Materials science

Memories made in microstructure

Nature Mater. **2,** 307–311 (2003)

Shape-memory alloys are used in a wide range of applications, from spectacle frames to instruments for keyhole surgery. Despite this technological importance, a fundamental explanation of the shape-memory effect in alloys such as NiTi ('nitinol') has so far eluded scientists. Xiangyang Huang and colleagues now suggest that shape memory might be stored in the internal stresses in the microstructure of the alloy.

Shape-memory alloys must be heated to recover their original shape after deformation from the 'parent' phase. Although each parent state can be deformed into several 'daughter' states, on heating each daughter returns to the same parent phase. How does the daughter state remember the structure of the parent phase if there is no unique crystallographic relationship between the two?

The conventional view is that there must be an atom-to-atom correspondence between the parent and daughter states. However, Huang *et al*. propose that shape memory is stored in the internal stresses. Because the stresses arise from the microstructure, they are expected to be present in both the parent and daughter phases. This also provides a simpler picture of the reverse shape-memory effect, by which nitinol can be 'trained' to remember its daughter structure — although experimental evidence will be required to confirm it. **Charlene Lobo**

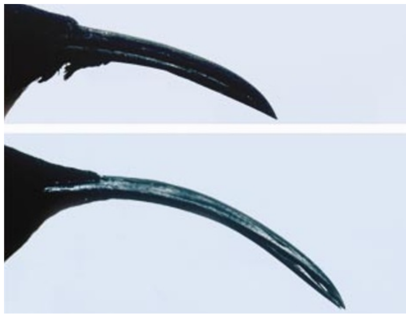
Evolution

Flowers to fit the bill

Science **300,** 630–633 (2003)

Males and females of the purple-throated carib hummingbird (*Eulampis jugularis*) are adapted to feed from different species of heliconia flower. Males have short straightish bills (pictured), designed to fit the flowers of *Heliconia caribaea*. Females are the smaller sex, but have longer, curvier bills and feed from *H. bihai*. The birds are the flowers' sole pollinators.

But it's more complicated than that, as Ethan J. Temeles and W. John Kress have discovered. On the Caribbean island of St Lucia, at sites where *H. caribaea* is rare, *H. bihai* has evolved a short and straight, male-friendly flower to fill the gap. On nearby Dominica, the two plant species are divided by altitude: *H. caribaea* in the lowlands, *H. bihai* at higher elevations. Where the two species overlap, the ecological situation is reversed, with *H. caribaea* having evolved an elongated form for females.



W. JOHN KRESS

The short and the long of it. Male (top) and female bills of the purple-throated carib hummingbird.

As well as shape and colour, the flowers change their nectar provisioning to match their clients, with those providing for the males producing more nectar. The inter-island differences show that flower and hummingbird have apparently evolved to get the most out of their association with each other. **John Whitfield**

Malaria

Pump hijacker

J. Cell Biol. **161,** 103–110 (2003)

By hijacking the membrane of red blood cells, the malaria parasite concocts for itself a bubble of calcium-rich soup, Marcos L. Gazarini and colleagues have found.

The single-celled malaria parasite, *Plasmodium falciparum*, needs concentrated calcium outside its cell so that it can let in calcium pulses that trigger various internal activities. But for part of its life cycle in humans, it dwells in red blood cells — which are low in calcium.

The parasite solves this problem by building around itself an envelope from the blood cells' plasma membrane. This previously known structure is called the parasitophorous vacuole. Gazarini *et al.* now show, using a dye that fluoresces more brightly when it binds calcium ions, that this bubble contains calcium concentrations that are 100–1,000 times higher than elsewhere in the red blood cell.

The parasite probably commandeers ion pumps already in the membrane that normally drain blood cells of calcium, using them instead to drive calcium ions into the vacuole. The authors found that blocking this ion flow prevented the parasite from maturing, suggesting that such a strategy might be used in the development of anti-malarial drugs. **Helen Pearson**

Electrochemistry

Magnesium power

Adv. Mater. **15,** 627–630 (2003)

Lithium batteries have become the pre-eminent lightweight, rechargeable power source, although lead–acid and nickel–cadmium cells are relatively cheap and still widely used in high-power applications such as electric vehicles. But cadmium and lead are toxic and heavy. In principle, magnesium-based batteries would represent a happy medium, being based on a metal that is light, cheap and environmentally friendly. Orit Chusid and colleagues have now demonstrated prototypes of viable, rechargeable magnesium batteries that withstand many recharging cycles with just a few per cent loss in power capacity.

Like lithium cells, these batteries are 'rocking-chair' devices in which magnesium ions shuttle back and forth in discharge and recharge cycles. The anode is a commercial magnesium alloy, more ductile than pure magnesium, and the cathode is Mo_6S_8, which can intercalate magnesium reversibly. The electrolyte is a polymer gel in which magnesium ions can move easily.

The result is a battery with a discharge voltage of 0.9–1.2 V and a specific capacity that, at temperatures above 60 °C, approaches the maximum theoretical value. The authors think it should be possible to make rechargeable magnesium batteries with energy densities up to 50% greater than those of lead–acid and nickel–cadmium cells. **Philip Ball**

Cell biology

Torpedo smart gel

Proc. Natl Acad. Sci. USA **100,** 3485–3490 (2003)

According to David Reigada and colleagues, synaptic vesicles from nerve cells of the electric ray *Torpedo* are filled with a matrix that acts like a smart gel. The authors propose that this provides an intelligent interface between nerves and the extracellular environment, regulating the fine-tuning of neurotransmitter release.

Neurotransmitters are the chemicals that neurons use to communicate. They are stored in synaptic vesicles, where they had been thought to exist in free solution. But Reigada *et al.* show that in the electric organ of *Torpedo*, 95% of the neurotransmitter acetylcholine (ACh) and the energy-storing molecule ATP is bound to a matrix inside the vesicles. This modulates the amount of ACh and ATP released, through an ion-exchange system. As the number of positively charged ions increases, ACh and ATP are displaced from the matrix, causing it to swell.

The matrix is a complex structure made of several proteins, but its core is formed from a vesicle membrane protein called SV2. This may be the molecule responsible for immobilizing and releasing ACh and ATP. The researchers suggest that the matrix regulates the amount of freely diffusible ACh and ATP in the early stages of neurotransmitter release. **Helen R. Pilcher**