EDITORS' CHOICE

edited by Gilbert Chin

APPLIED PHYSICS

Rewritable High-Density Memories

The storage capacity of magnetic hard disks has increased rapidly from 0.02 gigabits per square centimeter ($Gbit/cm^2$) in 1990 to the current level of around 1 $Gbit/cm^2$. But at this rate of growth (60% a year), the upper limit of a few tens of $Gbit/cm^2$ for this type of magnetic encoding will be reached by 2006, so the search is on for an alternative storage technology. One approach is to modify a surface locally with the tip of a scanning tunneling microscope (STM) or an atomic force microscope (AFM). In an air atmosphere, the tip of the STM or AFM is brought into proximity to a titanium surface, and a voltage pulse is applied at the tip to oxidize the surface. Although a density of 60 $Gbit/cm^2$ has been attained, the resolution of the modified region is limited by the tip geometry.

Cooper *et al.* have overcome this limitation by attaching a single-walled carbon nanotube, 2 to 5 nanometers (nm) in diameter to the end of the AFM tip. Because the nanotube extends approximately 65 nm beyond the tip, the high electric field necessary for the oxidation process is confined to the region between the end of the nanotube and the surface. They fabricated an array of 8-nm bits spaced 20 nm apart, which corresponds to a storage density of 250 $Gbit/cm^2$.

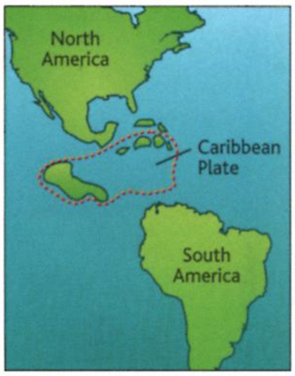
This write process is, however, a once-only event. Hasegawa *et al.* used a scanning probe technique, ballistic electron emission microscopy, to reversibly modify the electronic properties of a gold-silicon interface. With a negative voltage applied to the tip for 5 seconds, an area of the interface about 50 nm in diameter was modified and remained so for at least 1 hour; application of a positive voltage then returned the interface back to its original condition. The minimum size of the rewritable unit corresponded to the size of individual grains of gold, about 15 nm. — ISO

Appl. Phys. Lett. **75**, 3566 (1999); *Appl. Phys. Lett.* **75**, 3669 (1999).

GEOLOGY

The Isthmus of Panama and the Ice Ages

The formation of the Isthmus of Panama about 3 million years ago (Ma), a fairly small event in terms of plate tectonics, had dramatic effects on evolution, ocean circulation, and Earth's climate. Previously isolated North and South American land faunas mixed, and the separation of Atlantic and Pacific waters imposed changes in ocean circulation. One hypothesis is that these changes in ocean circulation triggered the ice ages; the onset of severe Northern Hemisphere glaciation was about 2.5 Ma. Long-term changes in ocean circulation can be monitored using neodymium (Nd) and lead (Pb) isotopes, which reflect the regional geology of exposed continental rocks bordering ocean basins. Thus, different waters will have different isotopic compositions, so their mixing and circulation can be resolved.



The Caribbean plate moved eastward, joining the Americas.

SOURCE: FLORIDA MUSEUM OF NATURAL HISTORY

Frank *et al.* and Reynolds *et al.* analyzed Nd and Pb isotopes from several ferromanganese crusts in the Atlantic and Pacific oceans and showed that the amount of water being exchanged through the Panama gateway waned noticeably before about 5 Ma, as the Isthmus began to form. This implies that the major effects on ocean circulation occurred considerably before glaciation increased. These records, along with new records of Nd isotopes from foraminifera preserved in sediments from near the Labrador Sea, reported by Vance and Burton, also show that formation of the ice sheets in North America and Eurasia increased erosion dramatically during the past 2 million years. — BH

Geology **27**, 1147 (1999); *Earth Planet. Sci. Lett.* **173**, 381 (1999); *Earth Planet. Sci. Lett.* **173**, 365 (1999).

NEUROSCIENCE

Memory Maps in the Brain

How the hippocampus records events as long- and short-term memories is still a matter of debate. In particular, it is not known how the firing of different groups of neurons in the hippocampus in response to incoming sensory information results in the encoding of this information. Now, Hampson *et al.* report that hippocampal neurons can be segregated into groups that encode different aspects of short-term memories. Using a panel of eight pairs of microwire electrodes, they recorded hippocampal neuron activity as the animals performed a multistep spatial task that was dependent on short-term memory. They classified 243 neurons (from 23 rats) into four groups according to when they started to fire during the spatial task, and then looked at the hippocampal locations of the groups. They found that the groups were arranged in a longitudinal pattern in the hippocampus and that interspersed between them were other sets of neurons that were active during the non-spatial aspects of the task, indicative of an anatomical representation of both spatial and non-spatial information. — OMS

Nature **402**, 610 (1999).

CHEMISTRY

Triple Bond Routes to Macrocycles

Many plants and marine organisms make large cyclic molecules that are used as fragrances or drugs. One challenge in developing synthetic pathways to these compounds, especially for target molecules containing double bonds, is closing the ring with the desired stereochemistry and without modifying other functional groups. Unsaturated macrocycles also have attracted attention recently for their electron transfer properties and their potential uses in nanotechnology.

Fürstner *et al.* show that ring closures of a chain bearing two triple bonds near each end can be effected by tungsten or molybdenum catalysts with yields of 50 to 80%. These macrocyclic compounds contain a single triple bond, which can be converted preferentially via a Lindlar reduction into a double bond with the *Z* (or *cis*) configuration as in many natural products. They synthesized the odorous cyclic lactone ambrettolide (musky) and a large building block of the cytotoxic alkaloid nakadomarin A, originally isolated from a marine sponge.

Mayor and Lehn have focused on highly unsaturated macrocycles. In a single step, they were able to couple 4, 6, 8, or 10 subunits through pairs of triple bonds to form

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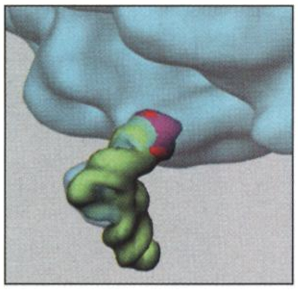
macrocycles; the subunits consist of benzene rings each carrying four *p-tert*-butylthiophenyl groups. These neutral molecules are reversibly reducible at potentials just below −1 volts, and they accept more electrons as more subunits are added without a corresponding increase in the reduction potential. This behavior suggests that larger species could serve as "molecular batteries," where the additional subunits act like cells in a macroscopic battery. — PDS

J. Am. Chem. Soc. **121**, 11108 (1999); *J. Am. Chem. Soc.* **121**, 11231 (1999).

BIOCHEMISTRY

A Toehold on the Ribosome

Recent descriptions of ribosome structure at 5- to 7.8-angstrom resolution have offered a wealth of information and have revealed how much more remains to be elucidated. Spahn *et al.* take a step forward by developing a method to insert an entire transfer RNA (tRNA) sequence at defined sites in the bacterial gene encoding the large 23*S* ribosomal RNA (rRNA). Whole 70*S* ribosomes containing this modified RNA visualized by cryo-electron microscopy revealed a peripheral, L-shaped foot corresponding to the known structure of tRNA. Two stem-loop regions of the 23*S* rRNA were precisely localized within the overall ribosome, and they also provide landmarks for interpreting the structure of the eukaryotic 80*S* ribosome. — GJC



A supernumerary tRNA

Structure **7**, 1567 (1999).

CELL BIOLOGY

Disappearing During Division

The Golgi complex is an organelle that is generally found in a single copy per cell. How does the parent cell ensure that each daughter receives one? Work over the past decade has shown that the Golgi disassembles early in mitosis and then reassembles toward the end of cell division. This was thought to occur by a process in which the membrane fusion portion of constitutive membrane recycling was inhibited at the beginning of mitosis; continual budding of vesicles from the Golgi would then lead to fragmentation into a cloud of vesicular Golgi remnants that would partition between the daughters passively. However, Zaal *et al.* suggest that the components of the Golgi complex do not disperse but are actually absorbed into the endoplasmic reticulum (ER). When normal intracellular transport resumes after mitosis, the Golgi is then reassembled. By quantitatively assessing the distribution and mobility of fluorescent proteins and lipids in living cells, they found that Golgi proteins recycled continuously through the ER during interphase and that these proteins accumulated in the ER during mitosis. The apparent lack of distinctive Golgi remnants challenges current ideas on Golgi stability and inheritance, yet the differing results may reflect differences in methodologies, and there may be redundant mechanisms to ensure that no new cell ends up without its Golgi. — SMH

Cell **99**, 589 (1999).

Science's stke

Turning Pathways Off with a Second Switch

The SMAD family of protein messengers carries signals from the cell membrane into the nucleus. When ligand binds to the membrane receptor on the cell surface, SMADs are phosphorylated and translocated into the nucleus where they activate transcription of specific genes. The messenger in the transforming growth factor–beta pathway is Smad2 (see also Wu *et al.*, Research Article, this issue, p. 92), while for the bone morphogenetic protein pathway, they are Smad1 and Smad5.

Although it seemed plausible that SMADs would be inactivated by dephosphorylation, new evidence points instead to a role for ubiquitin-dependent degradation. Lo and Massagué found that phosphorylated and translocated Smad2 becomes covalently tagged with the small protein ubiquitin, and thus targeted for destruction via the proteasome, and that the essential event that provokes ubiquitination of Smad2 appears to be its translocation to the nucleus. This mode of regulation is distinct from that recently described by Zhu *et al.* for Smad1 and Smad5, in which the ubiquitination is catalyzed by Smurf1 and occurs in the cytoplasm. — LBR

Nature Cell Biol. **1**, 472 (1999); *Nature* **400**, 687 (1999).

CREDIT: SPAHN *ET AL.*, *STRUCTURE* 7, 1567 (1999).