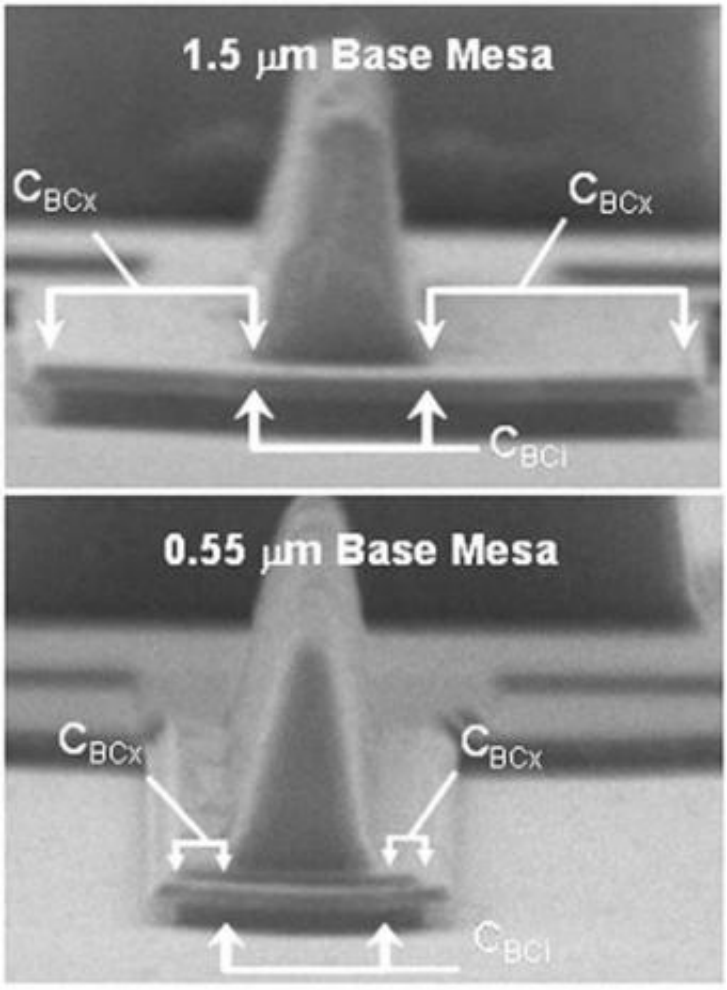
World's fastest transistor approaches goal of terahertz device

December 11 2006



Scanning electron microscope images of original base-collector mesa (top) and improved design (bottom). Credit: University of Illinois at Urbana-Champaign

Scientists at the University of Illinois at Urbana-Champaign have again broken their own speed record for the world's fastest transistor. With a frequency of 845 gigahertz, their latest device is approximately 300 gigahertz faster than transistors built by other research groups, and approaches the goal of a terahertz device.

Made from indium phosphide and indium gallium arsenide, "the new transistor utilizes a pseudomorphic grading of the base and collector regions," said Milton Feng, the Holonyak Chair Professor of Electrical and Computer Engineering at Illinois. "The compositional grading of these components enhances the electron velocity, hence, reduces both current density and charging time."

With their latest device, Feng and his research group have taken the transistor to a new range of high-speed operation, bringing the "Holy Grail" of a terahertz transistor finally within reach. Faster transistors translate into faster computers, more flexible and secure wireless communications systems, and more effective combat systems.

In addition to using pseudomorphic material construction, the researchers also refined their fabrication process to produce tinier transistor components. For example, the transistor's base is only 12.5 nanometers thick (a nanometer is one billionth of a meter, or about 10,000 times smaller than the width of a human hair).

"By scaling the device vertically, we have reduced the distance electrons have to travel, resulting in an increase in transistor speed," said graduate student William Snodgrass, who will describe the new device at the International Electronics Device Meeting in San Francisco, Dec. 11-13. "Because the size of the collector has also been reduced laterally, the transistor can charge and discharge faster."

Operated at room temperature (25 degrees Celsius), the transistor speed

is 765 gigahertz. Chilled to minus 55 degrees Celsius, the speed increases to 845 gigahertz.

Feng, Snodgrass and graduate student Walid Hafez (now at Intel Corp.) fabricated the high-speed device in the university's Micro and Nanotechnology Laboratory.

In addition to further increasing the transistor speed, Feng wants to reduce the current density even more, which will reduce junction temperature and improve device reliability.

Source: University of Illinois at Urbana-Champaign