'Major' IBM breakthrough breathes new life into Moore’s Law

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Silicon is dead. Long live, carbon nanotubes.

In transistors, size matters — a lot. You can’t squeeze more silicon transistors (think billions of them) into a processor unless you can make them smaller, but the smaller these transistors get, the higher the resistance between contacts, which means the current can’t flow freely through them and, in essence, the transistors and chips built based on them, can no longer do their jobs. Ultra-tiny carbon nanotube transistors, though are poised to solve the size issue.

See also: IBM announces functioning 7-nanometer chip breakthrough

In a paper published on Thursday in the journal *Science*, IBM scientists announced they had found a way to reduce the contact length of carbon nanotube transistors — a key component of the tech and the one that most impacts resistance — down to 9 nanometers without increasing resistance at all. To put this in perspective, contact length on traditional, silicon-based 14nm node technology (something akin to Intel’s 14nm technology) currently sits at about 25 nanometers.

"In the silicon space, the contact resistance is very low if the contact is very long. If contact is very short, the resistance shoots up very quickly and gets large. So you have trouble getting current through the device,” Wilfried Haensch, IBM Senior Manager, Physics & Materials for Logic and Communications, told me.

Because of their unique properties,

carbon nanotubes, which happen to be 10,000 times thinner than a single strand of human hair, have been a promising tech for continuing Moore’s Law, which roughly states that the number of transistors in an integrated circuit will double every two years. However, according to Haensch, the technology faces considerable hurdles before it can be considered appropriate for commercial integrated circuit development.

First of all, the creation of tubes you can use in semiconductors isn't easy. Haensch told me the current yields for useful material are still well below what they need. They also have to work out how to place the nanotubes 10nm apart or less on a wafer. Thirdly, they have to be able to scale devices based on carbon nanotubes to competitive dimensions.

There are actually two size issues to manage in chip scalability: Transistor gate and contact length. IBM solved the gate issue two years ago. "Scalability of contact was the last challenge on scalability," said Haensch, and now IBM scientists report they've solved that, too. In their experiments, IBM scientists shrunk the contact length down to 9nm without any increase in resistance.

SEM (Scanning Electron Microscopy) image showing the fabricated nanotube transistor with an end-bonded contact and a contact length below 10 nm.

Image: IBM Research

These results put the world one step closer to carbon nanotube-based integrated circuits. Such chips could conceivably run at the same speed as current transistors, but use significantly less power.

At maximum power, though, Haensch told me, these carbon nanotube chips could run at significantly faster speeds. Not only does this promise a future of ever faster computers, but it could lead to considerably better battery life for your most trusted companion — the smartphone.

This was an engineering breakthrough, though, that almost wasn't. After working on the scalability problem for years, Haensch's team came to him last year with results that shortened the contact length to 20nm.

They said, "Oh, we have something here. We need to publish," Haensch recalled, who deflated the team's excitement, telling them, "No, you don't really have anything."

Haensch sent them back to the lab telling them not to come back until they could produce something smaller than 10nm. "They were very disappointed they couldn't write the paper," said Haensch.

Then, a few months ago, the team returned with new results. "'We got down to 9nm, and, by the way, we can reproduce the results."

Haensch was thrilled. "Taking away the early gratification really gave us good results," he said. It may also have given Moore's Law a new lease on life and the world an exciting new future of electronics.

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