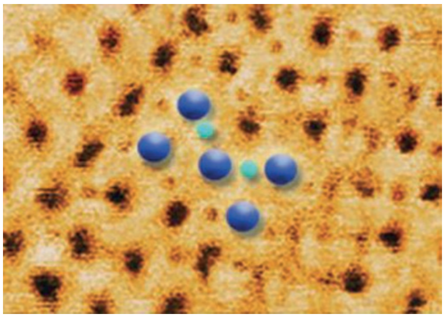
SOLUTE STRENGTHENING

How to pin a screw

Science **347,** 635–639 (2015)



AAAS

Introducing solute into a crystalline lattice is a known approach for strengthening materials; solute atoms cause localized lattice strain, making the passage of a dislocation more difficult. It is assumed however that screw dislocations do not substantially interact with solute, making only a small contribution to material strength. Qian Yu, Liang Qi and colleagues now perform a detailed mechanistic study of how oxygen solute can interact with screw dislocation cores in α-titanium. By performing *in situ* nanopillar compression and electron tomography of alloys with varying interstitial oxygen solute content, they observe that screw dislocations become tangled and pinned in samples with higher oxygen content, resulting in an approximate 8-fold increase in yield strength. Atomic-scale imaging and first-principles calculations reveal that the displacement of oxygen interstitials is more tightly confined at screw dislocation cores in higher oxygen samples, associated with which is a strong short-range repulsion for oxygen, causing pinning of screw dislocations. *JP*

SUPERCONDUCTIVITY

Switched by light

Science **347,** 743–746 (2015)

Ionic liquids used as gate dielectrics in transistors enable large carrier densities in the transport layer. Large charge accumulation can cause electronic phase transitions. Although ionic liquid gating allows superconductivity to be induced in different materials, the ionic motion is frozen below a certain temperature, making the ionic liquid insensitive to variations of the gate voltage and preventing the superconducting phase from being switched on and off at a fixed temperature. Masayuki Suda and colleagues now report an alternative approach to modulate the superconductivity in an organic crystal. As a dielectric they use a self-assembled monolayer of molecules that undergo photoisomerization from a non-ionic to an ionic state when ultraviolet light is applied, and from the ionic to the non-ionic state when visible light is used. In addition to demonstrating reversible switching from an insulating to a superconducting phase using light, the technique could also broaden the range of carrier doping densities achievable in transistors. *DC*

OPTICS

Flat lenses

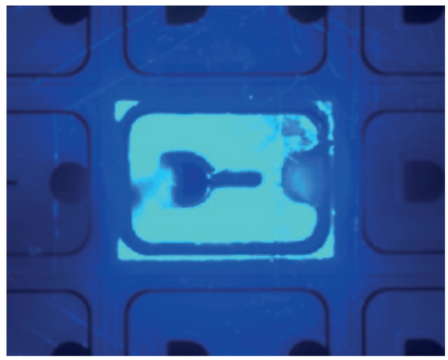
Science http://doi.org/2mn (2015)

Reducing the dimensions of lenses can prove useful for a plethora of applications. Most lenses however, especially when reduced in size and thickness, suffer from large chromatic aberrations due to the wavelength dependence of their focal distance. Although such behaviour can be corrected, it requires additional optical elements, increasing the complexity and the size of the system as a whole. Now, Francesco Aieta and colleagues have demonstrated a flat lens design based on metasurfaces. Such arrays of low-loss dielectric resonators allow continuous control of the phase profile, making it possible not only to correct the aberrations that degrade the performance of conventional lenses, but also to achieve broadband operation. The team managed to overcome the wavelength dependence, demonstrating the same focal length for red, blue and green light — the primary colours used in display applications — as well as deflection of these three different wavelengths by the same angle. This approach is an important step towards the implementation of flat optics in conventional applications. *MM*

GALLIUM NITRIDE GROWTH

A 2D barrier to defects

ACS Appl. Mater. Interfaces **7,** 4504–4510 (2015)



AMERICAN CHEMICAL SOCIETY

Gallium nitride is a large-bandgap semiconductor widely used in blue light-emitting diodes and lasers. However its crystal quality, which influences the performance of the devices based on this material, is limited by structural defects. Such defects arise as a result of the lattice mismatch between the substrate and the epitaxially grown GaN layers. Lei Zhang and colleagues now demonstrate that the deposition of 2D nanosheets of graphene or hexagonal boron nitride on a first layer of GaN limits the propagation of such defects in the layers grown subsequently. In fact, GaN nucleates only on the areas that are not covered by these nanosheets and then epitaxially grows in the lateral directions forming a complete layer. In this way, the defects underneath the 2D materials do not affect the crystal structure of the uppermost GaN layer. The improved quality of the semiconductor is confirmed by the increased light output of light-emitting diodes fabricated with this approach. *LM*

METAL-ORGANIC FRAMEWORKS

Crystals and chains

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The processing of metal–organic framework (MOF) powders into specific macroscopic shapes can be achieved by applying mechanical pressure, by using extrusion methods or by the inclusion of additives and binders. Now, Xiao Feng, Bo Wang and colleagues report the formation of elastic, stand-alone membranes of MOF crystalline powders in which polymeric chains covalently join the crystals together. Nanoscale crystals of a MOF — UiO-66-NH_2 — are modified with methacrylamide groups, and then mixed with the monomer butyl methacrylate and a photoinitiator to form a suspension that is dropped into a Teflon mould. Irradiation of the mixture with ultraviolet light induces polymerization resulting in a MOF–polymer hybrid membrane, which is flexible and can be easily peeled away from the mould. The mild conditions of the photopolymerization step allow the MOF nanoparticles to retain their crystallinity producing homogeneous, crack-free membranes that have good abilities to separate heavy-metal ions, such as Cr^{VI}, from water. This method could be used for a range of MOF crystals and to prepare many differently shaped hybrid materials. *AS*

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