

Synthetic superdiamonds beat nature's best

When asked how much money is enough, Nelson Rockefeller reportedly replied: "A little bit more." Scientists feel much the same about the unparalleled properties of diamond.

Last week, a research team announced it had made synthetic diamonds that conduct heat 50 percent more efficiently and can withstand 10 times more laser energy than the best natural diamonds, the previous world champions at these material skills.

"This is a whole new material that hopefully will enable technologies that we haven't even thought of yet," says William F. Banholzer, a chemical engineer who heads the diamond-making team at the General Electric Research and Development Center in Schenectady, N.Y. The group harvested its first carat-sized superdiamonds in 1988, and has since measured some of the gems' properties with scientists at Wayne State University in Detroit. They describe their findings in the July 15 *PHYSICAL REVIEW B - CONDENSED MATTER*.

The synthetic diamond's heat-dissipating power makes it attractive for heat sinks that keep electronic components from overheating on chips — a critical safeguard in hard-to-reach places such as satellites. In addition, the ability to withstand more radiation than any other transparent material could make the superdiamond ideal for mirrors and other components crucial to laser weaponry or laser-based machining of, say, tough superalloys.

The key to improving on nature's own gems emerged nearly 50 years ago when a Soviet physicist argued that material properties such as thermal conductivity depend on a crystal's isotopic composition. Elements come in several isotopes, or chemically identical forms having the same number of protons but different numbers of neutrons. Natural diamond — the coveted all-carbon crystal — contains about one carbon-13 atom for every 110 carbon-12 atoms.

Theoreticians had calculated that diamond would conduct heat better if it were made entirely of one carbon isotope. The different mass of the minority isotope dampens the heat-carrying "vibrations," or phonons, that course through a crystal lattice. An isotope-independent process in which phonons scatter off of each other also theoretically degrades heat transmission.

The GE researchers followed up on these tantalizing ideas by combining one old and one newer diamond-making technique to produce carat-sized diamonds with unnaturally low amounts of carbon-13. The gems' unexpectedly enhanced abilities to transmit heat and withstand more radiation than the best natural diamond reveal gaps in the ear-

lier theories, Banholzer notes. To account for the record-breaking properties, other GE scientists are developing a theory in which both types of phonon scattering depend on isotopic composition.

To make the gems, the researchers first use a low-pressure technique, called chemical vapor deposition (CVD), that rearranges the carbon atoms of methane gas molecules into diamond films. By using isotopically purified methane, the scientists produce enough starting material for the second process, marked by temperatures over 2,500°F and pressures nearing 1 million pounds per square inch. In the presence of a metal catalyst, such as nickel, and a diamond seed crystal, the CVD material dissolves into the catalyst and recrystallizes into gem-quality diamonds as big as pencil erasers. "By making isotopically pure diamond, some-



Carat-sized synthetic diamond.

GE Research and Development Center

thing we never could do before, we have a product that is better than you can take out of the ground," says Banholzer.

"It's absolutely fascinating," comments Michael Pinneo, chief scientist at Crystallume, a diamond-film manufacturer in Menlo Park, Calif. Though the diamonds may help reveal how energy moves within crystals, their cost could keep them from finding a big market, he and others say. GE nonetheless predicts a multimillion-dollar market. — I. Amato

PMS study pans popular prescription

Many women suffering the emotional and physical anguish of premenstrual syndrome (PMS) look to the hormonal drug progesterone for relief. But according to the first large-scale test of progesterone's effectiveness in PMS, they might just as well take a placebo.

In a group of 168 PMS-afflicted women, placebo vaginal suppositories relieved PMS symptoms at least as well as suppositories containing progesterone, reports an interdisciplinary team of researchers from the University of Pennsylvania and Hahnemann University in Philadelphia.

"This is the first study that has a large enough sample size and the statistical power to say with certainty that the progesterone treatment is useless, that you can save the money and try other therapy," asserts coauthor Karl Rickels, a psychiatrist at the University of Pennsylvania.

Among U.S. women of childbearing age, as many as 10 percent suffer from PMS, Rickels says. PMS typically flares up only during the last week of the menstrual cycle, with symptoms severe enough to interfere markedly with daily routines. Symptoms may include depression, anger, sudden bouts of tearfulness, food cravings and headaches, among others. Though the cause remains unknown, physicians widely prescribe progesterone on the hypothesis that PMS stems from an abnormally high ratio of estrogen to progesterone late in the menstrual cycle.

Each woman in the Philadelphia study received either placebo or progesterone vaginal suppositories on days 16 through 28 of the menstrual cycle. Neither the women nor the researchers

knew which treatment went to whom. During the next menstrual cycle, patients received double doses of their respective treatments. The two groups then switched treatments and repeated the two-month regimen.

Overall, patients did show some improvement during the first two months of the study, but the researchers found essentially no difference between the groups, regardless of dose. Women who then switched from placebo to progesterone actually experienced a worsening of symptoms, while the new placebo recipients showed no change, the team reports in the July 18 *JOURNAL OF THE AMERICAN MEDICAL ASSOCIATION*.

"The study is solid, but that's not saying we might not in some cases find women for whom progesterone or its derivatives might work. But certainly not in the broad category. If it works, I don't know why it works," comments Florence P. Haseltine, a reproductive endocrinologist at the National Institutes of Health.

Pharmacist David Myers remains a progesterone proponent. "We have patients who have been on progesterone for 10 years who have had too dramatic a change in their life to call it a placebo effect. No one can tell me that a placebo effect can last 10 years," he says. Myers is vice president of Madison (Wis.) Pharmacy Associates, Inc., which specializes in PMS treatment.

Rickels says he suspects "there is a much larger emotional than physical component behind PMS symptoms." He and others are now conducting preliminary studies using antidepressants and appetite suppressants to treat the monthly menace. — W. Stolzenburg