

Carbon-based logic

M. Simon



[Physics World](#) [1] reports some spectacular advances in turning graphene-based semiconductors into real-world logic chips. Graphene will do some real good for us logic guys because of its carrier mobility. It is over [140 times](#) [2] that of silicon. Plus its heat conductivity is about 10x that of metals like copper and aluminum, and its resistivity is about 2/3rds that of copper at room temperature. It cools better and generates less heat to begin with.

I'm just going to give you the highlights of the Physics World report. Go to the article for the full scope of what this advance means.

First off comes manufacturability. The graphene is grown by CVD. Chemical Vapor Deposition. A common integrated circuit process that is fairly low temperature — with respect to integrated circuits any way. It is also a common process in chip manufacture. A big plus. It extends what is already being done instead of having to deal with something completely new.

Second off, they have raised the voltage gain from a useless for practical purposes of .04x to a relatively hot 5.3x. That means the logic will saturate — gates can be cascaded. Extremely important. In fact more important than CVD. And CVD is very important.

So far there is one big fly in the ointment. The power dissipation is too high. So you will not be seeing graphene-based chips in the next six months. But at the current rate of advance, I'd bet on the next six years.

What does that mean in terms of real-world logic? This hot little [ARM microprocessor development board](#) [3], which sells for under \$15 and runs at 168 MHz peak, will be running at 16.8 GHz peak. Whoa. Talk about a jump to light speed. Light travels about 1.8 centimeters in one cycle at that clock speed, so the chips will have to be small to make them work at speed. Probably under 1 mm on a side maximum. But that is not too much of a limiting factor. Keeping such a chip cool is going to be the big problem because of fCV^2 [4], even if the researchers get the gate power consumption down. Fortunately, the high thermal conductivity and

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low electrical resistance of graphene will help.

M. Simon's e-mail can be found on the sidebar at [Space-Time Productions](#) [5].

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Links:

- [1] <http://physicsworld.com/cws/article/news/2012/aug/06/graphene-logic-for-the-real-world>
- [2] <http://news.softpedia.com/news/Electrons-100-times-Faster-in-Graphene-81534.shtml>
- [3] <http://www.mouser.com/ProductDetail/STMicroelectronics/STM32F4DISCOVERY?qs=sGAEpiMZZMutVogd4PRsvEN8XDBeCtgD>
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