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Nanowire transistors outperform MOSFETs

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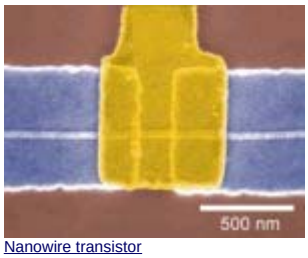
Researchers at Harvard University, US, say they have made the best nanowire transistors to date. The devices consisted of germanium/silicon core/shell nanowire field-effect transistors (FETs) using high-κ dielectrics and a metal top gate geometry.

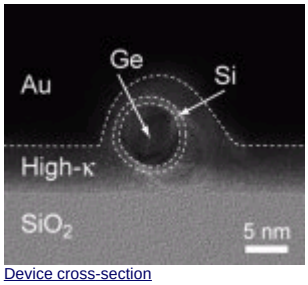


Nanowire transistor

"We showed that our current Ge/Si nanowire FETs perform three to four times better than silicon CMOS [devices]," Charles Lieber of Harvard told *nanotechweb.org*, "thus demonstrating for the first time that there is a clear advantage to nanowire versus conventional planar FETs. This justifies further (aggressive) work on the nanowire FETs and, by reporting results in an industry standard, we hope we will also make industry better aware of the potential of this basic research."

Lieber and colleagues used band structure design to create a hole gas in the Ge/Si core-shell system. "This has proved to be an ideal system with reliable ohmic contact and high mobility," said Lieber.

The researchers employed a benchmark typically used by the semiconductor industry to characterize the on-current and intrinsic delay properties of their devices. The transistors exhibited a scaled transconductance of 3.3 mS μm^{-1} and on-current of 2.1 mA μm^{-1}. Hole mobility, meanwhile, was 730 $cm^2 V^{-1} s^{-1}$ – 10 times higher than that of a silicon *p*-metal-oxide semiconductor field effect transistor (MOSFET).



Device cross-section

What's more, according to the scientists, the device's intrinsic switching delay was comparable to that of similar length carbon nanotube field-effect transistors and much better than the length-dependent scaling of planar silicon MOSFETs.

Lieber reckons the devices could have applications in next-generation high-speed logic circuits after conventional CMOS technology hits its limits. "In addition, the high-performance nanowire transistors can also [work] on many unconventional substrates, such as glass or plastic for transparent or flexible applications, where conventional crystalline Si technology is not possible," he added. "The excellent mobility exhibited by the nanowires would greatly improve device speed for these applications."

Now the researchers plan to improve the performance of the Ge/Si nanowire devices and scale them to smaller sizes; develop their ideas for other systems, for example by creating devices with a carrier gas of electrons rather than holes; and to create large-scale assemblies of the nanowire devices for integrated systems.

The researchers reported their work in *Nature*.

About the author

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