A girl's toughest friend?

Diamonds

Scientists use lasers to put mineral to stringent pressure test

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We've all heard that diamonds can cut through glass, but now scientists have found Earth's hardest solid can withstand pressures just over a million atmospheres before getting crushed.

For comparison, the pressure at the center of Earth is about 3.5 million atmospheres, according to the researchers. One atmosphere is the natural pressure of air at sea-level. And the human body can withstand about 27 atmospheres, if it's applied gradually, according to the U.S. Department of Energy.

The results, which were published Jan. 22 in the journal Physical Review B, could help scientists understand diamond formation and how pressure affects diamonds used in high-pressure experiments.

Here's how they put the tough mineral to the test:

A team led by Stewart McWilliams of Lawrence Livermore National Laboratory (LLNL) in California shot a large laser at a tiny diamond, just about a hundredth of a carat (one carat equals about 200 mg). The lasers put out more than a couple hundred Joules of energy in just a couple nanoseconds (billionths of a second).

Bottom line: "It's a whole lot more energy than what an ordinary tabletop laser would give," said study researcher Jon Eggert, an LLNL physicist.

Essentially, the laser heated up the surface of the diamond, creating plasma, or hot charged particles, that blasted like a jet toward the laser. The result created a pressure pulse, or shock wave, back into the diamond.

The team measured the pressure of this shock wave as it traveled through the diamond, with resulting pressures ranging from 1 million to 10 million atmospheres.

The diamonds could withstand just over 1 million atmospheres. "Once you go beyond that the diamond basically breaks up and fails," Eggert told LiveScience. "It's like stretching a rubber band beyond its elastic limit."

After this "elastic failure," meaning the diamond doesn't snap back into shape even after the force gets removed, the tiny diamonds were crushed. Then, as the pressure increased further to 10 million atmospheres, the diamond melted.

The research could help scientists to understand how diamonds are made. "It could also provide insights into the ancient history of natural diamonds found on Earth and in meteorites, where shock waves caused by impact are common," McWilliams said.

Most natural diamonds form under high-pressure, high-temperature conditions that exist some 87 to 120 miles (140 to 193 km) beneath Earth's surface. They grow over long periods from 1 billion to 3.3 billion years. For comparison, Earth is estimated to be about 4.5 billion years old.

In addition, Eggert says scientists use diamonds to apply extreme pressures to materials. And so understanding how diamonds respond to such pressures is important for interpreting the experiment results.