Physics Update

Unusual magnetism in a carbon foam. First synthesized a few years ago by a collaboration of researchers from Greece, Australia, and Russia, carbon nanofoam consists of carbon clusters that are, on average, 6 nm across and randomly interconnected into a weblike foam that is extremely lightweight (2–20 mg/cm^3). In addition, it is a semiconductor. Now, the same collaboration has uncovered unconventional magnetic properties in its ethereal carbon froth. For starters, freshly produced carbon nanofoam is ferromagnetic: It is strongly attracted to a permanent magnet at room temperature. Next, the room-temperature ferromagnetic behavior decays after a few hours, but a weak remanent magnetic equilibrium is reached after several weeks and persists at cryogenic temperatures. The researchers suggest that the ferromagnetism arises from the separation of nanometer-scale conducting regions by regions of a different electronic structure. They also suggest that products with similarly unusual properties might be synthesized from different starting materials. A possible application of carbon nanofoam is in biomedicine, where tiny ferromagnetic clusters injected into blood vessels might improve magnetic resonance imaging. (A. V. Rode et al., http://arXiv.org/abs/cond-mat/0310751.) —BPS

Unambiguous identification of three copper isomers has been achieved in a radioactive-beam experiment at CERN. Isomers are excited states of a specific nucleus (they differ slightly in their masses)—not to be confused with isotopes, which are nuclei having the same number of protons but different numbers of neutrons. Isomers relax through the emission of gamma rays or by alpha or beta decay. Almost half of all known nuclei have isomers, whose half-lives range from nanoseconds to beyond the age of the universe. At the ISOLDE (On-Line Isotope Mass Separator) facility, the researchers created the exotic nuclide copper-70 by bombarding a thick target with energetic protons. Different isomers were selected using mass spectrometry and then captured and contained in a Penning trap, where the ions zipped around in looping trajectories. An isomer's mass could then be deduced from its orbital period (the cyclotron frequency). The new observations have cleared up some mysteries about specific assignments of spin and mass in the isomers of ^{70}Cu. Furthermore, because ^{70}Cu has 41 neutrons, the results are an important step toward understanding the complex structure of nuclei with a closed subshell of 40 neutrons. (J. Van Roosbroeck et al., *Phys. Rev. Lett.* **92**, 112501, 2004.) —PFS

Tunable surfaces. In a new experiment, a liquid drop was maneuvered around a specially treated silicon wafer patterned with an etched forest of tiny stalks. The blades of this "nanograss" could be selectively electrified. At low applied voltage, the drop was spherical (as in the photo below) and highly mobile, able to be guided by moving the voltage. At higher voltage, the drop was impaled on the posts and immobilized, and at still higher voltage, it completely infiltrated the stalks and wetted the entire substrate. The so-called electrowetting technique has been used since the 1980s to adjust

the energy of liquid–solid interfaces, but this experiment, conducted at Lucent Technologies' Bell Labs, showed remarkable abrupt transitions from superhydrophobic to hydrophilic behavior. At the March meeting of the American Physical Society in Montreal, Tom Krupenkin, who led the group, said that such tunable behavior could have many potential applications. For example, a liquid could absorb heat from the hottest spots on a microchip and then rapidly carry that heat away. Optical properties of a surface could be switched from one state to another through electronically controlled wetting. Microfluidic devices and microbatteries might also make use of the technique. (T. N. Krupenkin et al., *Langmuir*, in press.) —PFS

Multilevel molecular memory. In memory cells, a bit of information is either a zero or a one. One way to cram more data into a fixed region on a data-storage device is to store more than one bit in each memory cell. The current record holder is silicon flash memory, with two bits per cell; going beyond that is difficult due to device compexities. Now, a team led by Chongwu Zhou (University of Southern California) has used self-assembled molecular electronics to build working three-bit memory cells. In a nanowire transistor, they coated the 10-nm $\times$ 2-μm wire with certain molecules and manipulated parcels of charge placed in the molecules. The resulting memory cell had three different controllable bit states, with a total of 8 (2^3) distinct levels. The multilevel molecular memory unit charges or discharges the molecules into different chemically reduced or oxidized (redox) states. The stored information is read out by sampling the resistance of the underlying nanowire: The attached redox molecules act like chemical gates for controlling the number of electrons in the wire. Data written this way have survived for as long as 600 hours, a new record for molecular memory, and are easily erased. The researchers suggest that data densities as high as 40 $Gbits/cm^2$ are possible. (C. Li et al., *Appl. Phys. Lett.* **84**, 1949, 2004.) —PFS