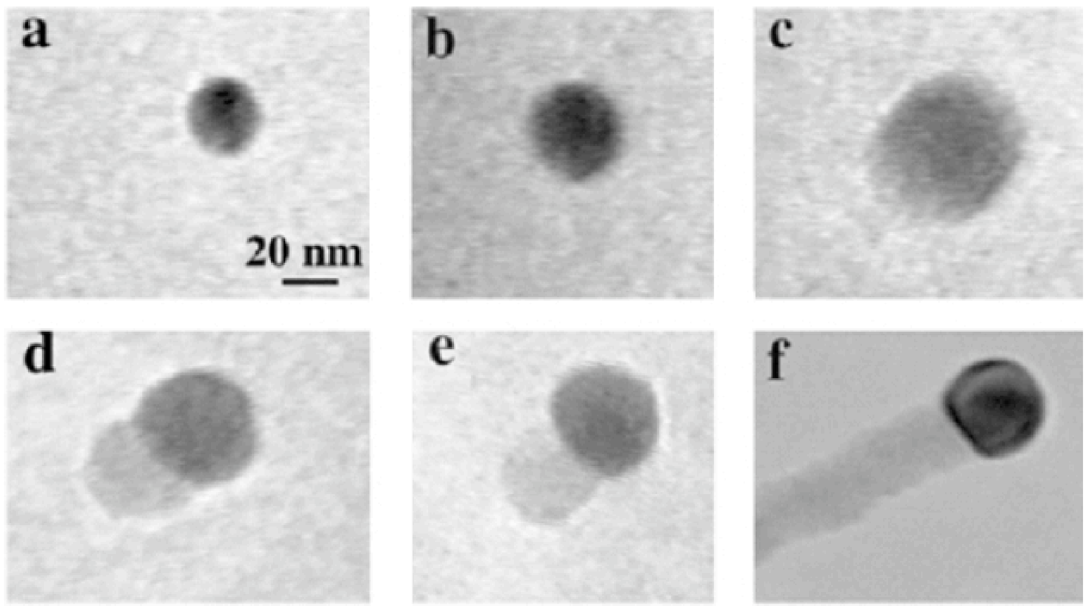

Figure 1 In situ TEM images recorded during the process of nanowire growth. (*a*) Au nanoclusters in solid state at 500°C; (*b*) alloying initiates at 800°C, at this stage Au exists mostly in solid state; (*c*) liquid Au/Ge alloy; (*d*) the nucleation of Ge nanocrystal on the alloy surface; (*e*) Ge nanocrystal elongates with further Ge condensation and eventually forms a wire (*f*). (Reprinted with permission from Reference 12, copyright Am. Chem. Soc., 2001.)

VLS growth of Ge nanowires starting from a gold seed.

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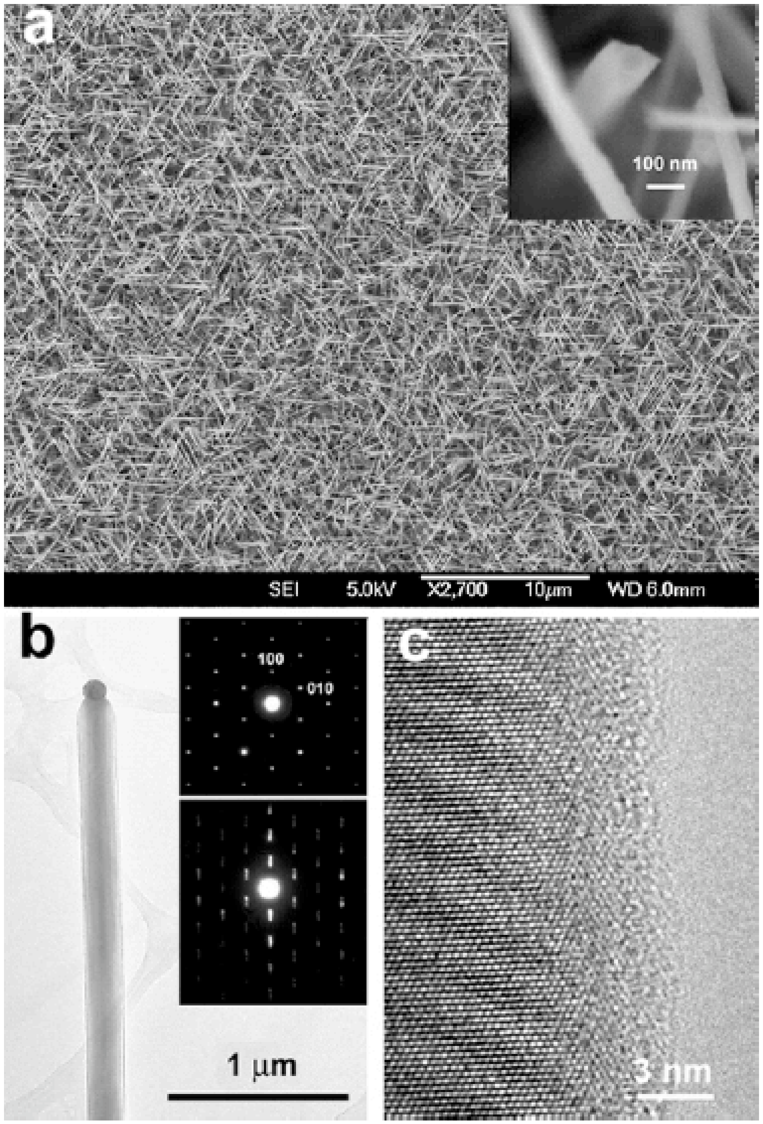

GaN nanowires grown by VLS using gold nanoparticle templates. The image in (b) shows a gold nanoparticle at the end of a nanowire.

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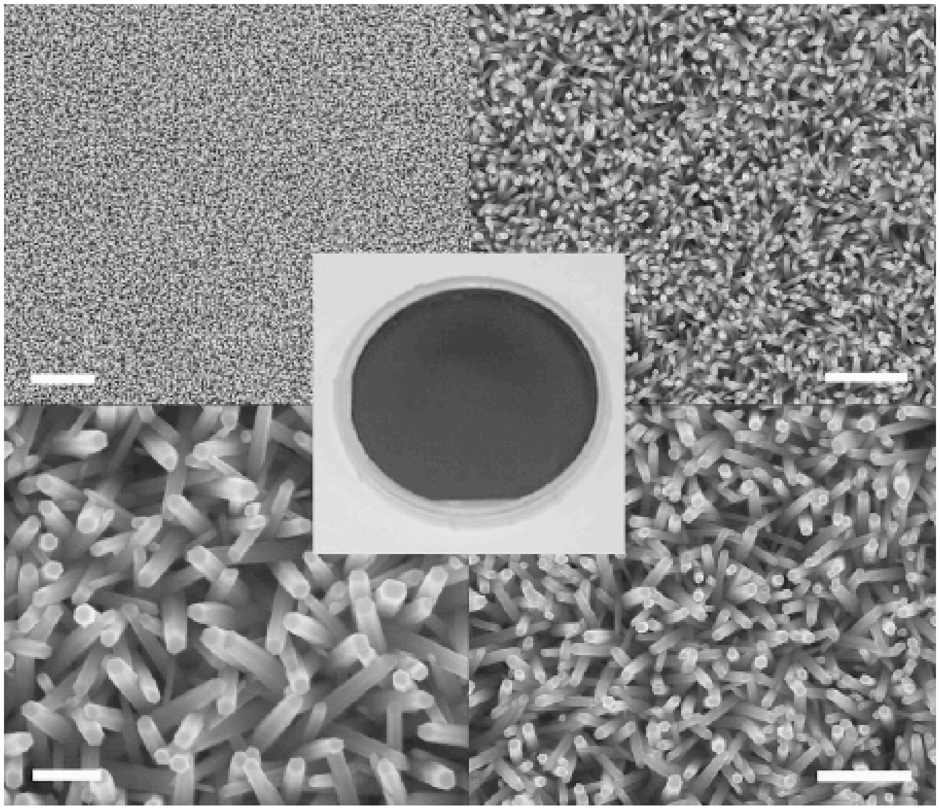

Figure 4 ZnO nanowire array on a 4-inch silicon wafer. Centered is a photograph of a coated wafer, surrounded by SEM images of the array at different locations and magnifications. These images are representative of the entire surface. Scale bars, clockwise from upper left, correspond to 2 μm, 1 μm, 500 nm, and 200 nm. (Reprinted with permission from Reference 57, copyright Wiley-VCH, 2003.)

ZnO nanowires grown by a hydrolytic route involving the amine-templated hydrolysis of Zn salts in solution.

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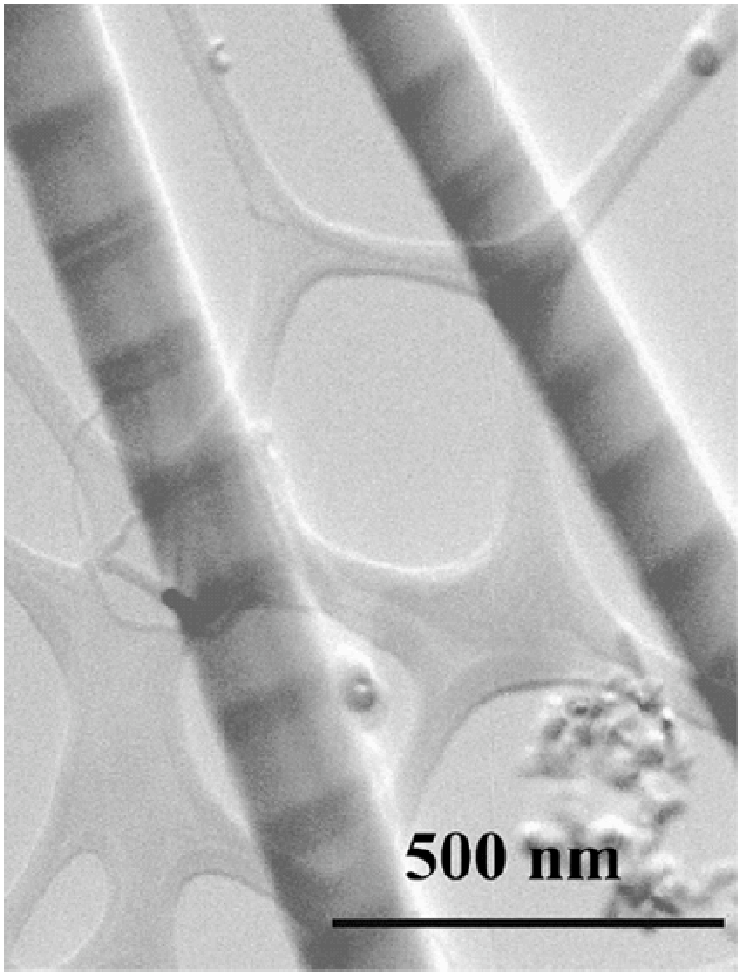

Figure 5 Transmission electron microscopy (TEM) image of two Si/SiGe superlattice nanowires.

Si/Si-Ge superlattices can be grown by pulsing the starting CVD precursors.

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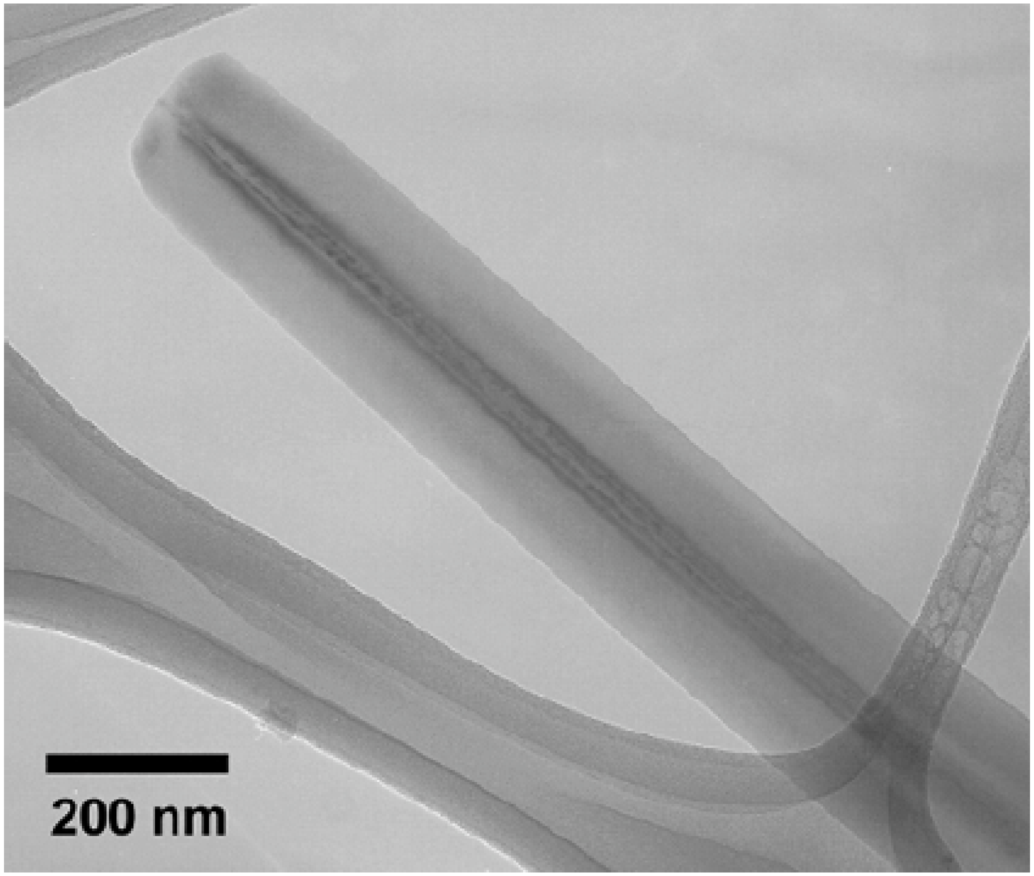

Figure 6 Transmission electron microscopy image of a GaN/AlGaN core-sheath nanowire.

Core/sheath nanowies are also possible by using the core as a template to grow the sheath.

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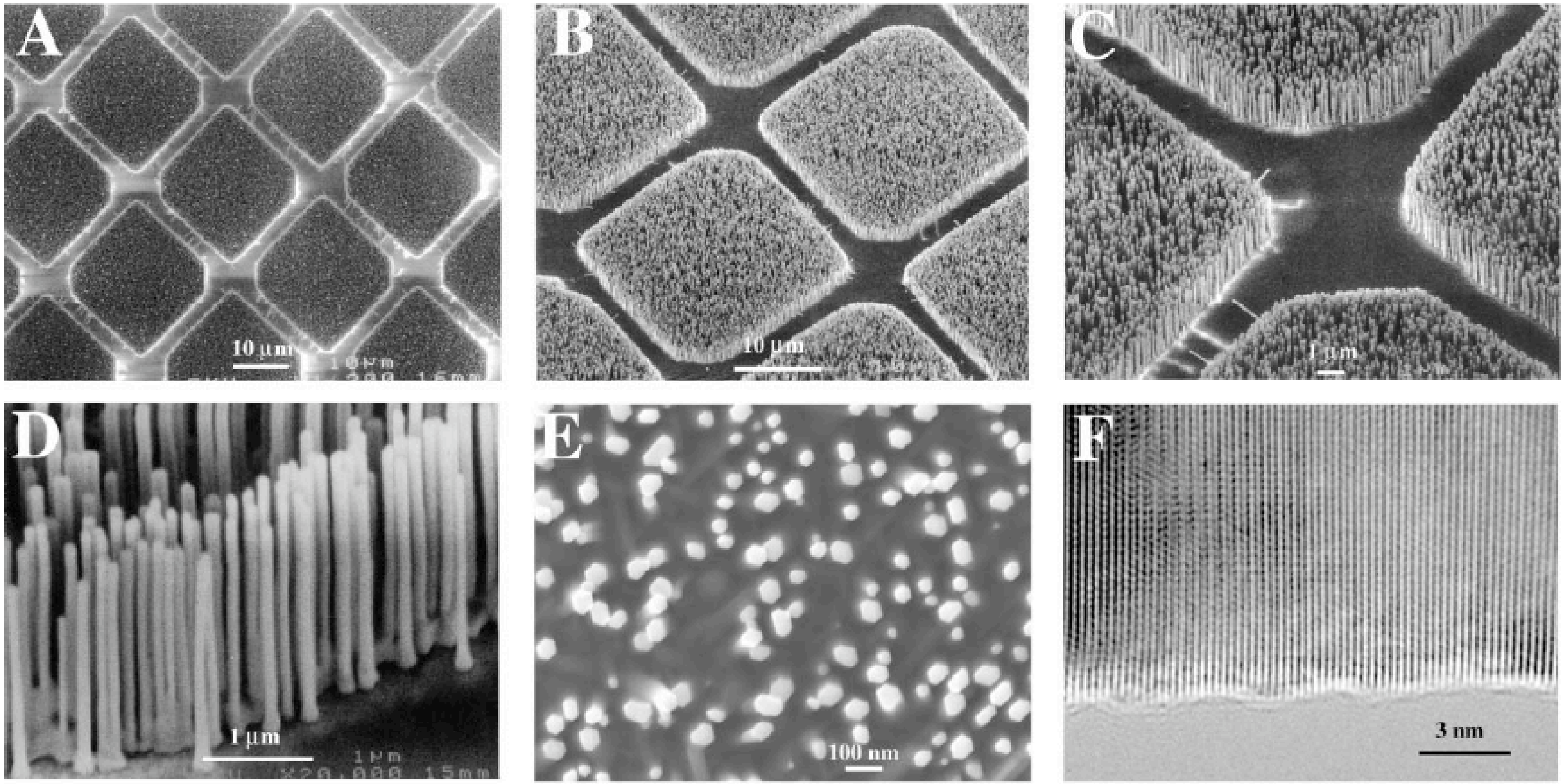

Fig. 1. (**A** through **E**) SEM images of ZnO nanowire arrays grown on sapphire substrates. A top view of the well-faceted hexagonal nanowire tips is shown in (E). (**F**) High-resolution TEM image of an individual ZnO nanowire showing its <0001> growth direction. For the nanowire growth, clean (110) sapphire substrates were coated with a 10 to 35 Å thick layer of Au, with or without using TEM grids as shadow masks (micro contact printing of thiols on Au followed by selective etching has also been used to create the Au pattern). An equal amount of ZnO powder and graphite powder were ground and transferred to an alumina boat. The Au-coated sapphire substrates were typically placed 0.5 to 2.5 cm from the center of the boat. The starting materials and the substrates were then heated up to 880° to 905°C in an Ar flow. Zn vapor is generated by carbothermal reduction of ZnO and transported to the substrates where ZnO nanowires grow. The growth generally took place within 2 to 10 min (*15*).

M. H. Huang, S.Mao, H. Feick, H. Yan, Y. Wu, H. Kind, E. Weber, R. Russo, P. Yang, Room-Temperature Ultraviolet Nanowire Nanolasers, *Science* **292** (2001) 1897.

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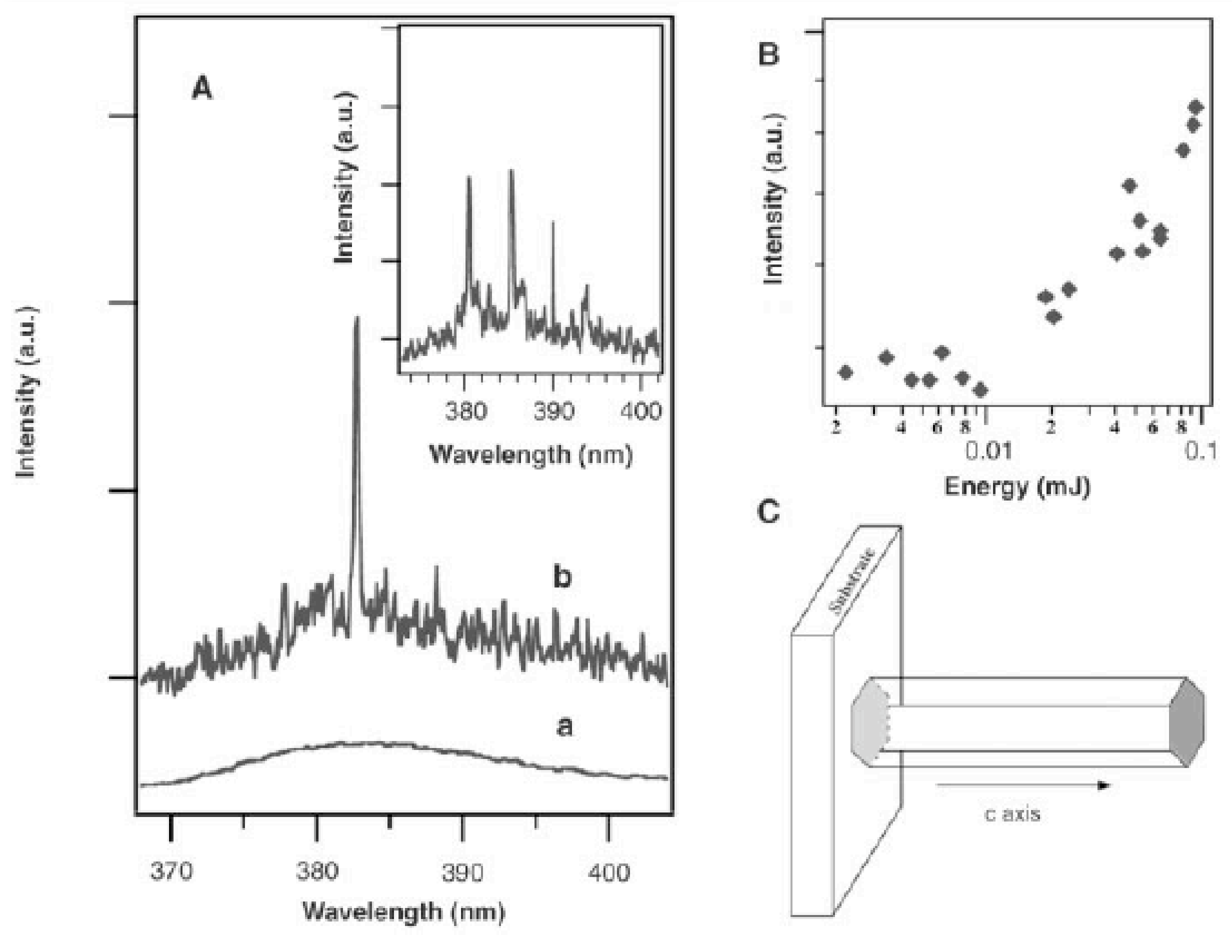

Lasing with 266 nm pumping

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