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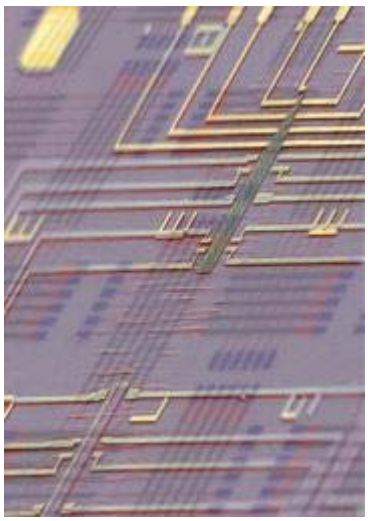
News

Criss-crossed nanowires can compute

Meshed wires made into programmable circuits.

Geoff Brumfiel

Scientists have stitched together nanowires to create a microchip capable of basic computation.



Researchers have used germanium wires to create a 'nanochip'.

LIEBER GROUP/HARVARD UNIV.

The unusual chip "looks like a screen mesh that you have to keep bugs out of your window", says Charles Lieber, a chemist at Harvard University in Cambridge, Massachusetts, who led the effort. But the nano-circuit can outperform a screen window (and many rival nanotechnologies) at addition and subtraction. The work appears in today's issue of *Nature*[1].

Modern electronics are created by stencilling patterns onto blank semiconducting chips, but for decades, physicists have believed that they could do better by building from the bottom up. Nanotechnology seeks to assemble nanometre (10^{-9} metres) components into practical devices to rival current silicon technologies.

Lieber's latest chip is based on germanium wires just 10 nanometres across. The team starts by making the wires, and then stamping them onto a silicon dioxide wafer. On top of the wires, the group lays down a layer of metal oxides, before crossing them at specific points with tiny metal wires.

Running a high voltage through the metal wire allows the researchers to turn individual crossing points on and off — effectively allowing them to program the mesh to do their bidding. Then, using lower voltages, the team can operate the germanium wires below as transistors. The finished chip contains 496 programmable transistors in an area of 960 micrometres.

The team was able to use the chip both add and subtract, basic elements of logic common in everyday computers. Moreover, researchers used one mesh to drive another — a critical task if the technology is to be 'scaled up' to larger circuits.

Still not small enough

"We believe that this is a big advance in the circuitry that's been built from synthesized components," says Lieber. Although the size of the mesh still exceeds the size of transistors in

standard electronics, Lieber believes that the technology could potentially work at scales below what can be achieved with conventional techniques.

However, not everyone is convinced that the new wires can compete. "It's a nice piece of work, but compared to the state-of-the-art, it's got a long way to go," says Franz Kreupl, a senior manager at SanDisk corporation in Milpitas, California. Kreupl says that modern silicon electronics can cram millions of transistors onto a single chip. For Lieber's mesh to equal that, it would have to drastically reduce its size and increase its reliability. The same goes for any bottom-up technology, Kreupl says. "The industry is almost already at compatible sizes to what nanotubes can do."

Lieber agrees that his new mesh will struggle to beat the rapid development of conventional electronics. "The key thing is to recognize that we're not trying to compete directly with high-performance silicon electronics," he says. Projections show that the new wires could be up to 100 times more energy efficient than conventional technologies. That could make the meshes useful as logic circuits in low-power applications such as small robots, or perhaps biomedical devices.

Lieber is now hoping to secure more funding to bring his nanomesh computers closer to the market: "We've demonstrated that this can work, but it really requires a dedicated programme to realize it," he says.

References

1. Yan, H. *et al. Nature* **470,** 240-244 (2011).

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