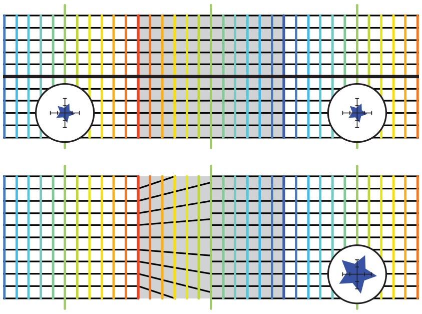
Transformation optics



Opt. Express **15,** 14772–14782 (2007)

The discovery of perfect imaging by materials with a negative refractive index has opened a new field where artificial metamaterials enable an entirely new way of controlling the propagation of light. The powerful capabilities enabled by metamaterials have recently been formalized into a theory that describes how the electro-optical parameters of metamaterials can be used to renormalize space and thus enable arbitrary control of the propagation of light through space. One well-known application of this 'transformation optics' is cloaking. To further highlight the power of this approach, Schurig, Pendry and Smith present a number of more practical optical elements. One example is a perfect magnifying lens free from geometric aberrations and with almost no back reflections. Although the planar structure of this lens and other possible devices eases their fabrication, advanced lithography will be required to fabricate such complex metamaterials with the necessary precision for practical frequencies in the optical range. Nevertheless, transformation optics may play a crucial role in complex integrated optics on a single chip.

A selective memory

New J. Phys. **9,** 365 (2007)

The electronic states of semiconductor quantum dots have already shown potential for quantum information. Robert Young and colleagues have now shown that a quantum dot can efficiently store the information contained in the polarization of a single photon. They embedded InAs quantum dots in a GaAs/AlAs diode, designed to allow the detection of single photons. The researchers used single photons with well-defined polarization to optically inject electrons with specific spin. They then triggered the optical recombination of the electrons with holes injected by applying an alternate voltage to the diode after a desired delay. For delays as high as 1 μs the polarization of the emitted photon was maintained with 80% efficiency. The ability of the dot to maintain the polarization of the photon during the excitation–emission process demonstrates the possibility of efficiently transferring the information between a transmitting qubit (the photon) and the storage qubit (the electron spin), which is one of the essential requirements of quantum information applications.

Beneficial weight gain

Science **318,** 780–783 (2007)

Friction arises when two interfaces slide on each other and part of the kinetic energy converts into lattice vibrations and transforms into heat. The microscopical origin of friction is likely to depend on the chemical details of the surfaces. However, Rachel Cannara and co-authors have now shown that the friction force can also be tuned by modifying the mass of the atoms on an interface while leaving the chemistry unchanged. They examined the sliding of the tip of an atomic force microscope on the surface of a diamond crystal and a silicon substrate terminated by either hydrogen or deuterium. In all cases the friction is considerably greater for hydrogen. Although quantitatively the values of the friction force might be influenced by factors not considered in the present study — such as the effect of surface defects — the data confirm quite unambiguously the researchers' proposal that lighter atoms vibrate at higher frequencies therefore allowing a faster energy dissipation.

Soft moiré patterns

Nano. Lett. doi:10.1021/nl071844k (2007)

A moiré pattern is an interference pattern created when two lattices overlap with one another. These patterns, commonly seen on television screens when someone is wearing clothes of a particular weave, can be used for studying microscopic strain in materials. Recently moiré fringes have also been shown to be a powerful tool for the generation of micro- and nanoscale patterns and two-dimensional superlattices. Now Manfred Stamm and colleagues observe the rotation of moiré patterns produced by overlapping block-copolymer thin films self-assembled in a well-defined hexagonal morphology. These periodic superstructures appear when films with long-range order characteristics are superimposed at small misorientation angles. Disordered nanoporous films can generate labyrinth-like patterns and overlapping films misoriented by 30° angles can produce aperiodic quasi-crystal-like structures with five-fold symmetry. The authors suggest that these block-copolymer superstructures could prove useful as nanolithography masks with controllable periodicity and morphology.

Unbreakable codes

Adv. Mater. **19,** 3854–3858 (2007)

One way to combat counterfeit pharmaceuticals is to label the drug itself rather than the packaging. To achieve this, the encoded additive must be non-toxic, capable of storing an almost unlimited number of codes and, bearing in mind drugs are usually administered in tablet form, must survive compression of the formulated drug during tablet manufacture. Now, Stefaan De Smedt and colleagues show that by entrapping digitally encoded microparticles (pictured) in starch-based granules, these high compression forces can be withstood and the codes remain readable. If the starch-based agglomerate is not formed before compression, the microparticles deform and are rendered unreadable. The particles, which are composed partly from polystyrene with immobilized fluorescent dye molecules and a ferromagnetic component, are encoded by bleaching certain regions using confocal laser microscopy. Following removal of the encoded particles from the drug,

by dissolution and filtration, they are decoded using fluorescence microscopy. A weak magnetic field is applied to ensure the correct orientation of the particles. Initial cell-based studies show that the microparticles are non-toxic — though further toxicological tests are required, this is a vital step towards the practical application of these encoded entities.