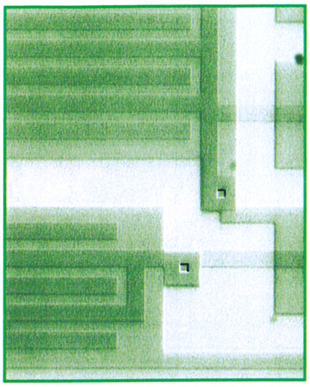
Physics Update

A HIGH-PERFORMANCE ALL-POLYMER integrated circuit (IC) has been developed. Scientists at the Philips Research Laboratories in The Netherlands have turned production of polymer transistors on its head. Previously, the group had sandwiched the organic semiconducting material between the conducting polymers used for the first electrode and the gate, but that arrangement proved to be difficult to fabricate and optimize. Now, Gerwin Gelinck and his colleagues have produced an IC with the gate on the bottom, followed by an insulating layer, then by the source and drain electrode layer. In the figure, the two tiny squares are vertical interconnects (vias), 5 μm on a side, and the structure is poised to receive the top layer of semiconductor. In this geometry, the researchers can streamline the processing, photochemically pattern the vias, and virtually eliminate material compatibility problems. They have built a working IC that combines more than 300 transistors and 200 vias. Although not yet as fast as silicon circuits, polymer components have the virtues of being lightweight, flexible, and potentially easier to fabricate. (G. H. Gelinck, T. C. T. Geuns, D. M. de Leeuw, *Appl. Phys. Lett.* **77**, 1487, 2000.) —PFS



SINGLE-MOLECULE CHEMISTRY with a scanning tunneling microscope (STM). Normally, one produces biphenyl ($C_{12}H_{10}$) molecules from iodobenzene (C_6H_5I) molecules with a copper catalyst, using thermal activation at about 200 K. But now, Saw-Wai Hla and his colleagues at the Free University of Berlin have used an STM at 20 K to manipulate single molecules through every stage of the complete chemical reaction. They started with several C_6H_5I molecules nestled at a step on a terraced copper substrate. They then dissociated some of the molecules into iodine and phenyl (C_6H_5) by injecting electrons from the STM tip. Next, they used the STM tip to move the iodine atoms away from the step, and then to bring two phenyl molecules next to each other. The phenyls could still be independently manipulated, and thus were not yet chemically bound. In the final step, another splash of electrons from the tip effectively welded the two phenyls together; when one was now pulled with the tip, the other came along for the ride. The researchers believe that more complex chemical reactions can be studied on the atomic scale with these techniques, and that new molecules, never before seen in nature, can be engineered in this way, perhaps for molecule-based nanodevices. (S.-W. Hla *et al.*, *Phys. Rev. Lett.* **85**, 2777, 2000.) —PFS

BIOLOGICAL APPLICATIONS of atomic force microscopy are now on firmer ground. For many AFM applications, the microscope's cantilever is assumed to behave like an ideal, massless, and frictionless spring as it bobs up and down over the individual atoms or molecules being studied. Biological samples, however, are usually found in a wet environment. There, hydrodynamic forces make the instrument behave differently than it would in air, especially at the relatively high frequencies of oscillation used for the so-called tapping mode of operation. Models exist for describing the different behavior, but those models have not been verified—until now. Researchers at the University of Tübingen in Germany have devised a method to apply a point force to cantilevers, and have calibrated not only the amplitudes of oscillation, but also the phases, while operating at frequencies up to at least 70 kHz in either liquid or air. The deviations that they found in their experiments agreed with the models. The work is part of a larger effort to study the high-frequency electromechanical properties of the hair cells in the inner ear. (M. P. Scherer, G. Frank, A. W. Gummer, *J. Appl. Phys.* **88**, 2912, 2000.) —SGB

FISSIONING ELECTRONS? No physics experiment has ever suggested that the electron is anything but an indivisible particle. But now, physicist Humphrey Maris (Brown University and Ecole Normale Supérieure, Paris) has asked, What happens if a single particle's wavefunction becomes confined in two separated regions of space? He contends that quantum mechanics makes no clear prediction for this situation. Maris analyzed a particular experimental situation, known for more than 30 years: An electron injected into liquid helium quickly comes to a halt and, in its ground state (1s), excludes helium atoms from a small region around it, forming an "electron bubble." If one then optically excites the electron into the 1p state, the extra energy will cause the bubble to oscillate. Furthermore, says Maris, because the electron's wavefunction now has a node at the center, the oscillating bubble can fission into two smaller bubbles, each in its own ground state with half of the original electron's wavefunction. In such a scenario, one would detect fragments of the original electron. He calls these partial electron bubbles "electrinos," and says that this hypothesis can account for several unexplained observations made over the past few decades, including anomalous conductivities and exotic ions seen in liquid helium containing electron bubbles. Maris suggests that his ideas on electrino bubbles can be tested using optical techniques. (H. J. Maris, *J. Low Temp. Phys.* **120**, 173, 2000. For more on bubbles in helium, see "Negative Pressures and Cavitation in Liquid Helium," by Maris and Sebastien Balibar, PHYSICS TODAY, February 2000, page 29.) —BPS

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