Fabrication of Substrate for Selective Contact to Nanowire Devices

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Principal Investigator(s): Sandip Tiwari
User(s): Brian Bryce

Affiliation(s): 1. School of Electrical and Computer Engineering, Cornell University; 2. School of Applied and Engineering Physics, Cornell University
Primary Research Funding: Samsung, National Science Foundation Integrative Graduate Education and Research Traineeship
Contact: st222@cornell.edu, bab79@cornell.edu

Abstract:
A patterned substrate for the selective contact of nanowire devices using only standard photolithography, evaporations and reactive ion etches has been fabricated. It offers scalable contact of one to many devices left on the growth substrate, but has the drawback of increased difficulty in wire synthesis.

Summary:
Most studies of nanowire-based devices make contact to devices either by the use of scanned probes of some type or by removing the wire from the growth substrate and performing nanolithography to form contacts [1-3]. Contact to single nanowire devices is thus of an ad hoc nature. While these methods are widely used and successful for exploring some of the fundamental properties of nanowires, they lack scalability. Our first attempt at a solution to this problem was to produce a well structure that allows for selective contact of wires, the cross section of which can be seen in Figure 1.

In this scheme, the wires are grown everywhere across the patterned substrate which contains blocks of wells. Regardless of the density of wires, the number of wells in each contact block is varied so that contact can be statistically made to as little as one wire device. Large ensembles of devices can also be studied on the same substrate simply by increasing the number of wells per block. This technique makes use of only standard photolithography and reactive ion etches (RIE). The ability to make contact to a single device without nanoscale lithography or other techniques is gained in exchange for increased difficulty of wire synthesis and statistical variation in the number of devices across sites.

The general scheme laid out in Figure 1 is a simple one for radial nanowire devices. The core of the wire would be connected to the substrate. The cladding of the wire would be connected to the metal layer which is isolated from the substrate by an oxide. This provides for a two terminal device. The other layers present are used for isolation of one well from the next. The tall aspect of the well structure is useful in protecting the wires during the final lithography step which requires the removal of the conformal cladding layer between the different wells, which is also done via RIE.

As can be seen in Figure 2, it is possible to catalyze the growth of wires in such wells; however it remains difficult, and other methods of scalable contact are worth exploring.
References:


Figure 2: A single Ge nanowire grown inside a well.  
(Courtesy of K. Date.)