

Making Connections in Molecular Electronics

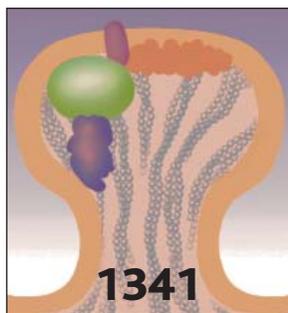
Potential device applications for silicon nanowires and carbon nanotubes will require improvements in manipulating and connecting individual components, as illustrated by two reports (see the news story by **Service**). One type of assembly is the crossbar array, in which inputs along one set of wires affect the output state along a connected set of wires in the normal direction. This approach requires methods to modify the interaction between wires so that each horizontal wire affects only one vertical wire. **Zhong et al.** (p. 1377) show that by chemically treating the junction points of an array of silicon nanowires with tetramethyl ammonium chloride, they can lower the threshold voltage of the depletion mode from 5 to 1.5 volts. They show selective addressing of wires in a small 2-by-2 array. **Keren et al.** (p. 1380) present results of a DNA-assisted templating method to fabricate a carbon-nanotube field-effect transistor that operates at room temperature. The pseudo-self-assembly technique utilizes the molecular recognition between biological substrates and the biologically tagged nanotubes to localize their position. The nanotube is then wired up with interconnects using a solution-based metal plating process.

Bake, Then Shake

Phase transformations can occur on picosecond time scales, and the mechanisms by which individual atoms rearrange are only now beginning to be probed. **Siwick et al.** (p. 1382; see the cover and the Perspective by **von der Linde**) studied the real time melting of aluminum with ultrafast laser pulses. After the energy was absorbed by the sample, the transformation proceeded through thermally sampled configurations—the superheated sample shook itself apart. Within 3.5 picoseconds, the x-ray diffraction changed to one characteristic of liquid aluminum.

From Electrical Activity to Dendritic Spine Morphology

The activity-dependent remodeling of synapses that involves new gene expression is believed to be important for long-lasting forms of synaptic modification. Synaptic remodeling after plasticity induction involves the dismantling and reorganization of key cytoskeletal and scaffolding protein complexes. **Pak and Sheng** (p. 1368; see the Perspective by **Meyer and Brose**) investigated an important element of the signaling cascade that couples electrical activity to changes in dendritic spine morphology. An activity-inducible kinase, SNK, moves to synaptic spines and causes the phosphoryl-



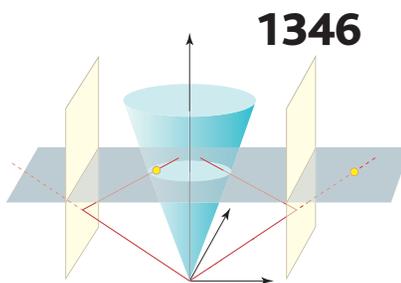
ation and subsequent degradation of SPAR, a key protein in the postsynaptic density. This loss of SPAR then leads to the dismantling of dendritic spines. ✂

Making New Protein Folds

A major goal in protein design is to specifically create proteins with predictable three-dimensional structures, including protein folds not found in nature. **Kuhlman et al.** (p. 1364; see the Perspective by **Jones**) take a large step in this direction. Using a fully automated design procedure that iterates between sequence design and structure prediction, they designed new folds and expressed the 93 residue α/β protein that they call Top7. The crystal structure, determined at 2.5 angstrom resolution, is strikingly similar to the design model.

Quantum Cascade Uplighter

The emission wavelength of quantum cascade lasers can be tuned in the mid-infrared regime by careful design of the quantum well structure, but the light is emitted only in-plane. Such lasers would be more useful for integrated optoelectronics and chemical sensing applications if the light was emitted through the surface layer. **Colombelli et al.** (p. 1374; see the Perspective by **Tredicucci**) combine the design capabilities of quantum cascade lasers with the tunable optical properties of photonic crystals to engineer an electrically pumped micro-cavity laser that emits light through the surface of the device. ✂



Looking at Herpes

Studies on regular macromolecular complexes have made remarkable progress, but detailed analysis of irregular pleiomorphic complexes has remained difficult. Herpes simplex virus represents a truly huge complex (more than 500 megadaltons in

mass and containing more than 7000 protein molecules, as well as DNA and lipids) that has not been amenable to standard structural analysis. **Grünewald et al.** (p. 1396) looked at the structure of the virus using cryoelectron tomography. Their images reveal the detailed organization of virion substructures—the nucleocapsid, tegument, and envelope—with a resolution of 5.5 to 6.3 nanometers.

Digging into Extinctions

Two reports present mineralogical and geochemical evidence that may lead to a better understanding of past extinction events (see the related news story by **Kerr**). Although there is abundant evidence for asteroid impacts in the past, meteorites have only been discovered in a few sedimentary rocks, including one chondrite from deep-sea sediments marking the Cretaceous-Tertiary boundary. **Basu et al.** (p. 1388) have now recovered dozens of meteoritic grains up to 100 μm across from two rocks samples from the purported Permian-Triassic (P-T) boundary in Antarctica. The grains contain remarkably unaltered magnesium-rich olivine and pyroxene and iron-rich metal. This association and the composition of the minerals are inconsistent with any terrestrial provenance, but are consistent with derivation from a chondritic meteorite. Whether these grains might be related to the dramatic and sudden extinction that is marked by the boundary remains uncertain, but is an interesting coincidence. Flood basalts, the igneous provinces formed by immense outpourings of lava, can reach volumes of more than 2 million cubic kilometers (greater than half

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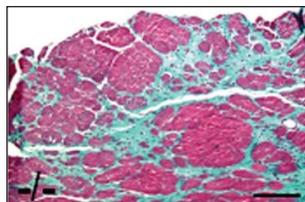
that of the Mediterranean Sea). The emplacement of these structures likely injected large amounts of CO₂ into the atmosphere that should have affected climate. However, the uncertainties associated with radiometric dating of these provinces have created an ambiguous chronology. **Ravizza and Peucker-Ehrenbrink** (p. 1392) present an osmium isotope record of the Deccan Trap flood basalts that associates Deccan volcanism with the warming event that predated the Cretaceous-Tertiary boundary by several hundred thousand years.

Population Size and Genomic Complexity

Adaptation has been considered as a primary force in evolution. **Lynch and Conery** (p. 1401) hypothesize that the evolution of genomic complexity may represent a more passive process that depended on the effective size of populations. Using nucleotide variation data from more than 40 phylogenetically diverse species, they observed a decline in effective population size moving from prokaryotes up to vertebrates. This observation led the authors to suggest that the expansion of the cell size and number in eukaryotes resulted in a reduction in population size, which in turn promoted types of genomic evolution that were previously impossible in microbial populations with enormous size. Examinations of mobile element expansions, intron size and number, and the half-lives of duplicate genes are consistent with this theory.

Movement Without Motors

Amoeboid cell locomotion requires protrusion of the leading edge and retraction of the trailing cell body. Analysis of motile systems has shown that protrusion is generated by polymerization and bundling of actin filaments. However, the lack of a suitable *in vitro* model system has made it difficult to study the mechanism of retraction. **Miao et al.** (p. 1405; see the Perspective by **Mogilner and Oster**) have reconstituted retraction *in vitro* using the motility apparatus of sperm from the nematode, *Ascaris suum*. This system, with a cytoskeleton based on major sperm protein (MSP), has previously been used to reconstitute protrusion that is analogous to the actin-based protrusion of crawling eukaryotic cells. Addition of *Yersinia enterocolytica* tyrosine phosphatase (YOP) to cell-free sperm extracts resulted in retraction of the MSP motility apparatus. The retraction was generated primarily by disassembly and rearrangement of the cytoskeleton. Thus, as for protrusion, cytoskeletal assembly and disassembly can generate retraction without the assistance of conventional molecular motors.



1416

Contradictory Calcium Entry

Calcium ions enter muscle cells through voltage-gated channels (so-called L-type channels) and initiate muscle contraction. However, in an analysis of mice lacking a different channel (the α_{1H} T-type calcium channel), **Chen et al.** (p. 1416) now show that calcium entering cells through T-type calcium channels can have the opposite effect and cause relaxation of smooth muscle and dilation of coronary arteries. The T-type channels,

which may act by influencing large-conductance calcium-sensitive potassium channels, provide a potential new target for treatment of cardiovascular disease.

Central Lynch Pin in Psychosis

The causes of some mental illnesses such as schizophrenia have been very difficult to pin down, probably because numerous neurotransmitter systems go awry in the brains of such patients. This apparent complexity may be because each of these transmitters activates a common downstream pathway that causes the negative symptoms of the disease. Mice injected with drugs that activate various transmitter pathways (amphetamines, LSD, and PCP) all exhibit psychosis-like symptoms. **Svenningsson et al.** (p. 1412) show that phosphorylation of the protein DARPP-32 at specific sites is necessary for each of the drugs to have these effects. Mice that did not have the ability to phosphorylate DARPP-32 did not show psychosis-like behaviors in response to these three different drugs.