Ultrathin quasicrystals

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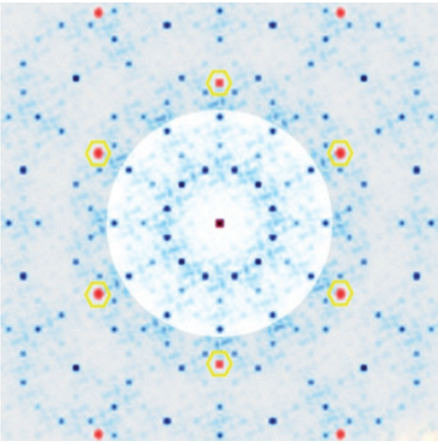

By displaying structural order yet simultaneously lacking periodicity, the counterintuitive nature of quasicrystals has fascinated materials scientists for three decades. Perhaps unsurprisingly, however, quasiperiodic order is rare and is restricted to a relatively small set of specific materials. Moreover, strategies for expanding this class typically focus on synthetic approaches seeking to expand the structural phase diagram of bulk intermetallic materials. Wolf Widdra and colleagues now present an elegant alternative, which is to induce quasicrystallinity in thin films of an otherwise periodic material, by exploiting the structural mismatch with a substrate with different symmetry. The material they choose for their investigation is perovskite barium titanate $BaTiO_3$. They find that by depositing it on a platinum substrate with three-fold symmetry, the barium titanate can be made to adopt a quasicrystalline dodecahedral structure. All of which suggests that interface-driven formation of ultrathin quasicrystals may open the way to a wider family of quasicrystalline oxides with intriguing physical properties. *AT*

Two-wave therapy

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Certain cancers, including pancreatic ductal adenocarcinoma (PDAC), are characterized by a dense stromal matrix that greatly reduces access of drugs to the tumour site. This is one factor that causes chemotherapeutic resistance *in vivo*. Now, Huan Meng *et al.* report a two-wave approach that targets stroma and enables more effective delivery of liposomal-encapsulated drugs to PDAC tumours. In the first stage, mesoporous silica nanoparticles with co-polymer coatings are used to deliver a small-molecule inhibitor to the tumour vasculature. The inhibitor blocks the TGF-β signalling pathway, preventing pericyte coverage of vascular fenestrations and thus improving access from the vascular system to the tumour. Two hours later, this enables gemcitabine-loaded liposomes to more effectively penetrate the tumour in the second phase of the treatment. Using fluorescently labelled liposomes, it was shown that the two-wave therapy improved the distribution of the liposomes within the tumour. In tumour xenograft models in mice, after 25 days, the two-wave nanocarrier treatment resulted in a greater reduction in tumour size compared with administration of gemcitabine-loaded liposomes only. *AS*

Lowering the threshold

Appl. Phys. Lett. **103,** 171104 (2013)

Colloidal quantum dots (QD) have demonstrated their potential as versatile light-emitting materials for photonic applications. However, detrimental fast multiexcitonic Auger recombination processes, which compete with the onset of optical gain, usually require ultrashort, high-power pulsed optical excitation sources to achieve amplified spontaneous emission in films of QDs. But $CdSe/Zn_{0.5}Cd_{0.5}S$ core/shell QDs demonstrate optical gain at single-exciton pumping conditions, where Auger processes are less effective. Cuong Dang and colleagues now show that densely packed films of these QDs can be deposited on nanostructured surfaces, such as the one-dimensional periodic gratings used in distributed feedback lasers, by means of a simple spin-casting process. Using this approach, they realize optically pumped QD-based lasers, which have low threshold excitation densities that can be easily reached using compact nanosecond-pulsed sources. *LM*

Inverse opal catalysts

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Semiconductor oxides with inverse opal morphologies are of potential interest for catalytic applications because they exhibit advantageous structural characteristics such as ordered porosity and high surface areas. The porous structure can be used for metal nanoparticle immobilization, but controlling nanoparticle size and dispersion for heterogeneous catalysis has proved difficult. Now Colm O'Dwyer and co-workers report the preparation of three dimensionally ordered, porous tin dioxide (SnO_2) inverse opals using a simple synthesis approach that involves tin acetate precursors. The hierarchical structure of SnO_2 is porous on multiple length scales and can be functionalized with immobilized Pd nanoparticle assemblies. The dispersion of the nanoparticles is governed by weak ligand–metal and strong metal–oxide interactions. These SnO_2–Pd inverse opals show strong electrocatalytic activity for formic acid oxidation and improved catalytic performance for liquid phase synthesis via Susuki cross-coupling reactions. The enhanced catalytic performance is due to the porosity, which allows easier access to the catalytically active sites. *VD*

Rapid unfolding

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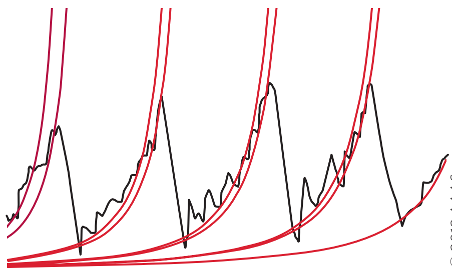

Titin — the largest known protein — is a chain of nearly 300 (immunoglobulin-like) folded protein domains that acts as a molecular spring in the contraction of striated muscle. Titin's function thus depends on how it mechanically unfolds, which has been studied by both force microscopy and spectroscopy (by pulling the protein after attaching one of its ends to a cantilever), as well as by steered molecular dynamics simulations. However, because atomistic simulations of large proteins can only reach a few microseconds with today's computational capabilities, the pulling speed needed to see domain unfolding is orders of magnitude larger than the fastest protein-pulling experiments. Now, Felix Rico and colleagues are able to compare force-spectroscopy and simulation data by using short cantilevers with small viscous damping, which makes them about three orders of magnitude faster than conventional ones. The researchers find that at pulling forces up to about 100 pN the unfolding and refolding of a β-strand pair of an immunoglobulin domain occurs at least at a rate of $10^5\ s^{-1}$, much faster than earlier predictions. *PP*

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