

Relaxed coupling

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An often-cited application for multiferroic materials is in information storage, where information can be written with an electric field and read with a magnetic field (or vice versa). Unfortunately, room-temperature multiferroics show only a weak coupling of magnetic and electric states. Ashok Kumar and colleagues now present a new strategy that achieves strong magnetic control of electrical polarization. In a solid solution of $\text{PbFeWO}_3/\text{PbZrTiO}_3$, an applied magnetic field of 0.5 T causes the material to switch between a stable ferroelectric state and a relaxor state. The relaxor state, although showing short-range polarization, is disordered on longer length scales and is thus unable to sustain a ferroelectric polarization — the polarization switches to zero. As the magnetic field is turned off, the polarization can be recovered. Whereas in typical multiferroics the polarization is switched from positive to negative, in the present case the two positive and negative states, as well as the magnetically induced zero polarization, can be used for three-state logic. With the strength of the magnetic control already far exceeding that of similar materials, this approach undoubtedly represents a promising new strategy for room-temperature multiferroics.

Molecules in a tight spot

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Enveloping guest molecules inside an encapsulation complex can dictate what conformations the guest can adopt. Julius Rebek Jr and colleagues use this conformational control to study the photophysics of their guest molecules, opening a future avenue for label-free sensing of small organic molecules. The researchers use an organic encapsulation complex that consists of two halves of a lozenge-shaped shell, linked together via hydrogen bonds to form a host capsule; they encapsulate derivatives of benzil inside. The small dimethylbenzil molecule fits easily inside the host in its lowest-energy, *trans*-planar configuration, from which it emits green phosphorescence when optically excited. When larger methoxy groups are

substituted for the methyls, the molecule will no longer fit in a planar fashion in the capsule, so it adopts a *cis*-skewed configuration that emits blue light. Finally, the small, unsubstituted benzil molecule is expected to fit easily in the capsule and therefore also emit green light from a *trans*-planar geometry. However, blue light is observed, indicating a *cis*-skewed configuration. The authors attribute this to more favourable interactions between the *cis*-skewed molecule and the components of the outer shell.

The bit on the tip

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Nowadays, scientists possess tools that allow characterization of materials systems with extremely high resolution and, when used in appropriate conditions, are able to see individual atoms. However, imaging the chemical structure of a molecule on a surface has been challenging so far because scanning tunnelling microscopy is sensitive to electrons near the Fermi level, which are delocalized. Furthermore, in non-contact atomic force microscopy (NC-AFM), the chemical termination and geometry of the AFM tip have too strong an influence on the molecule to be imaged. Leo Gross and colleagues have now solved the problem by using the proper choice of tip termination. In particular, they found that CO termination allows

observing both carbon atoms and hydrogen terminations in a pentacene molecule with great clarity. A comparison with calculations showed that such contrast can be achieved when the termination is set-up to maximize the Pauli repulsion between the tip and atoms, as both electrostatic and van der Waals interactions have a small influence and generate a diffuse background.

Single-crystalline nanowires

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Porous semiconductors such as silicon are not only attractive for applications in sensing and optoelectronics, but also as gene- and drug-delivery matrices because of their good biocompatibility. Porous silicon is typically synthesized by applying a voltage bias to a silicon substrate followed by etching. Peidong Yang and colleagues now report a synthetic approach that relies on an electroless metal-deposition process that provides the current flux necessary for porous-silicon formation. The etching-based synthesis results in the production of single-crystalline mesoporous silicon-nanowire arrays with high surface area and luminescent properties consistent with conventional porous silicon. The nanowires retain the crystallographic orientation of the wafer from which they are etched. Furthermore, their photoluminescence properties suggest they are made of crystalline silicon with sufficiently small dimensions that the arrays could prove useful as active components for nanoscale optoelectronic devices or photocatalytic substrates. With further analysis of the underlying chemical mechanisms, the authors believe that their methodology could be applied to other low-bandgap semiconductor systems.

Broadband detection

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A broadband polymer-based photodetector (PPD) with detection properties as good as, or better than, inorganic devices is possible, report Xiong Gong and colleagues. Many photodetectors in use at present contain inorganic compounds. However, they suffer from several drawbacks, including narrow spectral range (hence the need for separate devices to detect different wavelengths) and low operational temperatures. Ultrafast photoinduced electron transfer occurs between semiconducting polymers and fullerenes, and has been exploited to produce PPDs operating from 400 to 900 nm. The PPD constructed by Gong *et al.* functions at room temperature and centres on a composite of poly(5,7-*bis*(4-decanyl-2-thienyl)-thieno(3,4-*b*)diathiazole-thiophene-2,5) (PDDTT) and (6,6)-phenyl- C_{60} -butyric acid methyl ester (PC_{60}BM). This composite absorbs light between 350–1450 nm, and transient absorption spectroscopy indeed shows ultrafast photoinduced electron transfer at the heterojunction. The final PPD has a layered structure in which photogenerated holes and electrons are prevented from travelling to the aluminium cathode and indium tin oxide anode by a C_{60} layer and conjugated conducting polymers, respectively. The applications of PPDs with such a large photoresponse include biological sensing and day- and night-time surveillance.