Bulletproof graphene makes ultra-strong body armour

- 19:00 27 November 2014 by Rebecca Boyle
- For similar stories, visit the Weapons Technology Topic Guide

<img height="1" width="1" border="0" alt="" style="display:none"
src="https://www.facebook.com/tr?id=283888028440926&ev=NoScript">



All-over protection from a single atom *(Image: Sipa USA/REX)*

Layers of carbon one-atom thick can absorb blows that would punch through steel. Recent tests suggest that pure graphene performs twice as well as the fabric currently used in bulletproof vests, making it an ideal armour for soldiers and police.

Graphene is a sheet of single carbon atoms bonded together in a honeycomb shape. Because it is an excellent conductor of heat and electricity, graphene is already used in computers and electronics. But it's also incredibly strong for its slight weight, potentially making it an ideal material for body armour.

However, it's tricky to fire high-speed shots through such a thin material to test its toughness because atom-thick material is completely destroyed by such an impact. Previous work used nano-pokers to push into graphene at walking speed (less than 1 meter per second), or a shotgun approach using several laser pulses. But these methods couldn't provide evidence of graphene's real strength in the face of a high-speed projectile, says Jae-Hwang Lee at the University of Massachusetts-Amherst.

Lee and colleagues devised a new miniature ballistics test to test graphene's mettle. They used a laser pulse to superheat gold filaments until they vaporised, acting like gunpowder to fire a micrometre-size glass bullet into 10 to 100 sheets of graphene at 3 kilometres per second – about three times the speed of a bullet fired from an M16 rifle.

The team found that graphene sheets dissipate this kinetic energy by stretching into a cone shape at the bullet's impact point, and then by cracking outward radially. The cracks are one weakness of single-layer graphene, Lee says, but it nevertheless performs twice as well as Kevlar and withstands 10 times the kinetic energy that steel can. Using multiple layers of graphene or incorporating it into a composite structure could keep the cracks from spreading, too.

<a
href="http://ad.doubleclick.net/N6831/jump/NewScientist/ns_section_tech;key=tech+dn26626+nologin+News+graphene+physics+materials-science+strength+science+weapons;tile=7;sz=450x250;ord=1234567890?">

Researchers have been studying graphene as armour for some time, but Lee's is the first paper to describe just how the material absorbs kinetic energy. Sound waves travel three times faster through graphene than they do through steel, which means material far beyond the impact point can quickly absorb and dissipate its energy – effectively slowing the projectile down and helping prevent its penetration. What's more, the microbullet methods Lee developed could be used to study other high-performance materials in extreme conditions.

Journal reference: *Science*, DOI: 10.1126/science.1258544

Correction, 1 December 2014: *When this article was first published, it misstated the comparison of the experimental projectile speed with that of a an M16 rifle.*