SYNW 1 Symposium: Nano-Wires I

Time: Wednesday 14:00–15:30 Room: HSZ 04

Invited Talk SYNW 1.1 Wed 14:00 HSZ 04

Electrodeposition and Functional Properties of Metal Nanowires — •Reginald M. Penner and — Department of Chemistry, University of California, Irvine, CA 92697-2025 USA

Semiconductor nanowires can be used as transducer to detect the binding of charged analyte molecules. However in view of the frenzied pace of research relating to nanowires synthesis, remarkably few publications report advances in semiconductor nanowire-based sensing. Progress in this direction has been impeded by the intrinsic instability of semiconductor nanowires toward corrosion.

Noble metal nanowires are attractive candidates for chemical sensing. However, in contrast to semiconductor nanowires, the conductivity of metal nanowires is not expected to be responsive to 'charge gating'. We have developed a new method for preparing arrays of noble metal nanowires that involves the electrodeposition of metals onto stepped graphite surface and the transfer of arrays of wires onto glass surfaces using a simple embedding process. These transferred nanowires form the basis for chemical sensors in which the resistance of the nanowire array is modulated by molecules that chemisorb at the surface. Two examples involve palladium nanowires in the presence of hydrogen, and silver in the presence of amines. For both systems, the changes in resistance ($\triangle$R/R0) can be 1000.

What is the origin of these unexpected resistance changes? We focus attention on this issue and we discuss the prospect for developing practical chemical sensors based on these novel mechanisms.

Invited Talk SYNW 1.2 Wed 14:30 HSZ 04

Quantum coherent transport in semiconductor nanowires — •Silvano De Franceschi[1], Jorden van Dam[2], Yong-Joo Doh[2], Leo Kouwenhoven[2], Aarnoud Roest[3], and Erik Bakkers[3] — [1]CNR TASC-INFM, Trieste, Italy — [2]Kavli Institute of Nanoscience, Delft University of Technology, The Netherlands — [3]Philips Research Laboratories, Eindhoven, The Netherlands

Much of the recent interest for chemically grown semiconductor nanowires arises from their huge versatility which translates into a wide range of potential applications. Many important proofs of concept have already been provided such as field effect transistors, elementary logic circuits, resonant tunneling diodes, light emitting diodes, lasers, and biochemical sensors. These achievements, together with the recent advance in the monolithic integration of III-V nanowires with standard Si technology, may open the way to the development of next-generation (opto)electronics. On the other hand, the high degree of freedom in nanowire growth and device engineering creates new opportunities for the fabrication of controlled one-dimensional systems for low-temperature applications and fundamental science. Here I will present an overview of this emerging field with an emphasis on the electronic transport properties of III-V nanowires. In particular I will report on single-electron transport, quantum confinement, and the recent observation of a tunable Josephson effect in superconductor-nanowire-superconductor devices.

Invited Talk SYNW 1.3 Wed 15:00 HSZ 04

In situ Transmission Electron Microscopy Studies of Vapor-Liquid-Solid Phase Growth of Si Nanowires — •S. Kodambaka, J. B. Hannon, J. Tersoff, M.C. Reuter, R.M. Tromp, and F.M. Ross — IBM T.J. Watson Research Center, Yorktown Heights, NY 10598

Using ultra-high vacuum transmission electron microscopy (UHV-TEM), we study the growth kinetics of Si nanowires. Wires are grown in situ on Au-covered Si(111) substrates using disilane ($P_{Si2H6} = 10^{-6}$ Torr) at temperatures between 500 and 700oC. We observe, in real-time, the growth of ¡111¿-oriented Si wires in the presence of molten Au-Si eutectic droplets serving as the catalysts. From the TEM images of individual Si wires, acquired at video rates, we measure time-dependent changes in lengths and diameters of the wires and volumes of the Au-Si droplets. We find that the lengths of all wires increase linearly with deposition time at a temperature-dependent constant rate that is independent of the droplet diameter. Volumes of all the droplets decrease with time during both deposition and annealing in vacuum. We attribute this behavior to loss of Au due to Ostwald ripening of droplets on top of wires and incorporation on wire surfaces. We find that presence of small amounts of O_2 during growth prevents loss of Au from the droplets and favors the growth of ¡110¿-oriented Si wires. Our results provide insights into mechanisms governing the kinetics of Si nanowire growth.