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Research Highlights

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Surface chemistry: Deterministic doping

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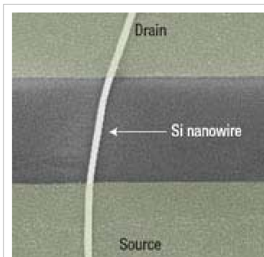
Silicon nanostructures can be very precisely doped by coating them with organic molecules that release dopant atoms when heated to high temperatures



The controlled doping of semiconductors is a critical step in the fabrication of microelectronic devices. In the case of silicon, the addition of phosphorous atoms produces regions with excess electrons (n-type doping), whereas the inclusion of boron atoms results in an increased number of positive charge carriers or 'holes' (p-type doping). Despite tremendous advances in the synthesis of semiconductor nanostructures, however, there is a lack of simple, accurate and reproducible means for doping them at such small scales.

Now, Ali Javey and colleagues[1 (#B1)] from the University of California, Berkeley and Lawerence Berkeley National Laboratory, both in the USA, have controllably doped Si surfaces using molecular monolayers. In the first step, a single layer of organic molecules — containing either phosphorus or boron atoms — were assembled on a Si substrate that was then capped with a 50-nm-thick oxide layer. A rapid thermal annealing step, using temperatures in the region of 1,000 °C, caused the P or B dopant atoms to diffuse into the Si lattice, and the oxide layer was subsequently etched away with HF. Doping concentrations were typically the highest near the surface, and sharply decreased by several orders of magnitude at depths of around 20 nm.

This strategy was also used successfully to dope other Si nanostructures, such as wires and belts. The ability to form atomically sharp doping profiles and control areal dopant concentrations so precisely may prove useful in the design and construction of nanoelectronic devices, and could be extended to semiconducting materials other than Si.

REFERENCE

1. Ho, J. C. *et al.* Controlled nanoscale doping of semiconductors via molecular monolayers. *Nature Mater.* doi: 10.1038/nmat2058 (2007). | **Article** (http://www.nature.com/doifinder/10.1038/nmat2058) |