Remaining switched on to silicon-based electronics

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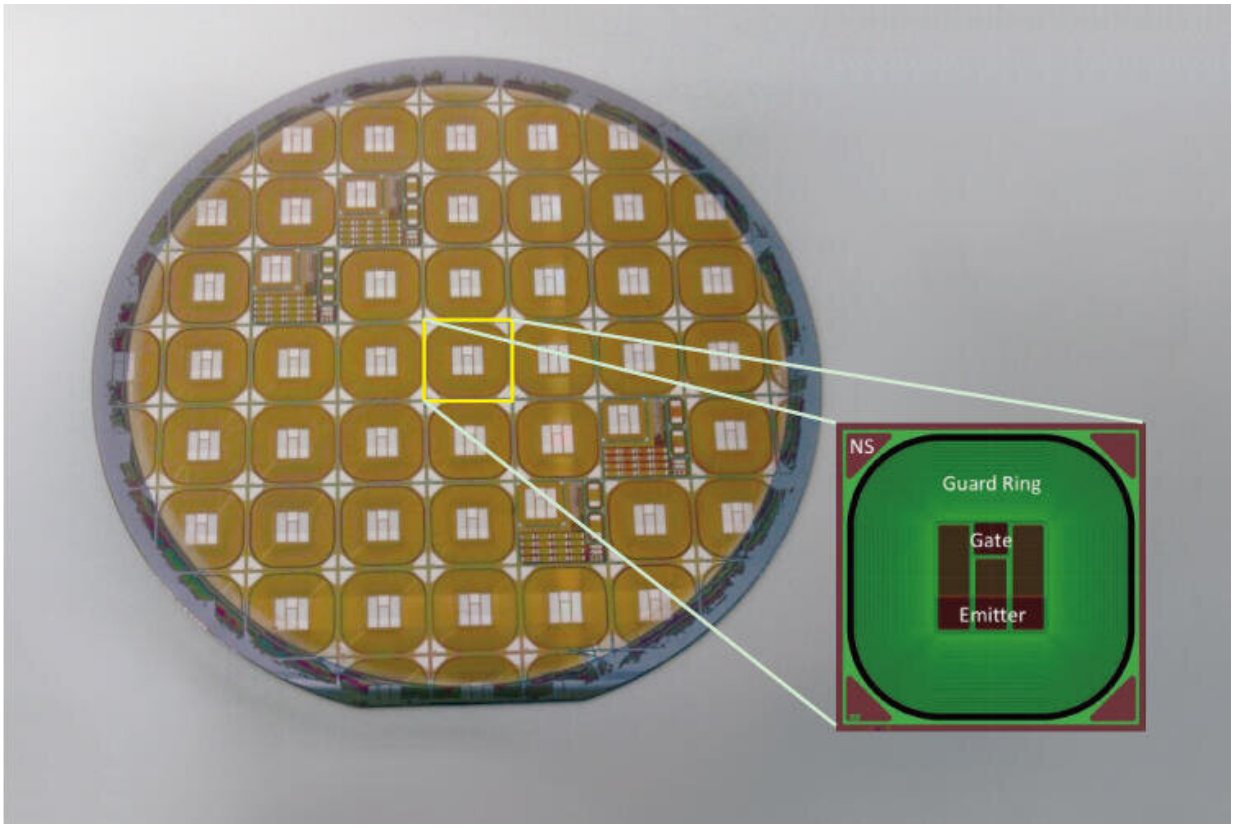

Credit: The University of Tokyo

The difficulty of further increasing the power conversion efficiency of silicon-based components in power electronics seems to indicate that we are reaching the limits of potential advances to this technology.

However, a research group headed by The University of Tokyo recently challenged that view by developing a power switching device that surpasses previous performance limits, illustrating that silicon technology can still be further optimized. The researchers developed an improved insulated gate bipolar transistor (IGBT), which is a type of switch used in power conversion to switch high voltages of around 600 to 6500 V.

To design their IGBT, the team used a scaling approach. Their scaling simulations revealed that downscaling part of an IGBT to a third of its original size could lower its operating voltage from 15 V to just 5 V and substantially decrease its driving power.

"Our IGBT scaling approach was based on a similar concept to that used in traditional microelectronics and indicated that an IGBT with an operating voltage of 5 V should be feasible," says Takuya Saraya. "However, we thought that a driving voltage of 5 V might be too low to surpass the unexpected noise level and ensure reliable operation."

To verify their simulation results, the researchers fabricated their IGBT with a rated voltage of 3300 V in a specialized clean room at The University of Tokyo and then assessed its performance. Notably, the IGBT achieved stable switching at an operating voltage of just 5 V. This represents the first time IGBT switching has been realized at 5 V.

An IGBT that exhibits stable performance at an operating voltage of just 5 V is extremely attractive because the power consumption of the drive circuit is only around 10% of that of a conventional IGBT operating at 15 V. Power conversion efficiency is also improved despite the lowered operation voltage. Such a low operating voltage is also compatible with standard electronics processing, which will aid the integration of the IGBT drive circuits with other electronics.

"IGBTs are important power electronics components," explains Toshiro Hiramoto. "Our miniaturized IGBT could lead to the further development of advanced power electronics that are smaller and have higher power conversion efficiency."

IGBTs are found in electronics ranging from electric trains and vehicles to home stereos and air conditioners. Therefore, the improved IGBT with low driving voltage and high power conversion efficiency shows promise to raise the performance of numerous electronics, helping to mitigate modern society's increasing energy demands.

More information: Takuya Saraya et al. "3300V Scaled IGBTs Driven by 5V Gate Voltage," the IEEE International Symposium on Power Semiconductor Devices and ICs, May 19-23, 2019, Shanghai, China.

Provided by University of Tokyo