

Graphene: New Miracle Material

The **strongest substance ever produced by man** promises a revolution in computers, aeronautics, automobiles, and more. ::

BY JEREMY BATTERSBY

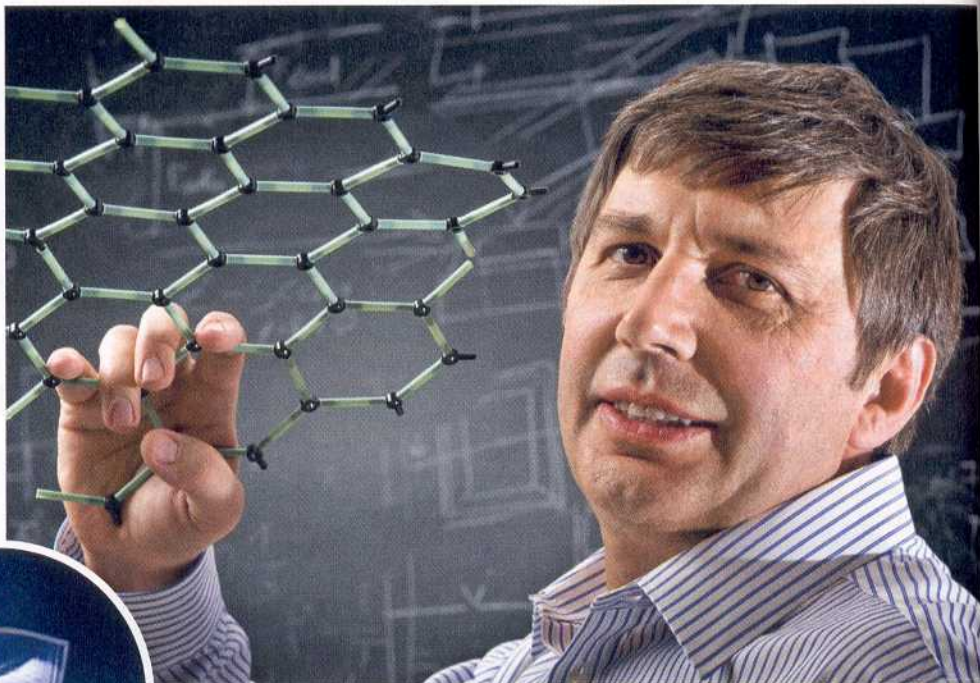
IMAGINE IPADS AS thin as credit cards, cellphones you can roll up like paper, and airplanes that don't weigh much more than their passengers and fuel.

These and many other stunning advances are possible in the near future because of a new material called graphene that is being hailed by research teams in the United States and around the world as the plastic of the 21st century.

Harder than a diamond and more elastic than rubber, it's a carbon lattice that is just one atom thick, and almost transparent. It

sounds flimsy, but it's not. Graphene is the strongest material ever produced by man. "It's 200 times stronger than structural steel," says mechanical engineering professor James Hone of Columbia University. "It would take an elephant, balanced on a pencil, to break through a sheet of graphene the thickness of Saran Wrap."

Graphene has been around for about 10 years, but scientists are just now starting to understand its potential, and it could



MODEL MATERIAL Physicist Andre Geim holds a model of graphene fibers. Inset: Actual piece of graphene, which is almost transparent.

bring a wide-ranging revolution that will likely affect everyone.

Three million sheets of graphene are only one millimeter ($1/25^{\text{th}}$ of an inch) thick, so its use as a component of incredibly strong composite materials could transform air travel and transportation. A new generation of lightweight, superstrong planes and cars could go farther on much less fuel.

Researchers have discovered it's the best conductor of heat and electricity ever known —

1,000 times more efficient than copper.

COMPUTER REVOLUTION

IBM's new graphene transistor is the fastest in the world, nearly four times faster than a conventional silicone equivalent.

In theory, graphene transistors could eventually be hundreds of times faster. And scientists at the University of California at Berkeley have created tiny graphene modulators 10 times faster at transmitting data than ordinary fiber optics.

Engineers at the University of Texas have discovered that by replacing the carbon used in ultra-capacitors with graphene, it's possible to store double the amount of energy.

Northwestern University has found that a specially crafted graphene electrode can allow a lithium-ion battery to store 10 times as much power and charge 10 times faster — and last longer, too. This means graphene makes it possible for a battery to be 10 times smaller than today's, but with the same capacity.

Such a battery is the holy grail of electric car manufacturers.

Graphene could have applications in the war on terror. New York's Rensselaer Polytechnic Institute has shown graphene is 10 times more sensitive when detecting gases from explosive devices than current sensors used by bomb squads.

"The most amazing thing for me about graphene is its strength," Rice University's professor James Tour tells Newsmax.

"This is a sheet one atom thick that you can pick up — it's mind-blowing. And it's so flexible you could theoretically roll up your iPhone and stick it behind your ear like a pencil.

"Another amazing thing about graphene is that you can see it. You can lay a sheet on a white piece of paper and actually see it.

"It is amazingly transparent, absorbing just 2.3 percent of light that lands on it, but if you have a blank sheet to compare it to, you can see that it is there. Meaning you can see a single layer of atoms with your naked eye."

Tour and his team have found a way to synthesize graphene using table sugar.

LIMITLESS RAW MATERIAL

There will never be a shortage of raw material because graphene is made

“It’s so flexible you could theoretically roll up your iPhone and stick it behind your ear like a pencil.”

— James Tour

from carbon, the fourth most abundant element in the universe after hydrogen, helium, and oxygen. “You can make graphene from just about anything,” says Tour. “Plastic waste, grass — anything with carbon in it. So source material for

graphene will never be a problem.”

Theoretically, the process to make graphene should be environmentally friendly.

Tour says the incredible range

of capabilities promised by graphene is so exciting everybody is working on it. “They’ll be using it in fluids needed for oil drilling, for superstrong lightweight composite tanks for hydrogen-fuelled cars, for smart glass with a memory — thanks to invisible graphene wires embedded in the glass. It’s got so much

potential.” Other scientists have predicted that it will be used to produce auto tires that last for the life of a car and superthin lighting that can be stuck to ceilings like wallpaper.

Although its existence was first theorized in 1947, a Soviet-trained scientist, Andre Geim, was the first to isolate graphene in a serendipitous moment in a lab in Manchester, England, in 2003.

The biggest challenge now is producing high-quality graphene on an industrial scale.

“The Koreans are already making and selling plenty of graphene,” adds Tour. The Korean electronics giant Samsung is now producing a touchscreen using the material, although it is not made from a high-quality version of graphene, he says. So far, the largest sheet of graphene produced

is 30 inches square, developed by Korean and Japanese researchers.

U.S. TAKES THE LEAD

But U.S. researchers are at the edge of promising developments that could lead to large-scale economical production of graphene, say experts.

The University of Texas is pioneering a chemical vapor method for creating large pieces of graphene. They heat up methane and hydrogen to 1,040 degrees Celsius and let the chemicals react with a copper sheet, leaving behind a layer of graphene.

At the Massachusetts Institute of Technology, researchers are working on an industrial-scale “printing press” to crank out large sheets of graphene. But this is just the beginning, says its discoverer, Andre Geim. “It doesn’t just have one application. It is not even one material. It is a huge range of materials like plastics.”

Geim and co-researcher professor Konstantin Novoselov were awarded the Nobel Prize in physics in 2010 for their work on graphene. “Carbon, the basis of all known life on earth, has surprised us once again,” said the judges.

Adds Tour: “Really, the possibilities of graphene are limited only by our imagination.” □



TOUR



NOBEL WINNERS Konstantin Novoselov, left, and Andre Geim, center, at Nobel award ceremony in 2010.