Ohm's Law Survives to the Atomic Scale

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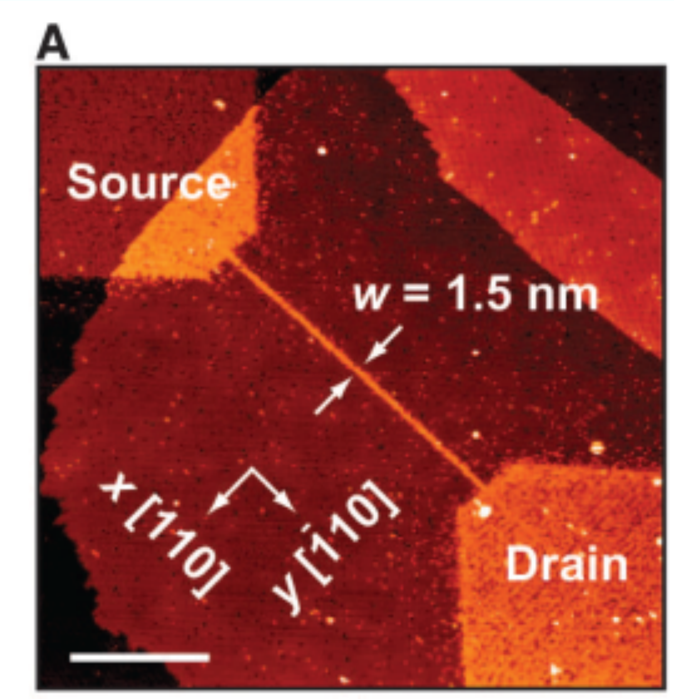

STM image of a 4-atomwide (1.5 nm), one-atom tall, and 106-nm-long wire template, patterned along the <110> direction and connected to source/drain leads.

As silicon electronics approaches the atomic scale, interconnects and circuitry become comparable in size to the active device components. Maintaining low electrical resistivity at this scale is challenging because of the presence of confining surfaces and interfaces. We report on the fabrication of wires in silicon—only one atom tall and four atoms wide—with exceptionally low resistivity (~0.3 milliohm-centimeters) and the current-carrying capabilities of copper. By embedding phosphorus atoms within a silicon crystal with an average spacing of less than 1 nanometer, we achieved a diameter-independent resistivity, which demonstrates ohmic scaling to the atomic limit. Atomistic tight-binding calculations confirm the metallicity of these atomic-scale wires, which pave the way for single-atom device architectures for both classical and quantum information processing.

LINK TO FULL PAPER (SUBSCRIBERS ONLY):
http://science.sciencemag.org/content/sci/335/6064/64.full.pdf