STKE: An Unkind Cut Can Lead to a Broken Heart
Elizabeth M. Adler, *et al.*
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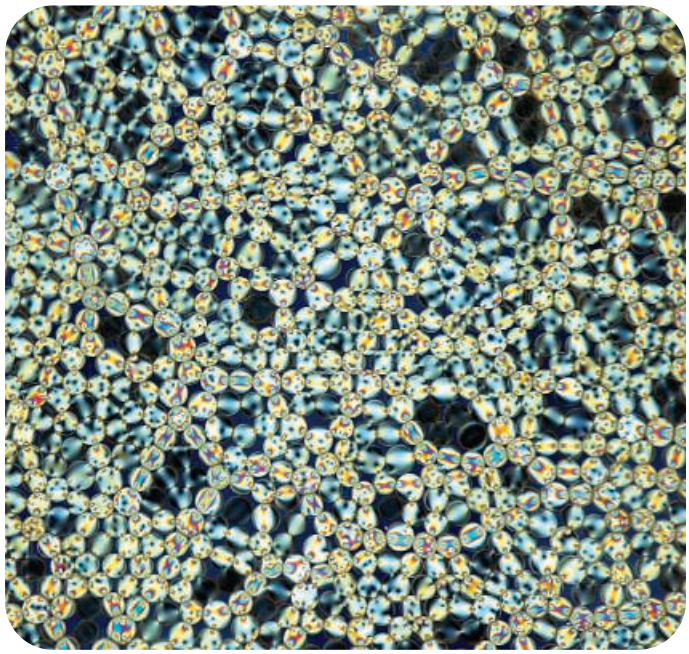


APPLIED PHYSICS

Squeeze Play

Cereals in grain silos, coal in freight cars, and powders in processing vats are all examples of granular materials that show similar flow properties despite the differences in size and shape of the particles. During flow, loosely packed granular materials are similar to fluids in that the particles are not closely connected but nonetheless interact with each other through periodic collisions. Above a critical packing fraction, the number of contacts between neighboring particles increases and creates mechanical stability leading to a jamming transition. In a set of elegant experiments, Majmudar *et al.* have tracked the jamming transition in two dimensions for a bidisperse mixture of disk-shaped particles (shown at right), with a size ratio and composition designed to guarantee a disordered system. The particles were made from a birefringent polymer so that contacts between particles and their stress fields could be measured with polarized light, while a second image taken without polarizers tracked the particle centers. The authors observed critical values at the jamming transition consistent with recent simulations, although the sharpness of the transition was diminished because of residual stress effects from the walls of the container. — MSL

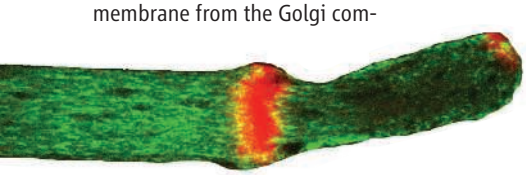
Phys. Rev. Lett. **98**, 058001 (2007).

NEUROSCIENCE

Supplying a Start-Up

After an injury to its axon, a neuron must reorganize rapidly in order to establish a new growth cone at the tip of the transected segment. The growth cone can then search for and reestablish synaptic contacts, but the axon must supply the requisite materials to promote regrowth.

By imaging cultured *Aplysia* neurons after axotomy, Erez *et al*. have followed the events by which axons establish new growth cones. Soon after an axon has been cut, the end of the portion still attached to the cell body partitions into two compartments. In the proximal region, vesicles can be observed en route to the plasma membrane from the Golgi com-



Vesicles (red) are delivered by microtubules (green) to the site of the new growth cone.

plex; if the production of Golgi-derived vesicles is blocked, a new growth cone cannot be established. In the distal region, vesicles also accumulate, but these arise via the retrieval of membrane from the cell surface. What drives this traffic are the microtubules, which form the structural scaffold of the axon and rearrange to establish a region that segregates the two classes of vesicles. This process, which involves the reorientation of polarized microtubules, collects and concentrates the components needed to regenerate a motile growth cone. — SMH

J. Cell Biol. **176**, 497 (2007).

MATERIALS SCIENCE

Freezing in the Glow

Polymer light-emitting electrochemical cells (PLECs) have mobile ions within the polymer layer, a feature that fosters low turn-on voltages and skirts the need for low-work-function cathodes or interfacial layers between the cathodes and polymer. However, in comparison with light-emitting diodes, PLECs tend to have slow response times and short operating lifetimes. Ion mobility limits the device speed, and performance can degrade as phase separation occurs between the emitting polymer and the second polymer used to store the mobile ions.

Shao *et al.* have fabricated PLECs with a simple sandwich structure, in which an organic ionic liquid, methyltrioctylammonium trifluoromethanesulfonate (MATS), acts as the reservoir for the mobile ions. Because MATS has a melting temperature of 56°C, the authors could freeze p-type–intrinsic–n-type (p-i-n) junctions into the devices at room temperature through heating/cooling cycles under an applied voltage bias. The consequent improved contact between the mobile ions and the luminescent polymer led to fast response times. Moreover, the compatibility of MATS with the luminescent polymer—in this case a substituted poly(*para*-phenylene vinylene) compound—precluded phase separation. The devices functioned with stable high brightness over days of continuous operation. — MSL

Adv. Mater. **19**, 365 (2007).

APPLIED PHYSICS

Reflecting X-rays into Focus

Coherent x-rays produced by synchrotrons have provided an invaluable tool for studying the static and dynamical structural properties of matter on the macroscopic scale. There is now a desire, in both biological and condensed-matter systems, to shift toward the probing of microscopic samples on the nanoscale. Although hard (short-wavelength) x-rays can be focused to approximately 100-nm spot sizes using reflection, refraction, or diffraction techniques, it is reflection from a high-quality surface that is expected to hone the focus down to the 20-nm level and thereby provide the capability of a true nanometer-scale structural probe. Using a combination of surface machining and surface interferometry, Mimura *et al.* have designed a platinum-coated, silicon-based elliptical mirror with a surface roughness better than 2 nm from peak to valley. After fabricating the mirror to match the optical requirements of their 1-km-long beamline, they demonstrate focusing of 15-keV hard x-rays to a beam

CREDITS (TOP TO BOTTOM): MAJMUDAR *ET AL., PHYS. REV. LETT.* **98**, 058001 (2007); EREZ *ET AL., J. CELL BIOL.* **176**, 497 (2007)

width of ~25 nm. By combining two such mirrors in orthogonal planes, they expect the x-rays to be focused to a spot size of ~30 nm. — ISO

Appl. Phys. Lett. **90**, 051903 (2007).

CHEMISTRY

Metal-Free Ringing

Chiral Brønsted acids have recently proven effective alternatives to metallic Lewis acids in a range of enantioselective catalysis applications. Rueping *et al.* extend this approach to electrocyclic ring closures. Specifically, they explored the capacity of binaphthyl phosphate derivatives to catalyze the Nazarov cyclization, a reaction in which two alkenyl groups flanking a carbonyl moiety connect at the β carbons to form a cyclopentenone ring. The resulting product bears two new chiral centers, which the optimized catalyst (at 2 mol % loading) produced with enantiomeric excesses up to 93% for the major diastereomer. The cis diastereomer was generally favored (with selectivities ranging from 1.5 to 9.3), though the products could be epimerized selectively at the α carbon to the corresponding trans isomers by treatment with basic alumina. The selectivity is sensitive to solvent, because it relies on the nature of the ion pair formed after proton transfer from the chiral anion to the substrate, and was found to be highest in chloroform. — JSY

Angew. Chem. Int. Ed. **46**, 10.1002/anie.200604809 (2007).

MICROBIOLOGY

Stepwise Sabotage of Susceptibility

Streptomycin was the first antibiotic found to target the ribosome; specifically, it works by promoting the misreading of the genetic code during translation. Although resistance to high levels of streptomycin has been assigned to mutations in *rrs*, the gene encoding 16*S* ribosomal RNA (rRNA), this mechanism does not account for the observed high prevalence of resistance to low levels of the drug.

Okamoto *et al.* have found that spontaneous mutations occur rapidly within the bacterially conserved gene *gidB*, which encodes a 7-methylguanosine methyltransferase specific for 16*S* rRNA. As a consequence of these mutations, there is a failure to methylate the invariant nucleotide G527, and hence low-level streptomycin resistance is conferred. Even though resistance to most drugs that interact with the ribosome occurs via changes in rRNA sequence, this finding suggests that this mechanism of resistance could be more frequent among bacteria than previously expected. Moreover, it is worrisome that these mutations do not appear to exact any fitness cost and seem to constitute a first step toward the evolution of high-level resistance. — CA

Mol. Microbiol. **63**, 1096 (2007).

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Postpartum (or peripartum) cardiomyopathy (PPCM), which occurs up to a few months after delivery (or late in pregnancy), is associated with an acute onset of heart failure in women with no history of heart disease. Hilfiker-Kleiner *et al.* have linked cardiomyocyte STAT3 (signal transducer and activator of transcription 3) to PPCM. Normally, pregnancy is associated with cardiac hypertrophy and increased capillary density—physiological changes that also were found to occur in mice lacking cardiac STAT3. However, postpartum mice lacking cardiac STAT3 lost the increased capillary density. These mice suffered an attenuated increase in cardiac manganese superoxide dismutase, which led to excessive levels of reactive oxygen species, which led, in turn, to an increased abundance of the proteolytic enzyme cathepsin D. Furthermore, the STAT3-deficient mice exhibited enhanced cleavage of full-length prolactin, which is a cathepsin D substrate, into a shorter, antiangiogenic form. Increasing the amount of circulating prolactin stimulated cardiac damage in mice that overexpressed cardiac cathepsin D. In contrast, pharmacological inhibition of prolactin secretion prevented PPCM. A preliminary study suggested that inhibiting prolactin release by administering bromocriptine was protective of cardiac function in women at high risk of PPCM. Thus, the authors suggest that cardiac STAT3 is critical to postpartum cardiac function and propose that inhibiting prolactin release may be a viable approach to PPCM treatment. — EMA

Cell **128**, 589 (2007).

CREDIT: HILFIKER-KLEINER *ET AL.*, *CELL* **128**, 589 (2007)