bisimide with the photochromic molecule dithienylcyclopentene. On illumination with ultraviolet light (wavelength, 280–350 nm), the dithienylcyclopentene undergoes photocyclization from an open form to a closed form, suppressing fluorescence from the perylene bisimide. Exposure to red light reverses this effect. The modulation depth of the fluorescence can thus be controlled by varying the intensities and exposure times of the ultraviolet and visible control beams. Fluorescence with a contrast ratio of over 80% is possible. The optically controlled gating is relatively slow (hundreds of milliseconds), but the team says further research should enable much faster operation rates to be realized.

DP

NONLINEAR OPTICS

Light needles in colloids

Phys. Rev. Lett. **111**, 218302 (2013)

Researchers in China and the USA have realized a new class of synthetic colloids that guide light, but exhibit negative polarizabilities. They investigated a colloid consisting of polytetrafluoroethylene (PTFE) nanoparticles in a glycerin–water system, and realized propagation and enhanced transmission of light over long distances — something impossible to achieve in conventional suspensions with positive polarizabilities. They attribute this result to the interplay between optical forces and self-activated transparency effects. Specifically, the negatively polarized PTFE nanoparticles are expelled from a propagating light beam, thereby forming a particle-rich tube about the beam, which effectively guides the light. The researchers tuned this system by adding small amounts of positively polarized polystyrene particles. By varying the polystyrene particle concentration, they were able to tune the light-propagation distance. Potential applications include local control of reactions and processes such as diffusion and osmosis.

SP

ATOM OPTICS

Photon sorting

Phys. Rev. Lett. **111**, 193601 (2013)

A fibre-optic switch with a photon-number-dependent routing capability has been demonstrated by researchers at the Vienna University of Technology in Austria. Danny O'Shea and co-workers made their four-port switch by interfacing two optical fibre tapers (named bus and drop) with a high-Q-factor whispering-gallery bottle resonator that is coupled to a nearby trapped

rubidium atom. In the switch's on state, all the light from the bus fibre is coupled to the drop fibre via the resonator. In contrast, in the off state, strong coupling between the atom and the resonator prevents light from entering the resonator; instead, the light remains in the bus fibre. When operating in its off state, the switch's routing depends on the number of photons, with the incoming stream of light sorted into single photons and pairs at the two output ports. In its current design, the switch had a fidelity of 0.62, but the researchers say that it should be possible to improve this to 0.95 by using a microresonator with a higher Q-factor and trapping the atoms closer to the resonator surface.

OG

PLASMONICS

Resistive memory

Nano Lett. **13**, 6151–6155 (2013)

Alexandros Emboras and co-workers at the Hebrew University of Jerusalem in Israel have experimentally demonstrated a type of nanoscale resistive random access memory device that uses a plasmonic waveguide for optical readout. The structure is an Ag/a-Si/p-Si layered structure butt-coupled to a silicon-on-insulator waveguide with a 280 nm × 350 nm cross section. As light travels through the structure in the silicon, it can couple to a plasmonic mode that has an asymmetric distribution across the Ag film, being concentrated at the Ag/a-Si interface. The optical transmission is controlled by altering the voltage applied to the a-Si layer, which results in the formation or annihilation (depending on the sign of the voltage) of nanoscale silver filaments. Thus, the transmission can be turned on and off electrically and the electrical state can be optically read out from the change in the absorption and scattering loss of the film plasmon. The system operates at the telecommunications wavelength of 1.55 µm, and its fabrication is CMOS compatible.

DP

PLANAR OPTICS

Taming Bloch waves

Light Sci. Applications **3**, e124 (2014)

Planar dielectric structures that can manipulate Bloch surface waves look set to provide new opportunities for constructing flat optical components. Bloch waves are a type of surface electromagnetic wave; like surface plasmon polaritons, Bloch waves are excited by light, but unlike surface plasmon polaritons, they exist in dielectric media instead of thin metal films or nanostructures. Libo Yu and co-workers

from EPFL in Switzerland report that by employing multilayer dielectric structures coated with a thin (1/15th of the wavelength) layer of patterned polymer to locally modify the refractive index it is possible to deflect, diffract and focus such Bloch waves. As a first demonstration, the team fabricated a flat plano-convex lens that couples incoming light into Bloch waves, which are then focused. Designs with a greater refractive index contrast and thus different propagation characteristics can be realized by using either thicker polymer layers or alternative materials. The approach could yield a set of two-dimensional, all-optical integrated circuits with applications in sensing, for example. The absence of metal in these designs means that the resulting structures can be low loss, unlike those that employ surface plasmon polaritons.

OG

OPTOFLUIDICS

On-chip router

Lab Chip <http://dx.doi.org/10.1039/c3lc51148k> (2014)

© 2014 RSC

Optical routing devices for photonic lab-on-a-chip systems are highly desirable for controlling the flow of light. Now, researchers based in Germany and Spain have used standard techniques for fabricating microelectromechanical systems (MEMS) to produce a fully integrated optofluidic router that employs electrically tunable liquid–liquid mirrors. By exploiting total internal reflection at liquid–liquid interfaces, the router can direct an optical input beam to one of five output channels. This device can perform optical switching over a broad wavelength range and can maintain a switched state for a long time using a low power. Although its switching times (1.5–3.3 s) are much longer than those of other techniques, the researchers believe that they should be acceptable for many photonic lab-on-a-chip applications.

SP

Written by Oliver Graydon, Noriaki Horiuchi, David Pile and Simon Pleasants.