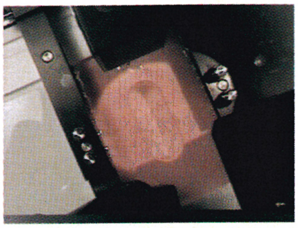
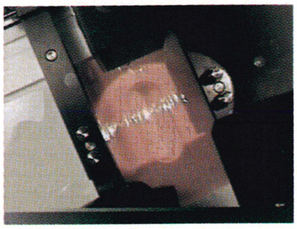
A REVERSIBLE INSULATOR–METAL TRANSITION has been created, at room temperature and pressure, in a quantum dot monolayer. University of California researchers, led by James Heath of UCLA, prepared a Langmuir film—a single layer of nearly identically sized silver nanocrystals, or quantum dots. Each silver dot was coated with compressible organic molecules, which allowed the dots to interact via attractive dispersion forces. By increasing the surface pressure on the film, the particles were brought closer together. In a typical experiment, 2.7 nm quantum dots start out 1.2 nm apart from each other (top figure), at which distance the film is an insulator and the dots are classically coupled, transferring energy by mutually inducing charge polarization across the intervening dielectric. As the separation between nanocrystals decreased below 1.0 nm, the researchers observed changes in the optical properties, signaling a transition to quantum coupling, in which the nanocrystals' electron clouds overlapped. Below 0.5 nm separation, a sharp transition to a metallic-like film was observed (bottom figure). All changes are reversible. This work is part of a large effort to create new materials with "tunable" chemical properties. (C. P. Collier *et al.*, *Science* **277**, 1978, 1997.) —BPS





TURNING ONIONS INTO DIAMONDS. Graphite material can be made into diamond the hard way, using very high pressure (above 10 GPa) and temperature (typically above 1600 K), and requiring catalysts to produce good yields. Now, significant yields of nanodiamonds have been nucleated and grown by irradiating carbon "onions" (nested shells of graphite) with ion beams. Florian Banhart's and Heinz-Dieter Carstanjen's groups at the Max Planck Institute for Metals Research, in Stuttgart, used a beam of 3 MeV neon ions to pelt the onions for 30 hours; the process created vacancies and interstitials in the graphite through knock-on collisions with the carbon nuclei. Diamonds nucleated in the regions of high curvature at the cores of the onions, which acted like miniature pressure cells. After nucleation, the diamonds grew without the need of high pressure. Electron beams were previously used, but with diamond yields that were smaller by a factor of 10^5–10^6. With an accelerator capable of higher ion currents than theirs, the researchers believe that macroscopic amounts of irradiation-induced diamond can be produced. Because no catalysts are needed, the diamonds are very pure. (P. Wesolowski *et al.*, *Appl. Phys. Lett.* **71**, 1948, 1997; M. Zaiser, F. Banhart, *Phys. Rev. Lett.* **79**, 3680, 1997.) —PFS

A NEW WAY TO CALCULATE nuclear magnetic resonance (NMR) spectra can be used for real materials. NMR is well known as an imaging technique, but it is also a valuable spectroscopic tool for deducing the chemical, electronic and geometric structures around nuclei in different environments. The spectrum of an atom's nuclear magnetic states depends on the local geometry, just as an atom's electron spectrum changes if the atom is suddenly lodged in a crystal. Previously, NMR calculations could produce spectra only for isolated atoms or clusters. Now, Steven Louie and his collaborators at the University of California, Berkeley, have devised a method for dealing with divergent terms, making possible rigorous calculations of NMR spectra of extended systems such as crystals, liquids, polymers or even amorphous or biological materials. They have now used their technique on an industrially important material—synthetic diamond films. Their theoretical NMR spectra for various carbon configurations are in very good agreement with the observed spectra, leading them to a microscopic, physical interpretation of otherwise obtuse experimental data. (F. Mauri, B. G. Pfrommer, S. G. Louie, *Phys. Rev. Lett.* **79**, 2340, 1997.) —PFS

A PHOTOREFRACTIVE (PR) POLYMER with a large optical gain has been demonstrated by researchers at the University of California, San Diego. In a PR material, an incident light beam redistributes electrons or holes so as to produce a spatially varying index of refraction. Inorganic PR crystals have been known for decades and can have an optical gain (characterizing the energy transferred from one beam to another) of 10^4–10^5, but they are expensive and difficult to make. Until now, organic PR polymers at best have just balanced optical gains against losses. The new material is multilayered; each layer blends buckyballs (which offer holes), poly(*n*-vinyl carbazole) molecules (which carry the holes along their backbone) and PDCST molecules (which form an asymmetric potential for electron motion and thereby make the refractive index electric field-dependent). The effect of the layers was cumulative. The researchers demonstrated an optical gain of about 400%; this can open the door for inexpensive and easily made devices, such as "optical transistors" that can amplify or attenuate a light beam. Self-oscillation based on this PR gain was also observed—for the first time in an organic material. (A. Grunnet-Jepsen, C. L. Thompson, W. E. Moerner, *Science* **277**, 549, 1997.) —BPS