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Nanowire processor signals route to ever-smaller chips

By Jason Palmer
Science and technology reporter, BBC News

Engineers have developed a computer chip made of tiny "nanowires" whose computing functions can be changed by applying small electric currents.

These "programmable logic tiles" may represent the building blocks of a new generation of ever-smaller computers.

Instead of etching chips down from chunks of material, the nanoprocessors can be built up from minuscule parts.

The work, **reported in Nature**, may outpace the shrinking of chips made with current manufacturing techniques.

The group led by Charles Lieber of Harvard University has spent the last few years developing the nanowires - each made of a core of the element germanium and sheathed in a silicon shell, thousands of times thinner than a human hair.

The latest report is a demonstration that the wires can be made reliably enough to enter the world of computing.

Small circuits made of nanowires have been assembled before, but the latest work is unique in the sheer complexity of the resulting circuit, along with the fact that the tiles can be "cascaded" to yield far more complex circuits.

The group's prototype design is based on a mesh of the nanowires.

The prototype contains nearly 500 of them in a 1mm-square area, criss-crossed with normal metal wires.

Together with a whisker-thin stack of semiconductor materials laid on top, this mesh acts as a collection of transistors.

Passing an electric current through the normal wires can change the so-called "threshold voltages" of each transistor; the whole ensemble is in this way completely programmable.

The team demonstrated the changeable nature of their chip by re-programming it to do a number of mathematical and logical functions.

"This work represents a quantum jump forward in the complexity and function of circuits built from the bottom up, and thus demonstrates that this bottom-up paradigm - which is distinct from the way commercial circuits are built today - can yield nanoprocessors and other integrated systems of the future," said Professor Lieber.

However, the team concedes its prototype needs to be scaled up greatly to begin to approach the power of current semiconductor chips, but should hold advantages in the longer term.

The manufacturing methods used in making current chips are projected to reach a limit of size, a threshold, below which the relentless shrinking of the chips seen in recent years would not be possible.

The nanowires can in principle be made to occupy an area just one-eighth of what many think that limit is.

However, Professor Lieber and his team do not expect their approach to replace current chips, because their devices operate at significantly slower speeds.

So while current designs will keep the lead in number-crunching power, nanowire chips could win out in terms of size and efficiency.

The nanowires suffer less leakage of electrical current than current transistors, so chips should be as much as 10 times more efficient.

"Because of their very small size and very low power requirements, these new nanoprocessor circuits are building-blocks that can control and enable an entirely new class of much smaller, lighter-weight electronic sensors and consumer electronics," said study co-author Shamik Das, of the Mitre technology firm.

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