New material structure produces world's fastest transistor

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A new type of transistor structure, invented by scientists at the University of Illinois at Urbana-Champaign, has broken the 600 gigahertz speed barrier. The goal of a terahertz transistor for high-speed computing and communications applications could now be within reach.

The new device -- built from indium phosphide and indium gallium arsenide -- is designed with a compositionally graded collector, base and emitter to reduce transit time and improve current density. With their pseudomorphic heterojunction bipolar transistor, the researchers have demonstrated a speed of 604 gigahertz -- the fastest transistor operation to date.

"Pseudomorphic grading of the material structure allows us to lower the bandgap in selected areas," said Milton Feng, the Holonyak Professor of Electrical and Computer Engineering and a researcher at the Coordinated Science Laboratory at Illinois. "This permits faster electron flow in the collector. The compositional grading of the transistor components also improves current density and signal charging time."

Feng and graduate student Walid Hafez fabricated the new device in the university's Micro and Nanotechnology Laboratory. They describe the pseudomorphic HBT concept, and discuss the transistor's high-speed operation, in the April 11 issue of the journal Applied Physics Letters.

The goal of a terahertz transistor was not possible using the previous device structure, Feng said. "To achieve such speed in a typical HBT, the

current density would become so large it would melt the components. In our pseudomorphic HBT, we can operate at higher frequencies with less current density. With this new material structure, a terahertz transistor is achievable."

Faster transistors could facilitate faster computers, more flexible and secure wireless communications systems, and more effective electronic combat systems.