

A Tale of Two Silicon Nanowires: Correlative Studies

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Abstract

The first tale concerns Si nanowires (NWs) grown by the vapor-liquid-solid technique, which were doped *ex situ* with boron (B) and phosphorous (P), yielding two monolayer line sources on two sides of the cylindrical Si NWs, with diameters ranging from 35 to 75 nm. This sandwich structure was rapidly thermally annealed at 10^{-2} Torr Ar at 970 °C to drive in B and P, for times ranging from 3 to 80 s. Utilizing atom-probe tomography we found a highly P-doped outer region and a uniformly B-doped interior, which were not predicted using the bulk diffusivities of P and B. Utilizing scanning tunneling microscopy, which detects only the electrically dopants, we determined the fraction of the total dopants that are electrically active.

The second tale involves Raman spectroscopy, electron microscopy and electron diffraction studies to identify strain energy release mechanisms of bent diamond-cubic Si NWs, which were elastically strained to >6% at room temperature and then annealed to activate relaxation mechanisms. High-temperature annealing of bent Si NWs leads to the nucleation, glide and climb of dislocations, which align to form polygonally-shaped grains separated by grain boundaries (GBs) consisting of aligned edge dislocations; this phenomenon is called polygonization (R. W. Cahn, 1949).

Short Biography

Seidman is a W. P. Murphy professor of materials science & engineering and is founding director of the *Northwestern University Center for Atom-Probe Tomography*. He was awarded a Ph.D. degree from UIUC and B.S. and M.S. degrees from N.Y.U. He is a member of the National Academy of Engineering, fellow of American Academy of Arts & Sciences, American Association for the Advancement of Science, American Physical Society, ASM International, Materials Research Society, John Simon Guggenheim Foundation, Microscopy Society of America, and TMS (Minerals•Metals•Materials). He is a recipient of: AIME Honorary Member Award (TMS), Albert Sauveur Achievement Award (ASM International), ASM Gold Medal, Alexander Von Humboldt Stiftung Prize, David Turnbull Lecturer Award (MRS), Edward DeMille Campbell Memorial Lectureship (ASM), Institute of Metals Lecture & Robert Franklin Mehl Award (TMS), Max-Planck Research Prize of the Max-Planck-Gesellschaft, Robert Lansing Hardy Gold Medal (TMS), and Sackler Lecturer (Sackler Institute of Advanced Studies). He is or was on the editorial boards of: *Journal of Materials Science*, *Materials Research*



Letters, Materials Today, MRS Bulletin, NanoLIFE, NANO Science and NANO Technology series, and Review of Scientific Instruments. Seidman is a co-founder of *NanoAl.com*, which develops high-temperature Al-based alloys for a range of technological applications.