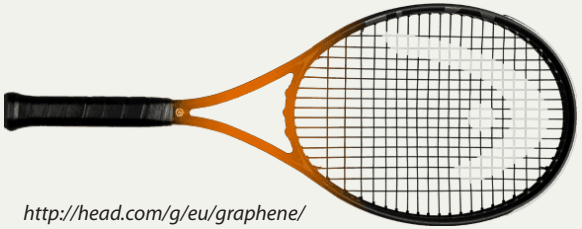
Remember the Graphene Tennis Racket

Head NV has introduced a graphene-infused tennis racket to the market! Because graphene is so strong, yet so light, this new type of racket can be built using significantly less material. This allowed the racket's designer to distribute the weight in the racket differently, making the middle of the racket lighter while concentrating the bulk of the weight in the grip and in the head of the racket. This makes it easier to swing and provides it with more power!



http://head.com/g/eu/graphene/

Nanotubes:

We have talked about graphene as a thin sheet of carbon atoms, but what if you take that sheet and roll it up to make a hollow tube? These little tubes are called "nanotubes" and may be extremely useful in creating computers out of graphene. Dr. Shulaker at Stanford University has designed the first nanotube computer. Unfortunately, it cannot handle a large amount of data, so it will let you play "Minecraft," but only very slowly. Still, it is an exciting first step in building a new type of computer!

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Physics Brochures Series by Sarah Marie Bruno, '16
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GRAPHENE

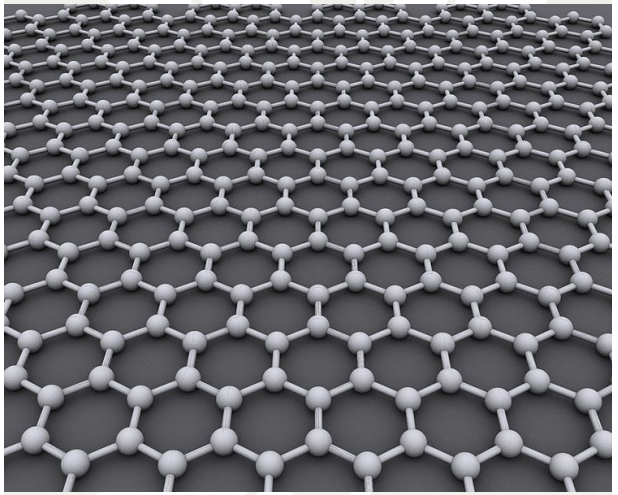


Image credit: Alexander AIUS

HELPING TO FURTHER

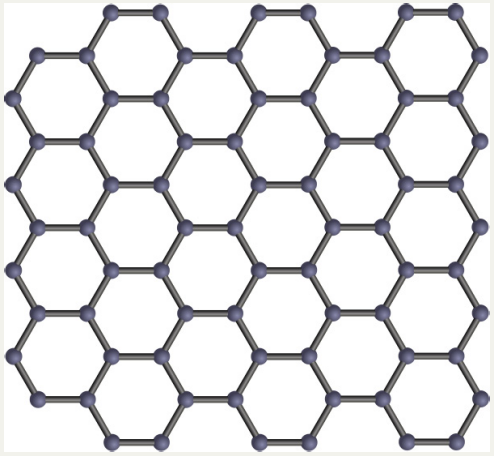
PUBLIC UNDERSTANDING

OF PHYSICS CONCEPTS

Graphene:

What is the thinnest possible layer of something you can imagine? Imagine the thinnest piece of paper you have ever seen. Now imagine slicing it in half, so you have two even thinner sheets. Now in half again. And again. If you continue this process forever, will you ever reach a point when you can no longer slice the paper in half? Yes, once the paper is reduced to a sheet of single atoms, you will, of course, not be able to slice it apart. The paper will be as thin as possible (and will be really hard to see!)

This is how graphene is produced, except using graphite (found in a typical pencil) rather than a piece of paper. Graphene was discovered by two Russian scientists, Andre Geim and Konstantin Novoselov, who used Scotch tape to peel off layers of graphite until they reached the thinnest possible layer. Both scientists were awarded the Nobel Prize in 2010 for this discovery. Graphene is essentially two-dimensional, because it is only one atom thick! It is a flat sheet of carbon atoms linked together, forming a honeycomb structure of hexagons.



The structure of graphene
Image credit: Open Clip Art Library http://openclipart.org/detail/29143.

Originally, scientists assumed that such a thin layer of graphite would be unstable and fall apart. An extremely thin piece of paper, as you could imagine, would easily tear. Why would graphene be any different? Actually, graphene is more than 100 times stronger than steel! Scientists at Columbia University calculated that a sheet of graphene the thickness of Saran Wrap would require an elephant standing on a pencil to poke through it!

Illustration by Matt Collins, from the Scientific American.

Extreme strength is not graphene's only superpower, however; Graphene is also incredibly light and flexible, and conducts heat and electricity better than any other substance! How can this amazing material be used to improve our everyday lives? The possibilities are endless!
Many scientists believe that graphene will replace silicon as the primary material used in electronics. Graphene ink can be used to literally print a circuit onto a surface. Dr. Ferrari at the University of Cambridge made a piano keyboard by printing a circuit of graphene onto a sheet of clear plastic. By tapping invisible keys on the sheet, Ferrari could play musical notes. The clear plastic sheet, of course, is flexible: it can be bent and folded, and still function as a keyboard!

Experiments are currently underway to create circuits that can be printed onto car seats to create heating devices. Scientists also hope to use graphene in solar cells and in flexible touch screens like Ferrari's keyboard. Imagine reading an electronic newspaper with moving graphics and interactive crossword puzzles and then folding it up and putting it in your pocket!

Of course, scientists need to learn more about graphene's properties before such technologies can be produced. At this point, graphene cannot be used in most computer-chip circuitry very well, because it is a little too good at conducting electricity—the electric current in graphene is so strong that it cannot be easily turned off. This is problematic, because computer code is based on a binary system of zeros and ones, where "zero" refers to the current being off and "one" refers to the current being on. Researchers would need to find a way to easily turn on and off the current in graphene before it can be used in this type of circuitry.

Still, researchers are finding plenty of applications for graphene. It has been used to improve a type of microscope called the "transmission electron microscope," which uses a beam of electrons to form an image. Apple will use graphene to create heat dissipators in mobile phones. Because the material is extremely sensitive to its environment, it can also be used to create sensors that detect certain chemicals. Other uses of graphene include technology for de-icing airplane wings, filtering the salt out of seawater, assisting in DNA sequencing, and creating rust-resistant coatings.