Scientists Develop World's Fastest Graphene Transistor

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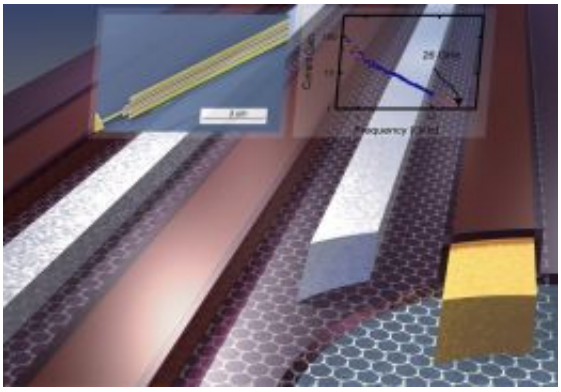

IBM Scientists from the company&acutes T. J. Waston Research Center have demonstrated the operation of a graphene field-effect transistors at GHz frequencies. Graphene is a special form of graphite, consisting of a single layer of carbon atoms packed in honeycomb lattice, similar to an atomic scale chicken wire. With a top gate deisgn and a gate length 150 nm, the team has achieved a cut-off frequency of 26 GHz for graphene transistors; the highest frequencies reported so far using this novel non-silicon electronic material. Image: IBM

(PhysOrg.com) -- IBM Researchers today announced that they demonstrated the operation of graphene field-effect transistors at GHz frequencies, and achieved the highest frequencies reported so far using this novel non-silicon electronic material.

This accomplishment is an important milestone for the Carbon Electronics for RF Applications (CERA) program sponsored by

DARPA, as part of the effort to develop the next-generation of communication devices.

Graphene is a special form of graphite, consisting of a single layer of carbon atoms packed in honeycomb lattice, similar to an atomic scale chicken wire. Graphene has attracted immense worldwide attention and activities because its unusual electronic properties may eventually lead to vastly faster transistors than any transistors achieved so far.

The work is performed by inter-disciplinary collaboration at IBM T. J. Waston Research Center. "Integrating new materials along with the miniaturization of transistors is the driving force in improving the performance of next generation electronic chips," said IBM researchers involved in this project.

The operation speed of a transistor is determined by the size of the device and the speed at which electrons travel. The size dependence was one of the driving forces to pursue ever-shrinking Si transistors in semiconductor industries. A key advantage of graphene lies in the very high electron speed with which electrons propagate in it, essential for achieving high-speed, high-performance transistors.

Now, IBM scientists have fabricated nanoscale graphene field-effect transistors and demonstrated the operation of graphene transistors at the GHz frequency range. More importantly, the scaling behavior, i.e. the size dependence of the performance of the graphene transistors was established for the first time. The team found that the operation frequency increases with diminishing device dimension and achieved a cut-off frequency of 26 GHz for graphene transistors with a gate length of 150 nm, the highest frequency obtained for graphene so far.

IBM researchers expect that by improving the gate dielectric materials, the performance of these graphene transistors could be further enhanced.

They expect that THz graphene transistors could be achieved in an optimized graphene transistor with a gate length of 50 nanometers. In the next phase, the IBM researchers also plan to pursue RF circuits based on these high-performance transistors.

The report on this work, entitled "Operation of Graphene Transistors at GHz Frequencies" is published today in the journal *Nano Letters* and can be accessed at pubs.acs.org/doi/abs/10.1021/nl803316h.

Provided by IBM