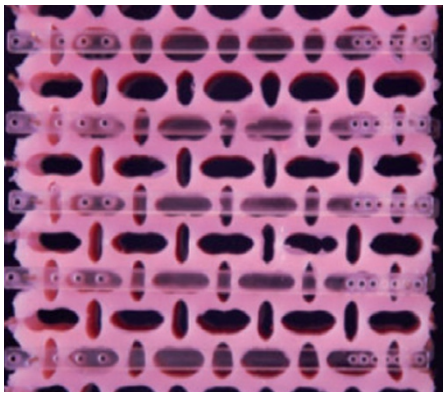
Vacant holes

Phys. Rev. Lett. **113,** 175503 (2014)



The deformation behaviour of mechanical metamaterials results from their unique architectures responding to applied loads. Various non-trivial mechanical properties have been demonstrated in these systems, including negative Poisson's ratio and the cloaking of a rigid core inside an external structure. One type of mechanical metamaterial utilizes a uniform network of equally sized cavities that buckle under load, leading to unique mechanical functions. However, each structure can display only one mechanical function, due to the cavities being identically sized. Martin van Hecke and colleagues now introduce a periodic distribution of two hole sizes in quasi-two-dimensional elastomeric sheets. By confining deformation along one axis of the sheet, and deforming it at 90 degrees to the confined axis, they find there is a switching in the polarization of the buckled holes. Then, through systematic variation in the extent of confinement and load, switching can occur in either a monotonic or non-monotonic process, or via hysteresis, in the force–displacement curves. Such structures offer potential for tuning complex mechanical functions in architectured systems. *JP*

Cooperative coupling

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Quantum technology applications rely on the fine control of light–matter interaction on the single-photon level. To obtain this level of control it is necessary to achieve a regime in which a light-emitting source radiates into a distinct light mode with very high probability. This cooperative coupling between the light emitter and the field radiated by the single photon can be reached, for example, by combining emitters that are polarizable with systems inducing large field enhancement, such as surface plasmons on metals. Following this idea, Sebastian Slama and co-authors now demonstrate experimentally cooperative coupling between the fluorescence emission of ultracold rubidium atoms and surface plasmons propagating on a gold substrate. A laser pulse excites electric dipole oscillations in Rb atoms while they move towards the gold surface. These dipole oscillations consequently couple with surface plasmons on the gold. The surface plasmons then decay into freely propagating photons, which are used to detect successful coupling. The demonstrated cooperative coupling is efficient, with Purcell factors as high as 4.9 for atomic dipoles oscillating normally to the gold surface, above what is currently obtainable in cold atom experiments. *ON*

Butterfly-inspired gratings

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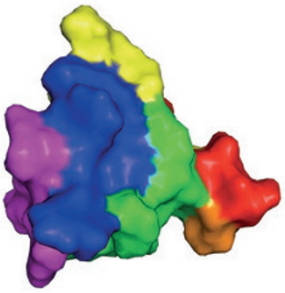
When looking at a typical diffraction-grating surface (such as a compact disc), colours with increasing wavelength appear more prominent at increasing observation angle. This is not the case for a spot on the dorsal side of the wings of male butterflies of the family *Pierella luna*: the coloured spots have periodically arranged curled-up scales, each with a ribbed nanostructure perpendicularly aligned to the wing's surface, that act as a diffraction grating with inverse colour order (the spots change from red to blue as the observation angle increases). Mimicking *P. luna*'s diffraction-grating structure, Joanna Aizenberg and colleagues have now fabricated grating arrays of nanostructured micrometre plates that display an inverse sequence in diffracted colour. The researchers also show that the diffraction pattern of the artificial photonic structure can be controlled by varying both the pitch of the ribbed patterns on the plates and the interplate distances, and that it can be dynamically modulated by changing the tilt angle of the plates (through mechanical shearing). The work should inspire the development of advanced photonic devices. *PP*

Protease probe

Adv. Mater. http://doi.org/wwh (2014)



Legumain, a protease that has been shown to be over-expressed in tumour-associated macrophages and cancer cells, is believed to promote tumour growth and metastasis. Hence, the activity of legumain in cancer and other inflammation-related diseases could reveal important information about tumourigenesis and aid the diagnosis and prognosis of various diseases. Now, Cheng Luo, Yongzhuo Huang and colleagues have designed a fluorescence-based probe that can be activated by legumain *in vitro* and *in vivo*. Molecular dynamics simulations are used to establish appropriate peptide sequences such that cleavage sites are available for legumain-mediated hydrolysis and so that paired dye molecules (a fluorophore–quencher pair) are positioned as close together as possible. In close proximity, the fluorescence of the fluorophore is quenched but cleavage of the peptides by legumain releases the fluorophore and fluorescence is recovered. Fluorescence was observed in legumain-expressing colon cancer cell lines but was absent in control cell lines. Using *ex vivo* imaging methods, the probe could also distinguish tumours from adjacent healthy tissues and could locate newly developed small tumours. *AS*

Current from intraband transitions

ACS Nano http://doi.org/www (2014)

The energy required by an electric charge to be excited from the valence band of a semiconductor to its conduction band usually determines the working spectral range of solar cells and photodetectors based on that material. However, intraband transitions — excitations between energy levels within the same band — have also been used to detect photons in the infrared range. Zhiyou Deng and colleagues have now prepared efficient infrared photodetectors by using intraband transitions in n-doped HgSe colloidal quantum dots. Precise control of the doping level is essential to minimize the noise current and to increase the device sensitivity to infrared radiation. The right doping is obtained for a range of sizes of HgSe quantum dots, which are used to realize prototypes that work efficiently at a temperature of 80 K and can still detect radiation at room temperature. The researchers expect that improved operation at room temperature will be possible by further controlling at the synthesis stage the surface composition and the ligands between the particles. *LM*

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