strut, Drelich said. Collaborator Jeremy Goldman, a biomedical engineer, placed these tiny wires into the abdominal aorta of rats, and then removed and examined the wires' corrosion after 1.5, 3, 4.5, and 6 months.

For the first three months, the researchers found that the zinc wires degraded in the rats at a rate that they calculated as just below 20 µm a year, the ideal corrosion rate. At four months, the pure zinc still retained about 70% of its cross-sectional area, and then its degradation rate accelerated rapidly, ensuring that it would not stay in the body for too long. Moreover, the team saw that more healthy arterial tissue stuck to the wires the longer the wires remained in the body, suggesting that the zinc was not damaging the arterial walls. And because zinc is known to fight arterial plaque, a zinc-based stent could further help patients suffering from ischemic problems.

Carlo Di Mario, a clinical cardiologist at Imperial College London who was not involved in the research, said that the work is interesting and it appears that zinc-based stents would last longer in the body than magnesium-based stents. However, he said that the low tensile strength of zinc is an issue: The wires work perfectly in rats, but the material is not strong enough to hold open human arteries. Using zinc alloys is necessary, but "the avenue to alloys seems a bit too long for a clinician to be interested at this stage," Di Mario said.

However, Drelich said they are already testing promising new zinc alloys to fix the strength issue—the invented alloys meet all of the benchmarks necessary for a bioabsorbable stent material candidate. The team is now continuing *in vivo* testing of new alloys and expects to complete prototype mini-stents this year. Within a few years, they should be ready to move on to clinical trials, he said.

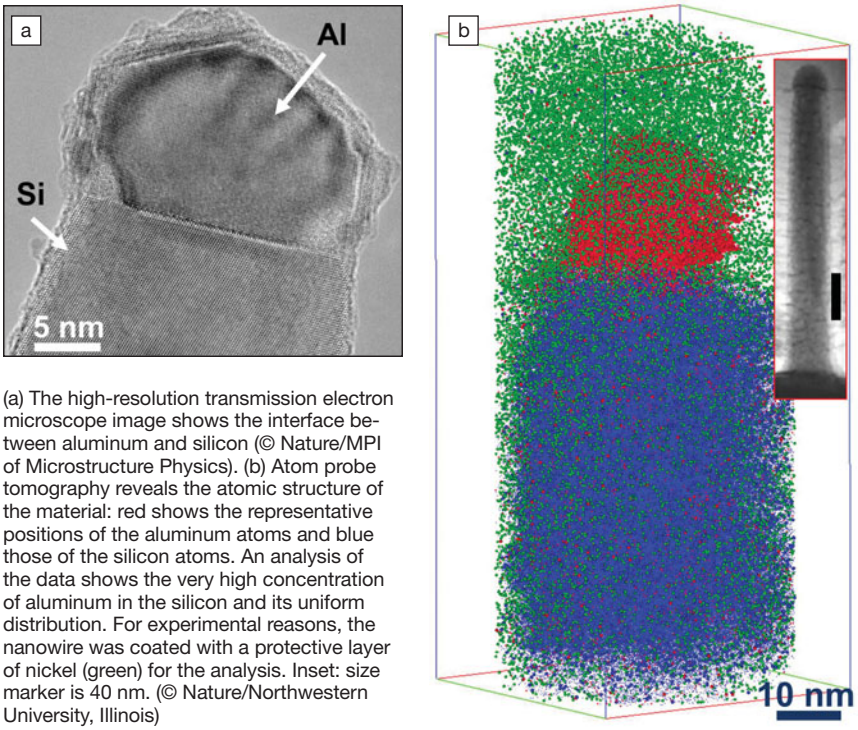
Joseph Bennington-Castro

Nano Focus

Al catalyst yields massive doping of Si nanowires

Semiconductor nanowires represent versatile nanoscale building blocks, finding applications as new transistors and circuits for next-generation electronics, as well as in photonics, solar cells, biosensing, and neuro-engineering technology. Silicon nanowires have attracted particular interest, where their properties are controlled by doping with foreign ions. It has recently been demonstrated that aluminum provides an effective growth catalyst for silicon nanowires, where the aluminum also provides an effective *p*-type dopant, being homogeneously distributed throughout the silicon.

As reported in the April 4 issue of *Nature* (DOI: 10.1038/nature11999; p. 78), an international team of researchers from École Polytechnique de Montréal in Canada, Max Planck Institute of Microstructure Physics in Germany, and Northwestern University in Illinois have now gained an atomic-level understanding of this process. Silicon nanowires were grown by heating a silicon substrate supporting aluminum islands to a temperature where only the aluminum melts, and not the silicon. The substrate was then exposed to a vapor-phase silane reactant. Part (a) in the figure shows how the surface of an aluminum drop adsorbs silicon from the silane, which then migrates to the bottom of the drop where it deposits in layers. Significantly more aluminum is thus embedded in the silicon wire than was to be expected theoretically.



(a) The high-resolution transmission electron microscope image shows the interface between aluminum and silicon (© Nature/MPI of Microstructure Physics). (b) Atom probe tomography reveals the atomic structure of the material: red shows the representative positions of the aluminum atoms and blue those of the silicon atoms. An analysis of the data shows the very high concentration of aluminum in the silicon and its uniform distribution. For experimental reasons, the nanowire was coated with a protective layer of nickel (green) for the analysis. Inset: size marker is 40 nm. (© Nature/Northwestern University, Illinois)

"The silicon here takes up as much as 10,000 times more aluminum than the laws of thermodynamics allow," said Eckhard Pippel, one of the participating researchers from the Max Planck Institute of Microstructure Physics. Theoretically, fewer than one in a million atoms should be replaced by aluminum in a silicon crystal. However, the aluminum content of the silicon wires is actually around 4%. Co-researcher David Seidman, the Walter P. Murphy Professor of Materials Science and Engineering at Northwestern, and Dieter Isheim, Research Assistant Professor, said, "We could see that aluminum triggers a self-doping process that results

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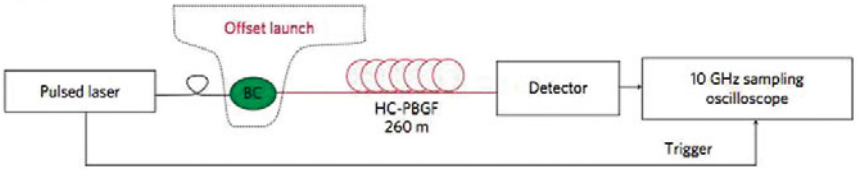
in an unexpectedly high concentration of aluminum atoms uniformly distributed throughout the nanowires." The researchers made their discovery with the aid of an ultraviolet laser-assisted atom probe tomography, which reveals the type and position of each individual atom in nanoscopic samples—see part (b) in the figure.

Oussama Moutanabbir, a professor at École Polytechnique in Montréal, said, "The data surprised us because of the high concentration, on the one hand, and also because the aluminum atoms do not form clusters in the silicon." The number of charge carriers in silicon increases only when the aluminum atoms are distributed uniformly. This increase is important for electronic applications.

In order to understand why more aluminum ends up in the silicon wire than is actually allowed, the researchers developed a model of how quickly the process proceeds on the atomic level. If this time is long, the atoms would arrange themselves until the chemical equilibrium is achieved. However, the time is not long enough for this, and atomic exchange stops as soon as one row of silicon atoms has been completed. "An aluminum atom that has previously been embedded remains permanently trapped," said Moutanabbir. "Until now, it has been assumed that the atoms can be exchanged between the metal drop and silicon until the whole silicon layer is complete." As the researchers have now clarified the process, it should be possible to apply it to the targeted doping of nanowires.

Nano Focus

High-capacity fiber-optic communications at the speed of light uses air as the medium



Time-of-flight experimental setup, where light is launched into 260 m of hollow-core photonic-bandgap fibers (HC-PBGFs) with a 12 mm laterally offset, butt-coupled (BC) standard single-mode fiber. Reproduced with permission from *Nature Photon*. **7** (2013), DOI: 10.1038/nphoton.2013.45; p. 279. © 2013 Macmillan Publishers Ltd.

Improving data transmission across computer networks is key to advancing the performance of modern data centers and massively parallelized supercomputers. Optical fibers provide outstanding transmission bandwidth, but light propagates 31% slower in a silica glass fiber than in vacuum, thus introducing a time delay. Air guidance in hollow-core fibers can improve this significantly, but it has proven challenging to achieve the combined values of loss, bandwidth and mode-coupling characteristics required for high-capacity data transmission.

Addressing this challenge, F. Poletti and colleagues from the University of Southampton have now fabricated hollow-core photonic-bandgap fibers (HC-PBGFs) that are capable of achieving both low surface scattering loss and wide surface-mode-free transmission bandwidth simultaneously (see Figure). This represents the first demonstration of fiber-based wavelength division multiplexed data transmission at close to (99.7%) the speed of light in a vacuum.

As reported in the April issue of *Nature Photonics* (DOI: 10.1038/nphoton.2013.45; p. 279), the team investigated the origin of the observed loss by developing a model of surface scattering in hollow fibers and performing simulations to predict the total loss. This showed that the surface-scattering contribution dominates at the center of the bandgap while confinement loss only reshapes its edges. To gain insight into the modal behavior of HC-PBGFs, the researchers used a combination of time-of-flight (TOF) and self-interferometric measurements (S^2). When the fiber is excited with an offset launch, light is efficiently coupled into several high-order modes. Their lower group velocities relative to the fundamental mode then generate clearly resolvable delayed peaks in the TOF measurement. By cross-comparing results from the TOF and S^2 measurements, the team was also able to identify all expected modes up to LP_{31}. This was attributed to selective excitation of individual polarization modes within a mode group, and the high extinction ratios to relatively low intermodal crosstalk.

The results demonstrate an important step toward the viability of using HC-PBGFs for low-latency data transmission. The achieved loss values are adequate for low latency application, for example, in realization of next-generation peta-to-exaflop scale supercomputers and mega data centers.

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