PHYS.ORG

Ultra-intense laser blast creates true 'black metal'

November 21 2006

"Black gold" is not just an expression anymore. Scientists at the University of Rochester have created a way to change the properties of almost any metal to render it, literally, black. The process, using an incredibly intense burst of laser light, holds the promise of making everything from fuel cells to a space telescope's detectors more efficient--not to mention turning your car into the blackest black around.

"We've been surprised by the number of possible applications for this," says Chunlei Guo, assistant professor of optics at the University of Rochester. "We wanted to see what would happen to a metal's properties under different laser conditions and we stumbled on this way to completely alter the reflective properties of metals."

The key to creating black metal is an ultra-brief, ultra-intense beam of light called a femtosecond laser pulse. The laser burst lasts only a few quadrillionths of a second. To get a grasp of that kind of speed--a femtosecond is to a second what a second is to about 32 million years.

During its brief burst, Guo's laser unleashes as much power as the entire grid of North America onto a spot the size of a needle point. That intense blast forces the surface of the metal to form and nanostructures--pits, globules, and strands that both dramatically increase the area of the surface and capture radiation. Some larger structures also form in subsequent blasts.

Guo's research team has tested the absorption capabilities for the black metal and confirmed that it can absorb virtually all the light that fall on it, making it pitch black.

Other similar attempts have turned silicon black, but those use a gas to produce chemically etched microstructures. Regular silicon already absorbs most of the visible light that falls on it, so the etching technique only offers about a 30 percent improvement, whereas regular metals absorb only a few percent of visible light before Guo hits them with the laser.

The huge increase in light absorption enabled by Guo's femtosecond laser processing means nearly any metal becomes extremely useful anytime radiation gathering is needed. For instance, detectors of all kinds, from space probes to light meters, could capture far more data than an ordinary metal-based detector could.

And turning a metal black without paint, scoring, or burning could easily lead to everyday uses such as replacing black paint on automobile trim, or presenting your spouse with a jet-black engagement ring.

Guo is also quick to point out that the nanostructures' remarkable increase in a metal's surface area is a perfect way to catalyze chemical reactions. Along with one of his research group members, postdoctoral student Anatoliy Vorobyev, he hopes to learn how the metal can help derive more energy from fuel cell reactions. The new process has worked on every metal Guo has tried, and since it's a property of the metal itself, there's no worry of the black wearing off.

Currently, the process is slow. To alter a strip of metal the size of your little finger easily takes 30 minutes or more, but Guo is looking at how different burst lengths, different wavelengths, and different intensities affect metal's properties. Fortunately, despite the incredible intensity involved, the femtosecond laser can be powered by a simple wall outlet, meaning that when the process is refined, implementing it should be relatively simple.

Despite the "wall outlet" ease of the use and the stay-cool metal, don't expect to see home-blackening kits anytime soon. "If you got your hand in the way of the focused laser beam, even though it's only firing for a few femtoseconds, it would drill a hole through your skin," says Guo. "I wouldn't recommend trying that."

Source: University of Rochester

Citation: Ultra-intense laser blast creates true 'black metal' (2006, November 21) retrieved 19 April 2024 from https://phys.org/news/2006-11-ultra-intense-laser-blast-true-black.html