December 19th, 2007, 14:49 GMT · By **Bogdan Botezatu**

Carbon, the New King in the Semiconductor Industry

ENLARGE

Silicon is one of the oldest veterans in the IT industry. It has marched a long way but modern requirements tend to ask for more than it can offer. Just like the transistor, silicone is about to retire, or at least this is what Princeton University researchers say.

The Princeton University engineers have discovered a method that is alleged to substitute the old fashioned silicon with carbon. They say that the team found a way to build transistors on a graphene substrate a few atoms thick. This will bring unimagined benefits to the semiconductor industry, as the method offers switching speeds up to ten times higher than the conventional, silicon substrate.

The main obstacle was getting a wide enough graphene sheet that can be used with modern wafer technology. Initially they could achieve a sheet of couple square millimeters in extreme laboratory conditions while a processor asks for 300 to 500 millimeter layers. The researchers needed to weld more tiny patches to achieve the desired surface and then to overlay them on a traditional silicon substrate wherever logic circuits are required. The final result is a set of graphene tiles paving the substrate.

The process is extremely delicate and involves an enormous amount of work, but "electronic hole" measurements show that carbon circuits can perform ten times faster than silicon. This will have a huge impact on tomorrow's technology, such as cell phones and wireless devices: they will be smaller and will consume less power at an improved performance rate.

The researchers consider that the technology will become truly viable in a few years. Once demonstrated, the technology must be scaled to match larger applications and it is highly likely that entire CPUs can be achieved - units that will be ten times faster at the same power consumption as the ones we are using today.

The full credit for the achievement goes to professor of electrical engineering Stephen Chou and graduate student Xiaogan Liang at Princeton University. As for the funds, the university is financed by the U.S. Department of Energy, as well as other government institutions.

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Comment #1 by: **Rbert Grant** on 26 Dec 2007, 12:01 UTC reply to this comment

Riae of the machines :)
Skip the hybreads and go straight to full processors.
Intell has the alll the resources neded
AMD "will just get you nowhere fast"

Comment #2 by: **Brum the car... beep beep!** on 21 May 2009, 23:13 UTC reply to this comment

Looks like the beginning of some really advanced a.i.. I guess cyborgs would be the intermediary step before all out terminators.

Comment #3 by: **PSA** on 14 May 2012, 07:22 UTC reply to this comment

References
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Silicon (Atomic Number 14) & Germanium (Atomic Number 32) are classified as good semiconductors and used in electronics for creating active components viz diodes, transistors, integrated circuits.

For the Group IV semiconductors such as silicon, germanium, and silicon carbide, the most common dopants are acceptors from Group III or donors from Group V elements. Boron, arsenic, phosphorus, and occasionally gallium are used to dope silicon. Boron is the p-type dopant of choice for silicon integrated circuit production because it diffuses at a rate that makes junction depths easily controllable. Phosphorus is typically used for bulk-doping of silicon wafers, while arsenic is used to diffuse junctions, because it diffuses more slowly than phosphorus and is thus more controllable.

By doping pure silicon with Group V elements such as phosphorus, extra valence electrons are added that become unbonded from individual atoms and allow the compound to be an electrically conductive n-type semiconductor. Doping with Group III elements, which are missing the fourth valence electron, creates "broken bonds" (holes) in the silicon lattice that are free to move. The result is an electrically conductive p-type semiconductor. In this context, a Group V element is said to behave as an electron donor, and a group III element as an acceptor.

According to 2n square rule they have 4 valence electrons in their outermost orbit.

2n Square rule

C - Atomic Number 6 -> 2, 4

Si - Atomic Number 14 -> 2, 8, 4

Ge - Atomic Number 32 -> 2, 8, 18, 4

Gd - Atomic Number 64 -> 2, 8, 18, 32, 4

Uuq - Atomic Number 114 -> 2, 8, 18, 32, 50, 4

As we see Carbon (Atomic Number 6) , Gadolinium (Atomic Number 64)
and Ununquadium (Atomic Number 114) do also have 4 valence electrons in which they can form chemical bonds.

1. Why Carbon , Gadolinium and Ununquadium cannot act as Good Semiconductors though they have 4 valence electrons in their outermost orbit/shell ?.

2. Why these elements though having 4 valence electrons in their outermost orbit/shell cannot be used for doping process with Boron, arsenic, phosphorus, gallium ?.

3.Other than Silicon and Germanium, which other elements
can be used as semiconductors ?

4. As compared to other Semiconductor materials why silicon and germanium are used for manufacturing electronic components viz diode, transistor, integrated circuits ?.

Is it because it is available in abundance and less costly as compared to other semiconductor materials ?

5. Can i use Carbon, Lead, Tin from Group IV element to dope with Group III or Group V to create diodes, transistors and integrated circuits ?

Awaiting your reply,

Thanks & Regards,
Prashant S Akerkar