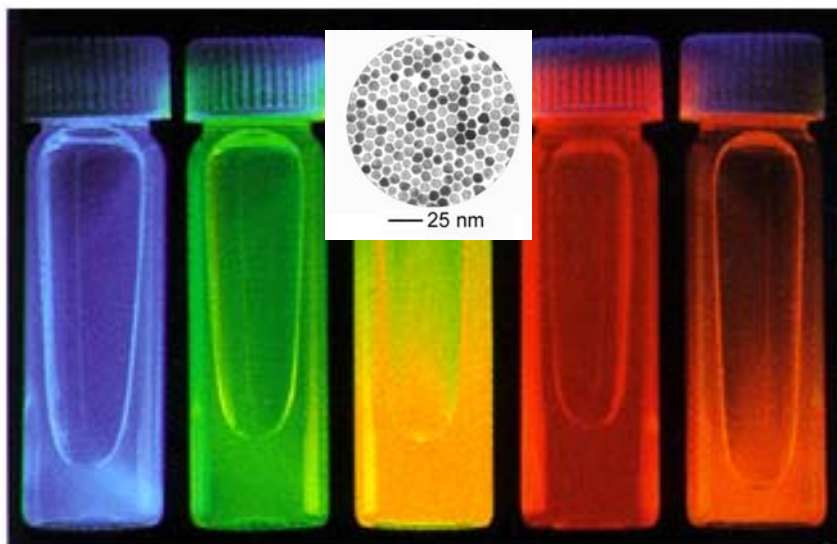


Shape-Controlled Synthesis of Nanostructured Materials

Younan Xia

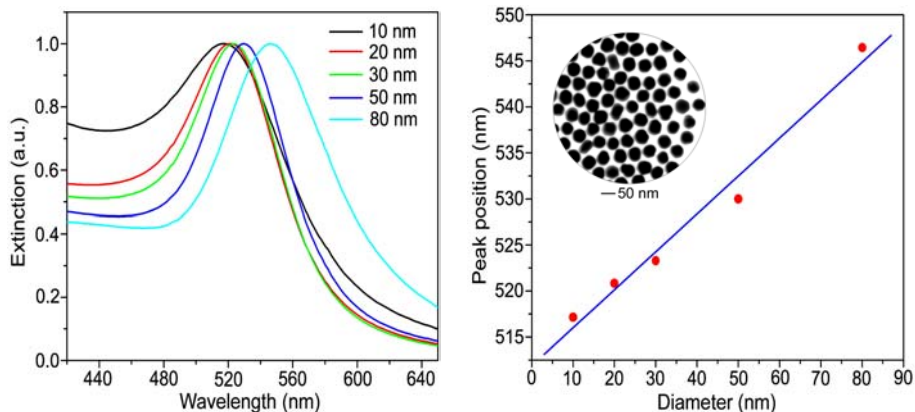
Department of Chemistry
University of Washington
Seattle, Washington 98195
E-mail: xia@chem.washington.edu

Quantum Dots: Same Material, Different Colors



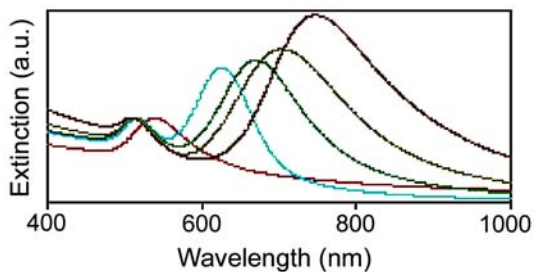
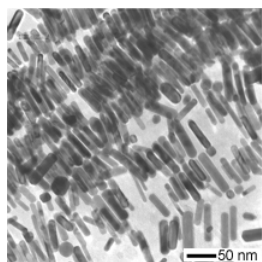
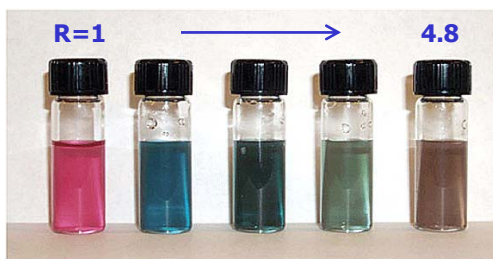
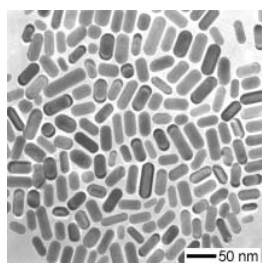
Alivisatos (UC Berkeley), Bawendi (MIT), Brus (Columbia), Peng (Arkansas)

Surface Plasmon Resonance (SPR) Features of Spherical Gold Nanoparticles: Size Dependence



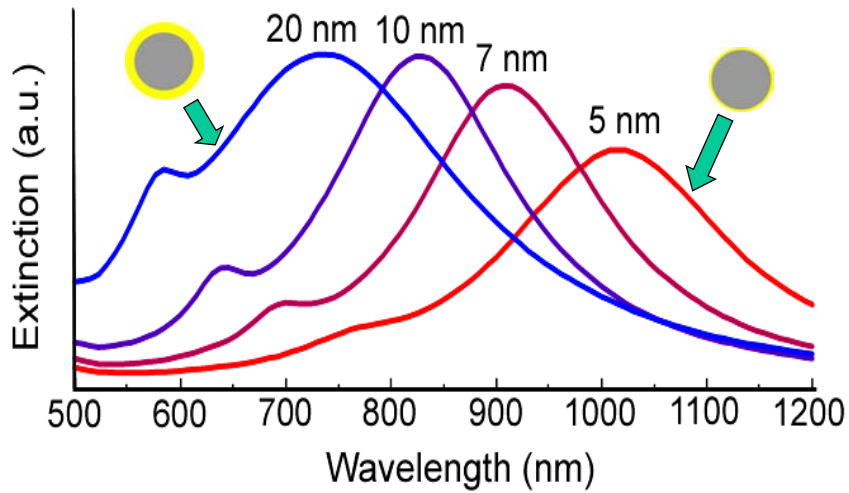
Sun & Xia, *Analyst* 2003, 128, 686

Dependence of SPR on the Shape (Aspect-Ratio)



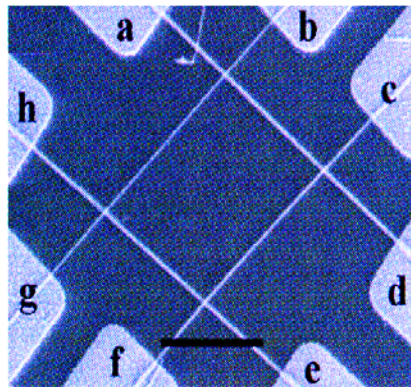
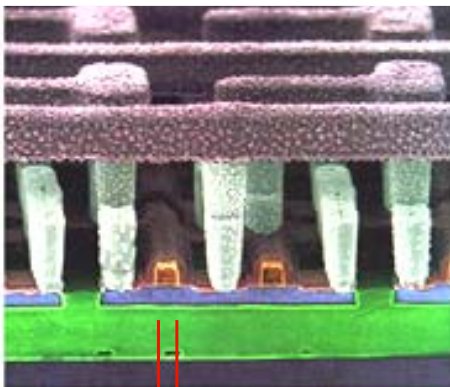
El-Sayed (GT), Murphy (USC), Mirkin (NWU), Yang (UCB)

SPR Modes of 60-nm SiO₂ Cores Coated with Au Shells of Different Thicknesses



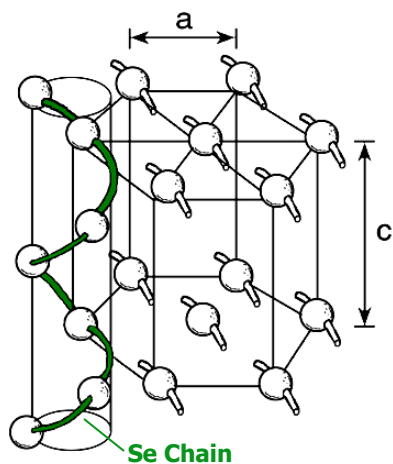
Halas et al., *Chemical Physics Letters* 1998, 288, 243

Nanoscale Electronic and Photonic Devices



Lieber et al. *Science* 2001, 291, 851

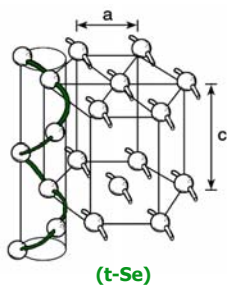
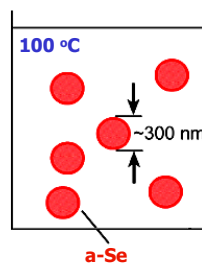
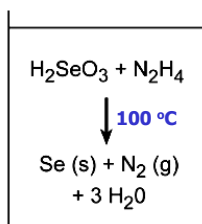
Selenium: A Multifunctional Semiconductor



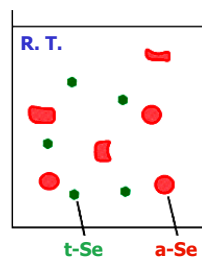
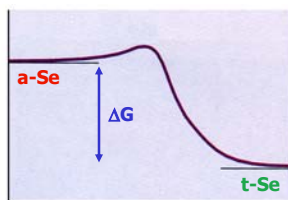
Trigonal Selenium (t-Se)

- Intrinsic Optical Chirality
- Highest Photoconductivity
($\sim 8 \times 10^4$ S/cm for t-Se)
- Piezoelectric & Nonlinear Optical (NLO) Properties
- Thermoelectric Behavior
- Unique Catalytic Properties (Oxidation, Halogenation)
- Reactivities to Form Other Functional Materials such as ZnSe, CdSe, and Ag_2Se

Synthetic Approach to Uniform t-Se Nanowires

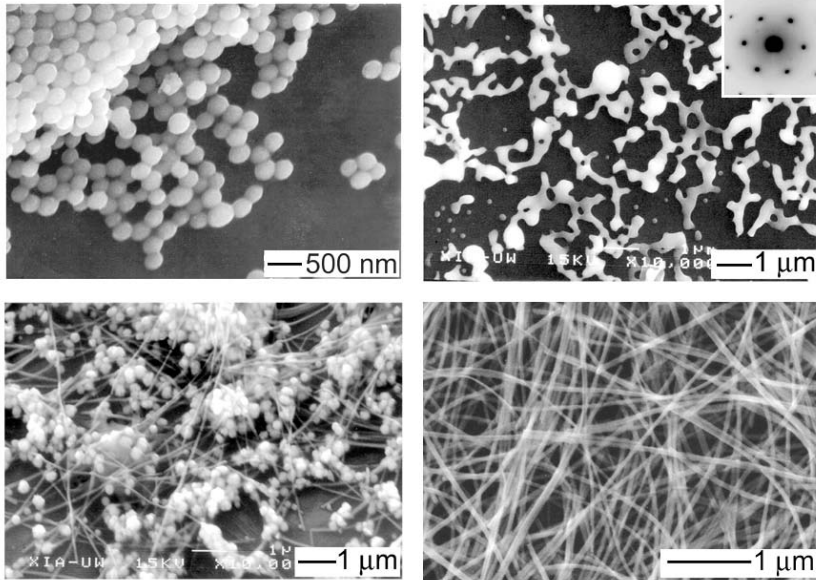


Ostwald Ripening



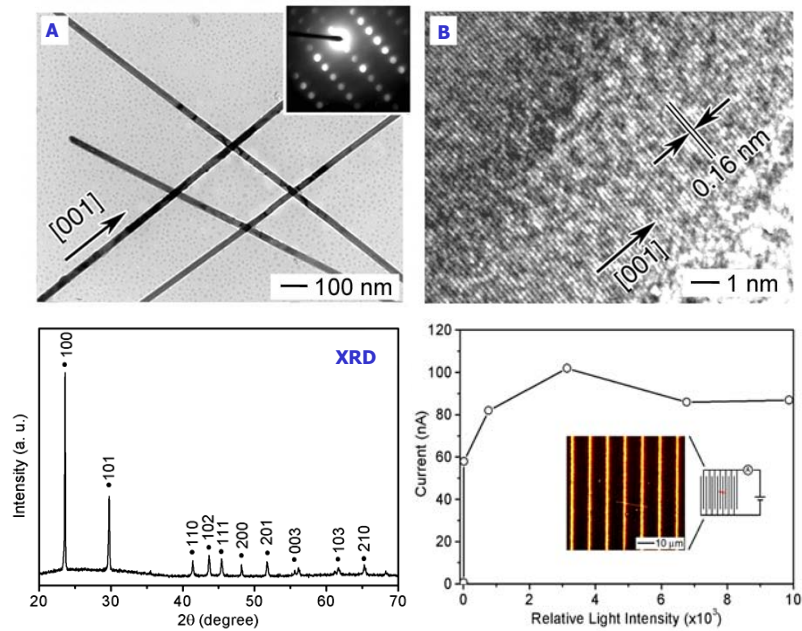
Gates, Yin & Xia, *J. Am. Chem. Soc.* 2000, 122, 12582

Different Stages of Nanowire Growth

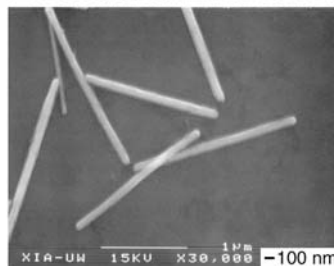
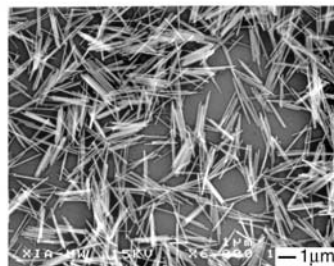
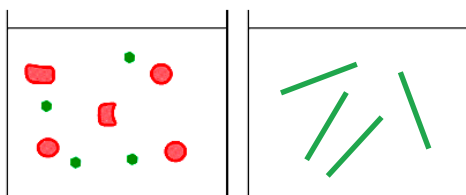
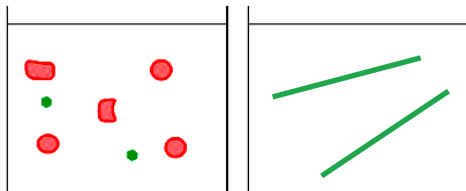


Gates, Mayers, Cattle & Xia, *Advanced Functional Materials* 2002, 12, 219

Uniformity and Purity of the Nanowires

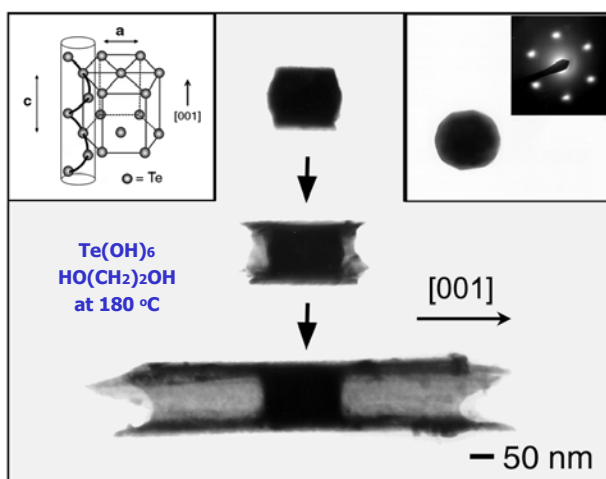


Control over the Longitudinal Dimension



Mayers & Xia, Journal of Materials Chemistry 2002, 12, 1875

Single Crystalline Nanotubes Made of Tellurium



Mechanism?



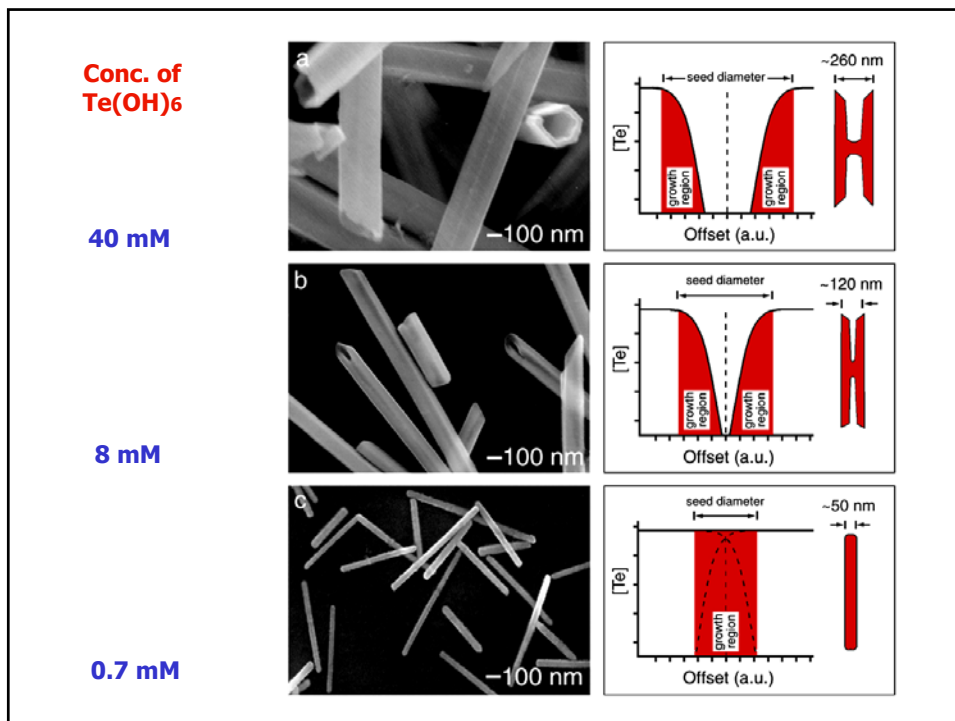
180 °C



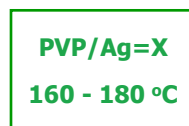
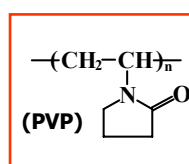
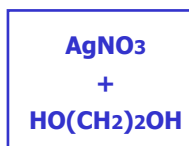
EG



Mayers & Xia, Advanced Materials 2002, 14, 279

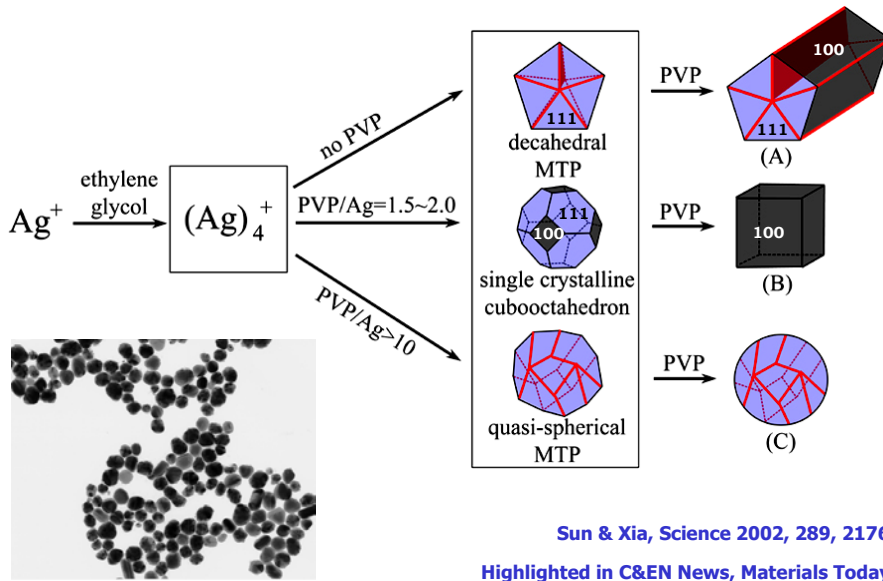


Polyol Synthesis of Silver Nanostructures

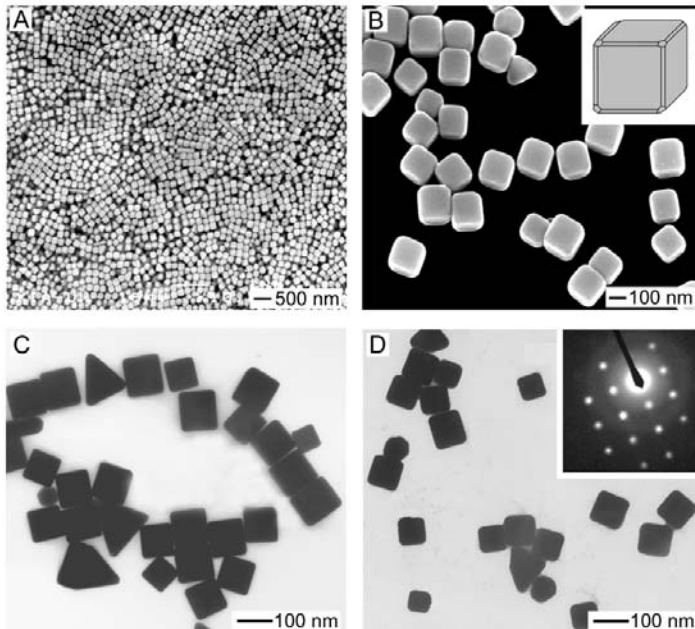


Sun & Xia, *Advanced Materials* 2002, 14, 833
 Sun, Gates, Mayers & Xia, *Nano Letters* 2002, 2, 165

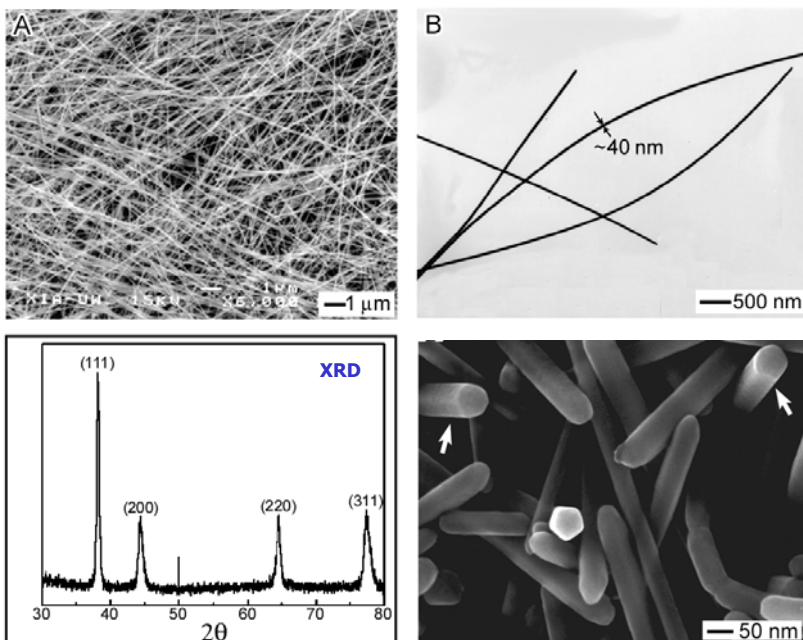
Silver Nanostructures with Different Shapes



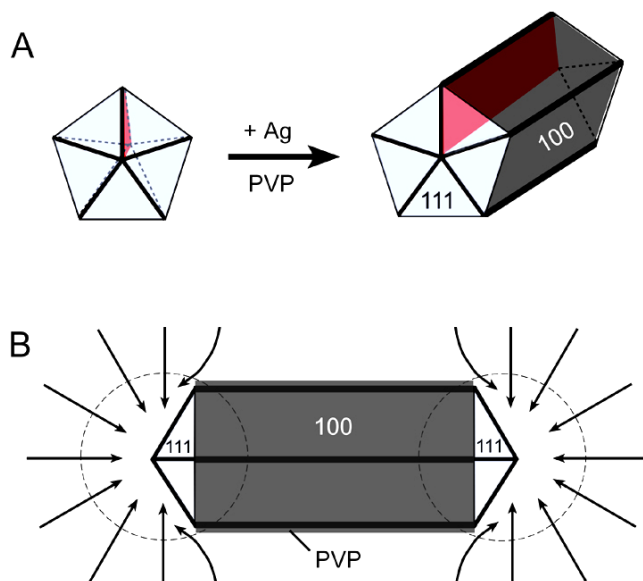
Single Crystalline Nanocubes of Silver



Silver Nanowires with Pentagonal Cross-Sections

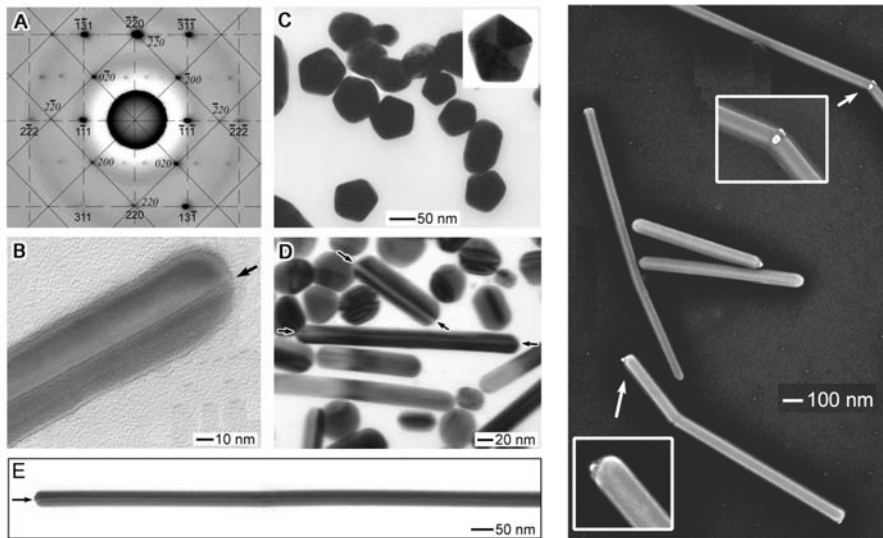


Growth of the Silver Nanowires

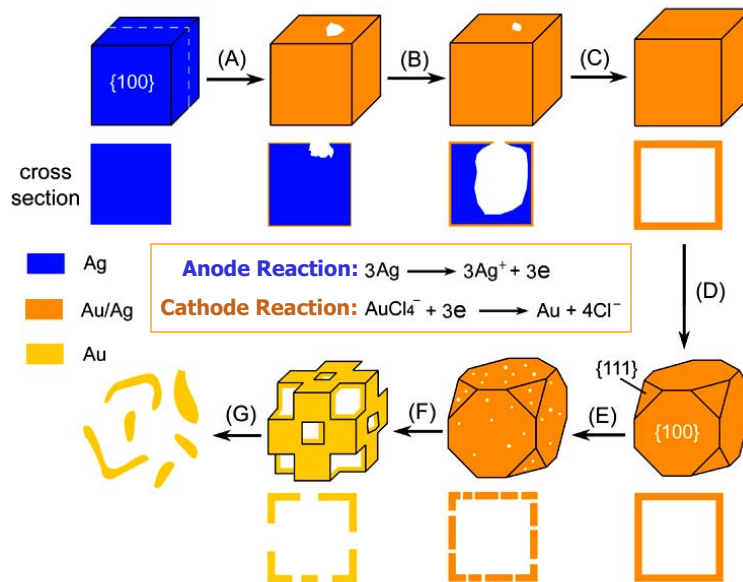


Sun, Mayers, Herricks & Xia, Nano Letters 2003, 3, 955

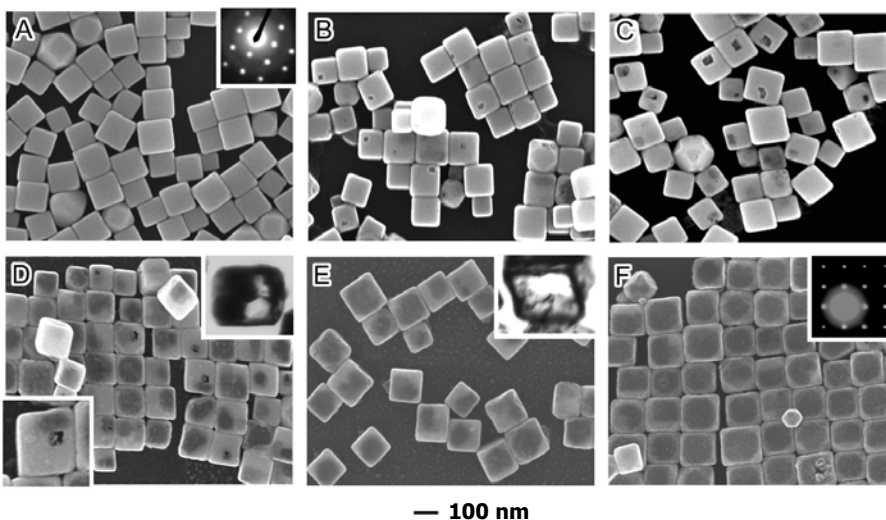
Evidence in Support of the Growth Mechanism



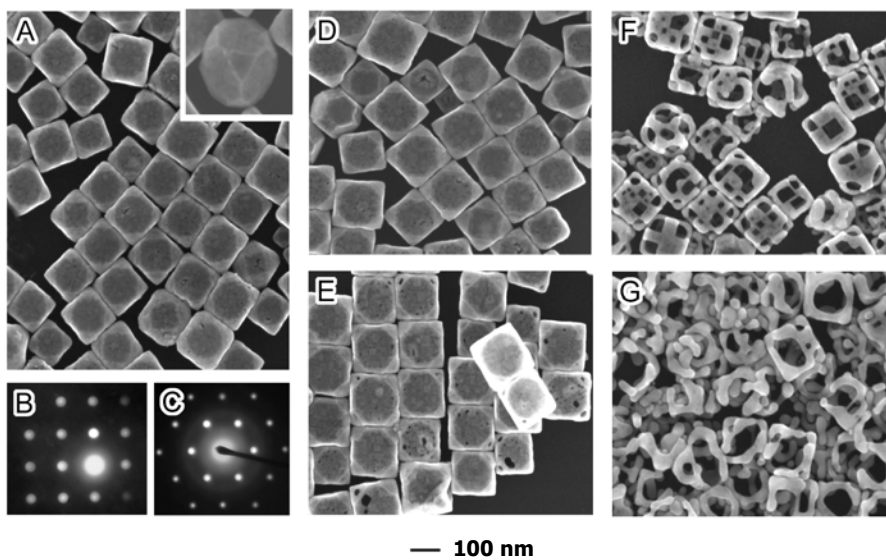
Galvanic Replacement of Gold by Silver



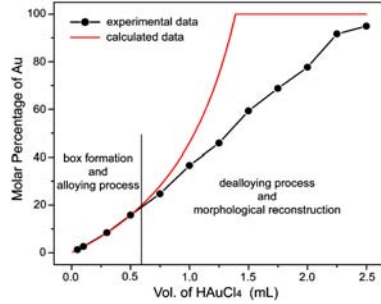
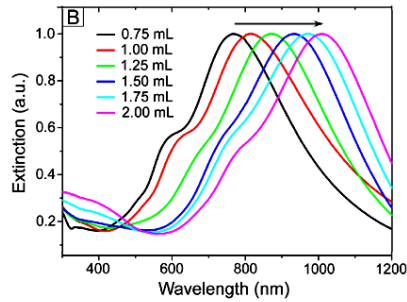
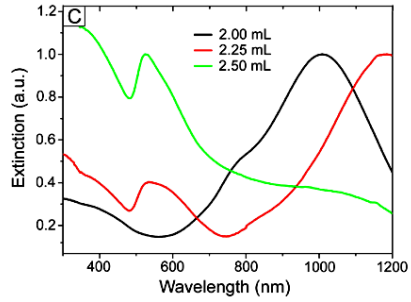
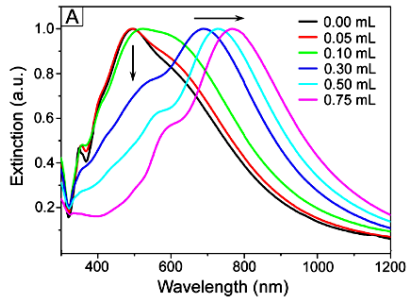
Titration by Increasing the Volume of HAuCl_4



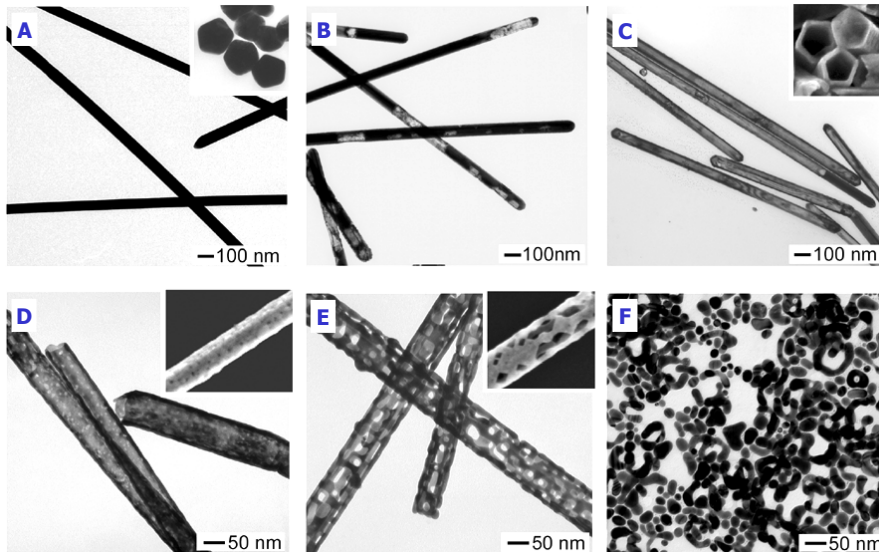
Further Increase in the Volume of HAuCl_4



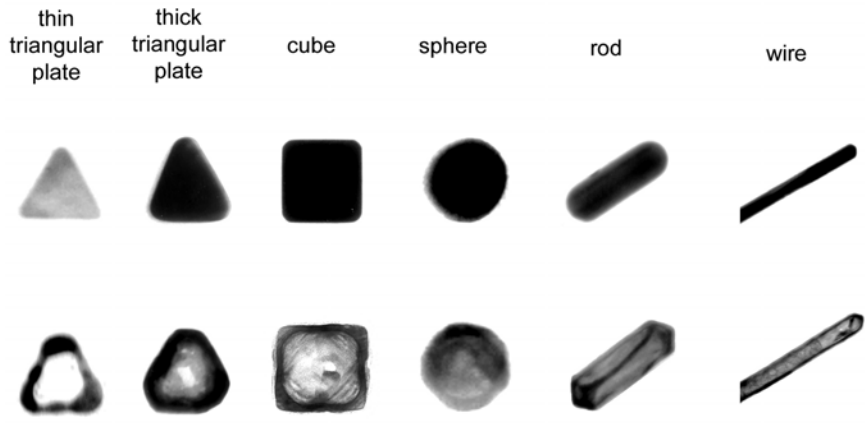
Metallic Pigments with Tunable Colors



Replacement Rxn between Ag Nanowires and AuCl₄⁻

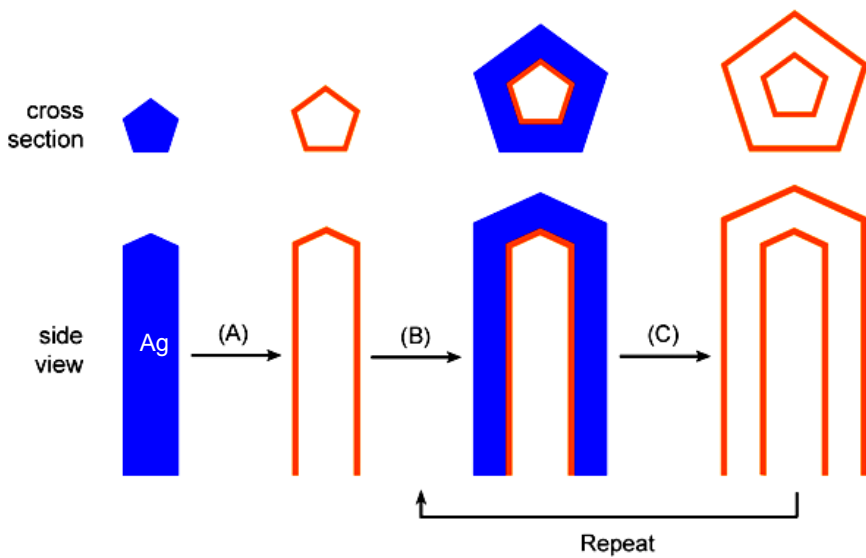


Silver Nano-Templates with Various Morphologies



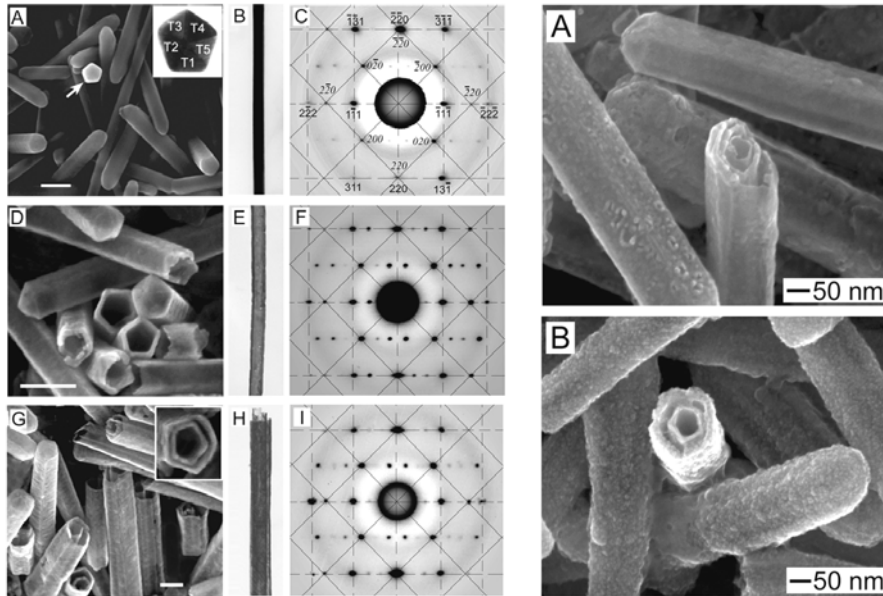
Sun, Mayers & Xia, *Advanced Materials* 2003, 15, 641

Multiple-Walled Nanotubes Made of Au-Ag Alloys

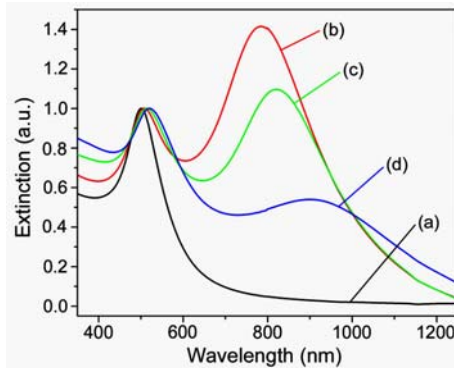
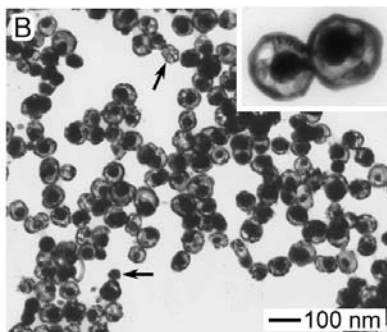
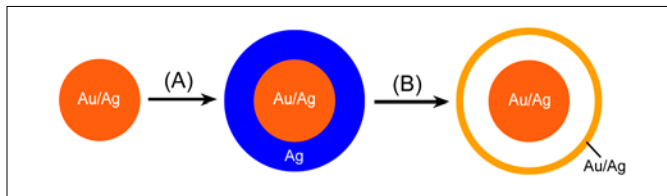


Sun & Xia, *Advanced Materials* 2004, 16, 264

Nanotubes Made of Au-Ag and Au-Ag/Pd-Ag Alloys

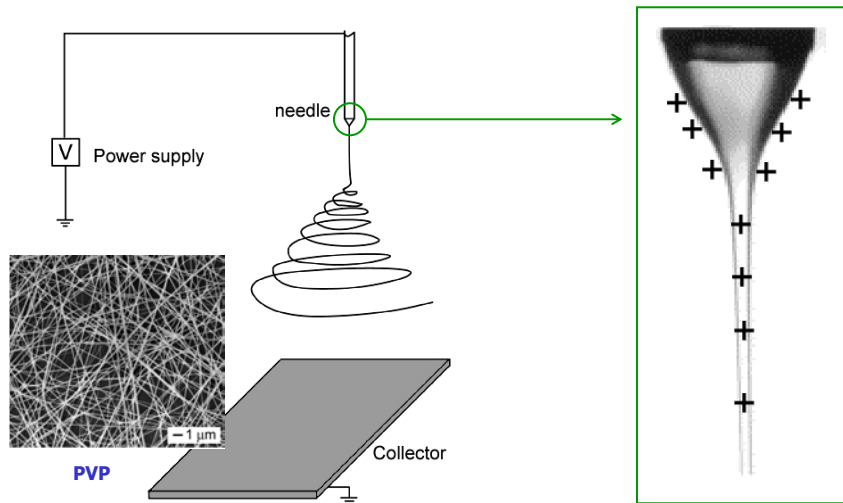


Nanorattles Made of Au-Ag Alloys



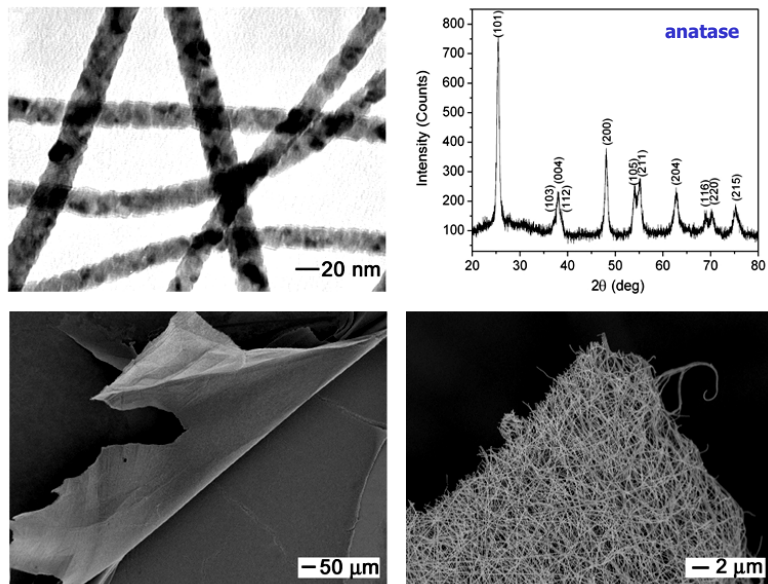
Sun, Wiley, Li & Xia, *J. Am. Chem. Soc.* 2004, in press

Conventional Setup for Electrospinning



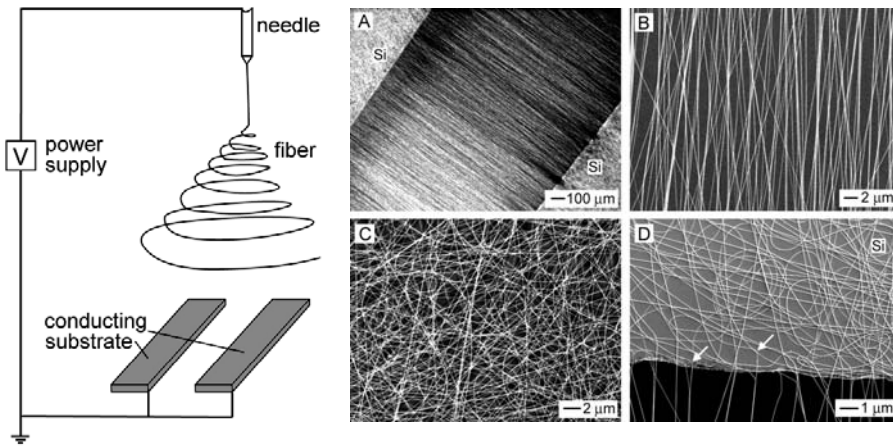
Li & Xia, *Advanced Materials* 2004, in press
Reker & Chun, *Nanotechnology* 1996, 7, 216

Electrospinning of TiO₂ Nanofibers



Li & Xia, *Nano Letters* 2003, 3, 555

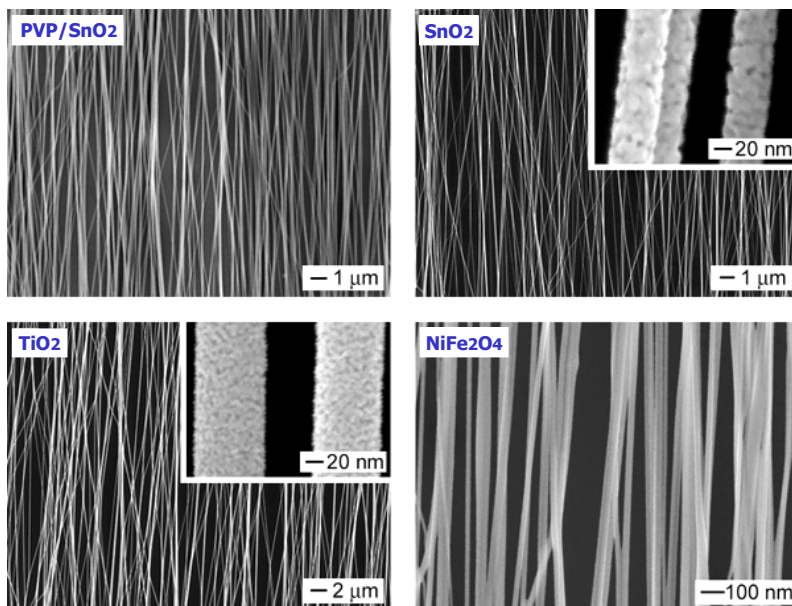
Uniaxially Aligned Arrays of PVP Nanofibers



Li, Wang & Xia, *Nano Letters* 2003, 3, 1167

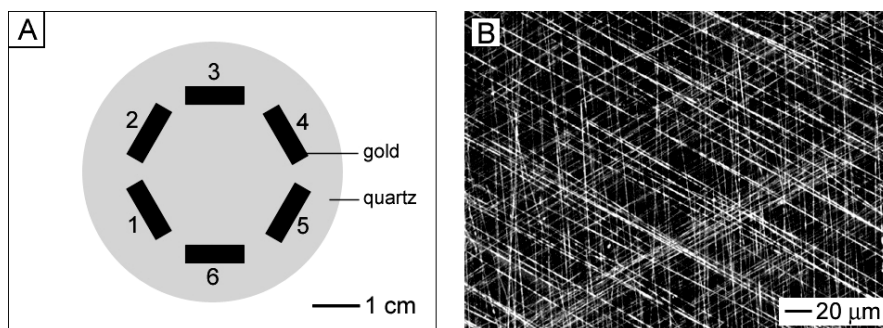
Highlighted as Editors' Choice, *Science* 2003, 301, 567

Aligned Nanofibers of Various Materials



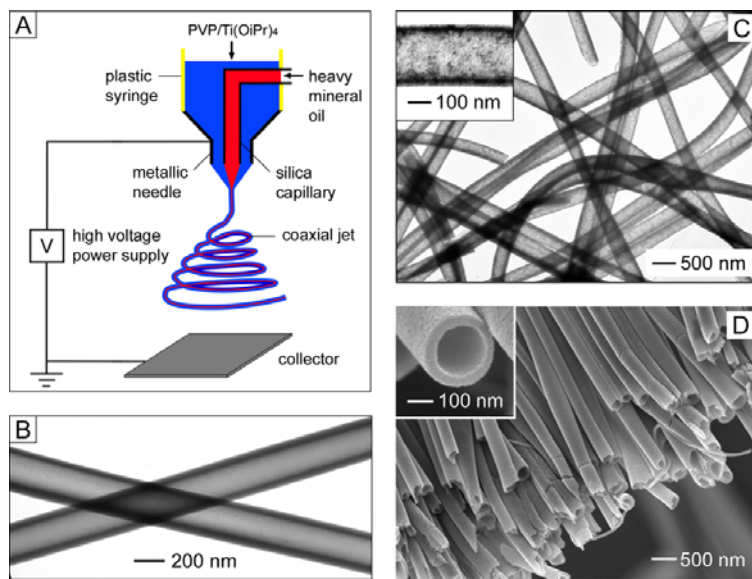
Li, Herricks & Xia, *Applied Physics Letters* 2003, 83, 4586

Hierarchically Structured Arrays of Nanofibers



Li, Wang & Xia, *Advanced Materials* 2004, 16, 361

Direct Fabrication of Hollow Nanofibers



Li & Xia, *Nano Letters* 2004, 5, 933
Highlighted in *C&EN News* (4/26, 2004) and *Materials Today* (6, 2004)