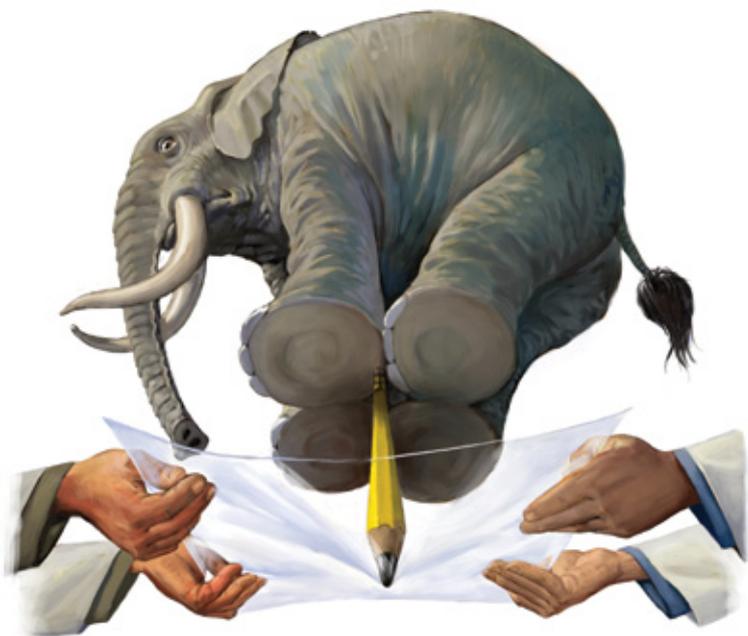


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## Balancing Act

A statement about a material raises heavy issues

**The tweet**, posted on September 1, 2011, by @qikipedia, read in its entirety: “It would take an elephant, balanced on a pencil to break through a sheet of graphene the thickness of cling film.” Some detective work revealed that the statement originated with mechanical engineering professor James Hone of Columbia University, who said in 2008, “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.”

The professor’s contention raises numerous questions, the first one being “What is graphene?” Microsoft Word doesn’t know—it keeps giving graphene the red squiggly underline, which means, “Surely you mean grapheme.” (I surely don’t, despite the fact that I’m littering this page with graphemes.)

Fortunately, the Wikipedia entry on graphene includes this definition from a paper by Andre Geim and Konstantin Novoselov, who won the 2010 Nobel Prize in Physics for their work on the miracle substance: “Graphene is a [sic] flat monolayer of carbon atoms tightly packed into a two-dimensional (2D) honeycomb lattice, and is a basic building block for graphitic materials of all other dimensionalities. It can be wrapped up into 0D fullerenes, rolled into 1D nanotubes or stacked into 3D graphite.” Picture chicken wire, but with each connection point being a carbon atom. The result of that mental metamorphosis is graphene. (Well, virtual graphene.)

Professor Hone has better things to do—such as figuring out

how to layer enough sheets of graphene together to get it to be the thickness of Saran Wrap—than to deal with the rest of my questions. So I leave them to you, gentle reader. And away we go.

Is the pencil vertical or horizontal? Let’s assume vertical, so that the entire weight of the elephant is concentrated at a single point on the graphene. Other than for writing on a wall, a horizontal pencil is useless in most cases, including pencil cases.

What is the pencil made of? You can’t expect a regular old pencil to carry the weight of an elephant. The obvious answer is graphene, rolled into a massive nanotube. (Massive for a nanotube, regular size for a pencil.) The manufacturer could include a thin cylinder of graphite within the roll of graphene so that the pencil could actually be used to write, but that strikes me as pedantic. (Then again, if it can’t write, is it really a pencil? Perhaps not. I’ve been told that I can’t write, and I’m certainly not a pencil.)

Anyway, we have the graphene Saran Wrap and the graphene pencil. The next question is, How do you get the elephant onto the pencil? Wait a second, back up. Is it an African elephant, weighing in at, say, 15,000 pounds, or is it the more diminutive Asian elephant, tipping the scales at a more manageable 10,000 pounds?

The two creatures also have vastly different temperaments. You might get away with this stunt using an Asian elephant, but I’d stay away from trying to get an African elephant onto a pencil, especially a bull African elephant. He might not be able to break the graphene pencil, but he’ll almost certainly destroy the lab in his zeal to avoid being balanced on it.

Come to think of it, there’s a lot we don’t know about the elephant. Is it a full-grown elephant or a baby elephant? A baby Asian elephant is going to be the easiest choice to get onto the pencil. As it approaches the graphene, do the researchers play Henry Mancini’s “Baby Elephant Walk”? If not, why not? These opportunities don’t come along every day.

Will the weight of the baby elephant concentrated at the tip of the pencil be enough to pierce the graphene? If it was going to require the weight of an adult African elephant balanced on the pencil, I doubt the baby elephant, at about 230 pounds, has enough heft. So if you put the full weight of our adorable little elephant onto the superstrong nanotube pencil, I have to figure that, although the Saran Wrap might hold, the elephant won’t. The pencil will puncture the poor baby’s hide and get swallowed up. Now you have a wounded baby Asian elephant bleeding all over your graphene, a mother elephant going out of her mind and a protest by People for the Ethical Treatment of Animals.

Ultimately we’ll have to go with a full-grown Asian elephant, itself necessarily encased in a protective layer of graphene, situated above the graphene sheet, balanced on a graphene pencil. And unlike this entire column, it can’t be missing the point. ■

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