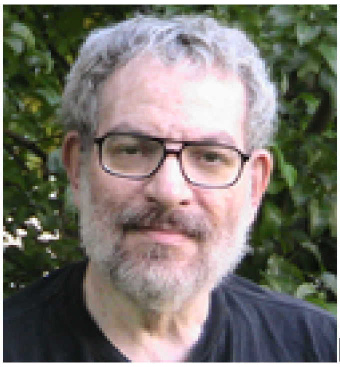
Speeding Things Along

M Simon

IBM has announced a really fast power transistor [1].

> *YORKTOWN HEIGHTS, N.Y., Feb. 5 /PRNewswire-FirstCall/ -- In a just-published paper in the magazine Science, IBM researchers demonstrated a radio-frequency graphene transistor with the highest cut-off frequency achieved so far for any graphene device - 100 billion cycles/second (100 GigaHertz).*

Of course power is a relative thing. At the frequencies involved power is a relative thing. I'd say they would be doing good if they could get between 1 and 10 watts out of the device.

> *Uniform and high-quality graphene wafers were synthesized by thermal decomposition of a silicon carbide (SiC) substrate.Â The graphene transistor itself utilized a metal top-gate architecture and a novel gate insulator stack involving a polymer and a high dielectric constant oxide. The gate length was modest, 240*
> *nanometers, leaving plenty of space for further optimization of its performance by scaling down the gate length.*
>
> *It is noteworthy that the frequency performance of the graphene device already exceeds the cut-off frequency of state-of-the-art silicon transistors of the same gate length (~ 40 GigaHertz).Â Similar performance was obtained from devices based on graphene obtained from natural graphite, proving that high performance can be obtained from graphene of different origins.Â Previously, the team had demonstrated graphene transistors with a cut-off frequency of 26 GigaHertz using graphene flakes extracted from natural graphite.*

So it looks like my earlier article asking why more effort wasn't going into graphene and carbon nanotubes was a little off base. There is work going on. Under my radar.

This announcement follows hard on the heels of another IBM announcement [2] dealing with graphene transistors.

YORKTOWN HEIGHTS, NY - 19 Dec 2008:Â 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.

They seem to be hard at work and getting results.

So who is the taskmaster driving IBM to ever new heights of accomplishment?

An outfit called **CRERA**. Carbon Electronics for RF Applications [3]. And their mandate is? As if that wasn't obvious.Â

The Carbon Elevelop wafer-scale graphene synthesis approaches and ultra-high-speed, low-power graphene-channel field effect transistors for RF/mm-wave circuits. The many desirable material properties of the novel graphene films, including ultra-high mobility, high saturation velocity, high current carrying capability, excellent thermal conductivity, ultra-thin geometry and the potential to integrate with traditional CMOS processes, offer the potential for graphene-based transistors with high promise for high-performance, high-integration-density RF system-on-chip applications. For this reason, the CERA program focuses on developing innovative approaches that enable revolutionary advances in materials science, epitaxial growth, transistor development, and RF
circuit design. Desirable properties of CERA transistors include high mobility, high cutoff frequencies (ft and fmax), high transconductance, low noise, and low voltage operation. In addition, graphene-channel devices also offer low parasitic resistances, excellent electrostatic scaling and high integration potential with silicon CMOS. The CERA program will culminate in a demonstration of high performance W-band (â‰¥ 90 GHz) low noise

> *amplifiers (NF â‰¤ 1dB) making use of graphene transistors on wafers with diameters â‰¥ 8 inches.*

One interesting thing about electrons in graphene is that they behave as if they are massless. Just like photons. And photons as students of Quantum Electrodynamics know are mediators of the electric charge. Now what could you do with knowledge like that?

The forthcoming book (end of April), Physics and Chemistry of Graphene: Graphene to Nanographene [4], might be of some use for those who want a deeper look into graphene. If you can't wait this overview of the field from October of 2009 could be helpful: Graphene and Graphite Materials. [5]

M. Simon is a semi-retired aerospace and commercial electronics engineer. If you could use his help his e-mail address is in the sidebar at IEC Fusion Technology [6].

Links:
[1] http://www-03.ibm.com/press/us/en/pressrelease/29343.wss
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