# The Next Miracle Material

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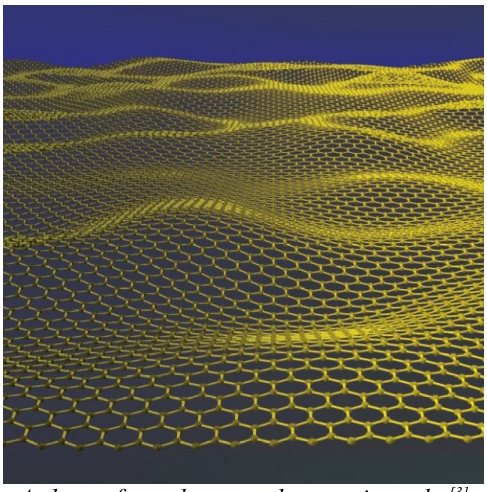
Carbon nanotubes have revolutionized the world of material science since their discovery and production in the 1990's. But now their title as a "miracle material" is being challenged by a sheet-like cousin of sorts: graphene. In fact, graphene has so many advantages, that for all considerable purposes, it can be considered the true miracle material. The only problem, which has thus far remained unsolved, is to somehow mass-produce graphene in a cheap and efficient manner. This is where Mr. H. Famenini comes in. Mr. Famenini has developed a method for the inexpensive production of sheets of graphene on an industrial scale. The machine, which appropriately matches graphene's tendency to surpass expectations, produces continuous sheets of the material at an incredible speed. All the while, it is the size of an ordinary house refrigerator, and creates the graphene sheets in only a few steps. Furthermore, the produced sheets may be plain, or patterned, and the patterned version can come in a variety of patterns (precise to the nanometer scale), which are useful in the production of circuits; in addition, more than one pattern may be deposited on a single sheet of graphene, and multiple patterns may even be electrically and physically joined together. Also, the design of the pattern can be altered or completely replaced by another pattern even while the machine is running; this means that there is no need to halt production to begin printing a different pattern. Finally, the sheets of graphene may be produced on the scale of anywhere from a nanoribbon (with a width so small that the ribbon can only be viewed under a microscope) all the way up to several feet in width.

With several patents currently pending, further information is available at www.canadagraphene.com

So, then, what exactly is this miracle material? Graphene is a single-layer sheet of carbon atoms, just one atom thick, interlocked into a honey-comb shape. It is in this sense essentially a carbon nanotube which has been unrolled - although the production process is not as easy as doing just that. In fact, the only processes by which graphene has been created thus far have produced very limited amounts of the material, and cost a lot of time and money, and proven extremely difficult. However all these efforts have been motivated by the fact that graphene offers incredible utility in a variety of fields, ranging all the way from the medical to the electronic, and everything in between.



*A sheet of graphene on the atomic scale.*[3]

For example, sheets of graphene can be manipulated to act as excellent anti-bacterial agents, while remaining completely harmless to human tissue. But the real effects really begin to shine when it is applied to the engineering sciences. Back in 2008, scientists at Columbia University proved graphene to be the strongest material in the world, due to the incredible power between the carbon bonds. Professor James Hone, who was head of the experiments, exclaimed, “Our research establishes graphene as the strongest material ever measured, some 200 times stronger than structural steel. It would take an elephant, balanced on a pencil, to break through a sheet of graphene the thickness of Saran Wrap.[1] This structural strength alone gives graphene inevitable applications in an almost unlimited number of situations; and yet this is nothing compared to what its electromagnetic properties boast.

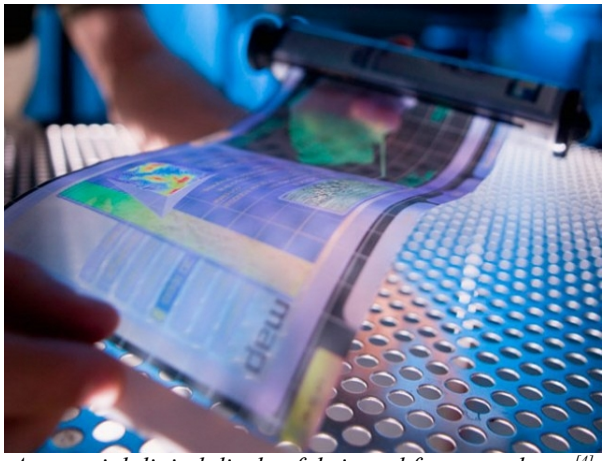
Every Carbon atom in graphene is bonded to three other Carbon atoms, and together they form a honeycomb-shaped sheet. A Carbon atom, however, has room for four bonds, which means in graphene there is an open space in every atom. This is where the superconductivity of the material comes from: the open space allows electrons to move throughout the material without collisions, which results in faster speeds, and less energy wasted. The obvious result of this property is to use graphene in making ballistic transistors, which can operate in the gigahertz (and potentially near terahertz) frequencies, leading to computers which are hundreds of times faster and more powerful; and already IBM has demonstrated this property in transistors operating at the gigahertz frequencies. As a bonus, this transition from the currently used silicone to graphene wouldn't be too

much trouble, as the very same process which creates silicone chips can be applied to the miracle material. And just in case you weren't happy enough with it, graphene transistors, which by the way can be not much larger than a molecule, will be able to work in ambient, room temperature conditions.

While all of these properties have made graphene truly exceptional, its most amazing applications arise when we keep in mind that the material is an incredible one atom thick—and also transparent. This has validated graphene as an excellent contender for transparent touch screens, or crystal-clear flexible displays, and even as an invisible conductor in LCD displays. To add to this, hundreds of sheets of incredibly thin graphene solar cells can be stacked on top of each other to produce a graphene solar panel; thus, a single graphene solar panel would replace hundreds of contemporary solar panels, thereby farther reducing the manufacturing cost as well as the cost per unit of energy generated in a very high-density energy extraction process. It should be mentioned that solar panel technology has been the most-funded alternative energy source this year.[2] The fact that graphene is only an atom thick also renders it an effectively two dimensional object, resulting in a very high surface area to volume or mass ratio, once paired with its incredible conductivity, making it an excellent sensor.

Furthermore, these properties make it an ideal building material for ultra-capacitors. These capacitors would be capable of storing vast amounts of energy in a much smaller size than is currently possible. In addition to this, thin sheets of graphene may also be used to "supercharge" lithium ion batteries, granting them the ability to charge up in incredibly shorter periods of time, or layered together with various other materials to form bendable batteries capable of outperforming their inflexible counterparts.

Although each of these properties and applications will surely make a positive impact on technology and the world in their own way, their whole is truly greater than the sum of the parts. The combination of faster transistors, better displays, performance at room temperature, higher energy efficiency (leading to longer operation between charges), longer-lasting and quicker-to-charge batteries, and solar cell properties allow for cheap laptops and tablets in the developing world, as well as superior mobile phones. In fact, with promises of paper-thin, flexible computers, operating significantly faster than any we have today, graphene is potentially the miracle material which will boost technology and humanity to the next magnificent level.



*A potential digital display fabricated from graphene.[4]*


[1]: http://www.physicscentral.com/explore/action/graphene1.cfm

[2]: http://cleantech.com/about/pressreleases/Global-Clean-Technology-Venture-Investment-Rises-in-1Q-2011.cfm

[3]: http://www.mirc.gatech.edu/raghu/?page_id=172

[4]: http://www.techsmart.co.za/gadgets/gizmos/Graphene_the_miracle_material.html