UNSW researchers ‘grow’ semiconductors into smaller electronics

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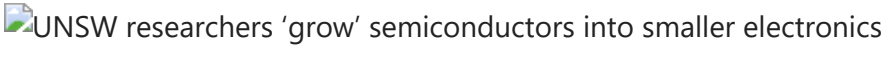

Main author FLEET -ph.d. student Yonatan Ashlea Alava (UNSW)

Image: UNSW

Researchers from the University of New South Wales (UNSW) have published a study which they claim shows the ability to build "homemade" semiconductors for use in ultra-small electronic devices as well as in quantum computing.

Working with the ARC Center of Excellence in Future Low-Energy Electronics Technologies (FLEET) said that "growing" electronic components directly on a semiconductor block avoid clutter, noisy oxidation scattering that slows down and impedes electronic operation.

UNSW Professor Alex Hamilton said that the homemade, all single crystal design would be ideal for the manufacture of ultra-small electronic devices, quantum dots and for quantum bit (qubit) applications.

"Making computers faster still requires smaller transistors, as these electronic components are now only a handful of nanometers in size — there are about 12 billion transistors in the central chip in the stamp size of modern smartphones," the researchers said.

However, they said in even smaller devices, the channel through which the electrons flow must be very close to the interface between the semiconductor and the metallic part used to turn the transistor on and off.

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Inevitable surface oxidation and other surface contaminants cause unwanted scattering of electrons flowing through the channel, and also lead to instability and noise, which is particularly problematic for quantum devices, the researchers explained.

"In the new work, we are creating transistors where an ultra-thin metal gate is grown as part of the semiconductor crystal, preventing problems associated with oxidation of the semiconductor surface," said Yonatan Ashlea Alava, FLEET PhD student and lead author of research.

"We have demonstrated that this new design dramatically reduces unwanted effects from surface defects, and shows that nanoscale quantum point switches exhibit significantly lower noise than devices made using conventional methods."

The researchers said one of the challenges was that electron scattering limits high-frequency components.

The mission of making ever smaller electronic devices requires that the conductive channel in high electron mobility transistors (HEMTs) be near the surface of the device. The challenging part, the researchers said, has its ro

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scattering' process. The more scattering events, the more difficult it is for electrons to travel in the solid, and thus lower conductivity, "they said.

"Semiconductor surfaces often have high levels of unwanted charge trapped by the unsatisfactory chemical bonds of the surface atoms – or" dangling "bonds. This surface charge causes electron scattering in the channel and reduces the conductivity of the device. the conductivity of HEMT quickly. "

In addition, they said that surface charge creates local potential fluctuations, resulting in charge noise in sensitive devices, such as quantum dot switches and quantum dots. It also lowers the conductivity.

The solution, the research claims, first grows "switch gate" to reduce proliferation.

Working with wafer manufacturers at Cambridge University, the team at UNSW showed that the problem associated with surface charging can be eliminated by cultivating an epitaxial aluminum port before the wafer is removed from the growth chamber.

"We confirmed the improv
laboratory at UNSW," expl

The team compared shallow HEMTs made on two wafers with almost identical structures and growth conditions — one with an epitaxial aluminum port and another with an ex-situ metal port deposited on an alumina dielectric.

“They characterized the devices using low-temperature transport measurements and showed the epitaxial gate design greatly reduced the spread of surface charge by up to 2.5x increase in conductivity.”

They also showed, UNSW explained, that the epitaxial aluminum gate could be patterned to make nanostructures.

“A quantum dot switch made using the proposed structure showed robust and reproducible 1D conductance quantization with extremely low charge noise,” it added.

“The high conductivity of ultra-shallow wafers and the structure’s compatibility with reproducible nano-device manufacturing suggest that MBE-grown aluminum slots are ideal candidates for the manufacture of ultra-small electronic devices, quantum dots and for qubit applications.”

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