Nano World: Ultra-dense circuits

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Conventional electronics could in the future tap into the computational power of ultrahigh-density nanowire circuits via novel linking devices under development at university and corporate labs across the nation, experts told UPI's Nano World.

Computer scientists and engineers are developing ever smaller circuits packed closer and closer together to increase computer power. A critical problem researchers face as wires approach the width of a nanometer or billionth of a meter -- only a few atoms wide -- is how to separate out the electrical signals from each nanowire when they are packed so densely together.

"Imagine trying to use your fingers to pick up a particular strand of fine string, when that string is closely surrounded by lots of other strings. Your fingers are too big for the task," said chemist James Heath of the California Institute of Technology in Pasadena.

Heath and his colleagues have developed an electronic device known as a demultiplexer that can sort out these signals to bridge future electronics that work on nanometer-length scales with conventional electronics that work at sub-micron length scales.

"Our approach is the only one that has so far been demonstrated as capable of bridging length scales," Heath said.

Instead of directing signals to and from each individual nanowire using an equal number of larger wires -- which would undo the space savings

of having nanowire-sized circuitry in the first place -- the researchers individually directed signals to and from a few wires within an array of 150 very closely spaced silicon nanowires using a demultiplexer composed of four pairs of relatively widely spaced and relatively large wires. The researchers basically increased the electrical resistance of all the nanowires they did not want to reach. "Thus, the only wire that wasn't addressed was the one that we wanted," Heath said.

"A few other approaches have been described in conceptual form, but they haven't been demonstrated. Of those other approaches, ours tends to work a little better because it makes a much more efficient use of the 'large' wires that are used to demultiplex the small wires, and when implemented, it provides a very energy efficient solution to demultiplexing," Heath said.

"Our demultiplexer doesn't yet work perfectly, but it does work," Heath said. "We do point out where it can be significantly improved, and we have begun implementing those improvements." This includes lowering the voltages the device requires by optimizing the silicon nanowires' chemistry.

Besides Heath's lab, research groups around the country are researching demultiplexers to bridge submicron and nanometer-length scales, including Harvard chemist Charles Lieber's lab and Hewlett-Packard Laboratories in Palo Alto, Calif.

"This is very creative and important work from the Heath group. In particular what it does, which is nontrivial, is bring together several ideas people had talked about and demonstrated all of them could be made to work at the same time. When you're inventing new technologies, it's not obvious all these new technologies are compatible with each other," said Philip Kuekes, a computer architect at Hewlett-Packard Laboratories.