OPTICAL MEMORY

Non-volatile storage

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According to Wolfram Pernice and Harish Bhaskaran from the Karlsruhe Institute of Technology in Germany and the University of Exeter in the UK, the fabrication of non-volatile optical memories should be possible by depositing thin films of the chalcogenide $Ge_2Sb_2Te_5$ (GST) onto silicon nitride waveguides. Their idea is to coat a short section of a ring waveguide resonator with GST, which switches between amorphous and crystalline phases when heated. Visible control light from a nearby waveguide would be evanescently coupled to the GST-coated section of the ring, which would trigger optically induced heating and thus a phase change of GST into its crystalline state. This would show up as a change in the ring resonator's transmission characteristics, as it would become significantly more lossy in its crystalline state. By sending a 1,550 nm probe beam into the ring resonator, its phase status (amorphous or crystalline) could be determined and used to represent a digital data bit. Numerical analysis suggests that a 600 fs optical pulse with a power of 5.4 pJ would be sufficient to raise the temperature of the GST to 400 °C and thus induce crystallization. The phase state can then be reset by re-amorphization by heating the GST to an even higher temperature. *OG*

PHOTODETECTORS

Plasmonic enhancement

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Researchers in Turkey have fabricated a visible-wavelength photodetector from layers of silicon and silver nanocrystals dispersed within a polymer. Sabri Alkis and co-workers from Bilkent University say that their device has a peak sensitivity at around 600 nm and a low dark current of approximately 30 mA cm^{-2}. The role of the silver nanocrystals is to create plasmon resonances, which enhance the absorption of light in the device. The layers of silicon and silver nanocrystals are separated by thin insulating films to reduce any current leakage. Previous detector designs have used silicon nanocrystals fabricated by chemical vapour deposition — a costly process that must be performed under vacuum conditions. This new approach, in contrast, can produce 20–150-nm-sized silicon nanocrystals using laser ablation, which is potentially a low-cost and high-throughput method. In addition to proving beneficial for making photodetectors, silicon nanocrystals made in this manner could be useful for creating a variety of other optoelectronic devices, such as flexible and disposable sensors or cost-effective solar cells. *OG*

CLASSICAL OPTICS

Spin Hall effect of light

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The spin Hall effect of light (SHEL) is the photonic analogue of the spin Hall effect in electronic systems, in which the electron spin and role of an applied electric field are replaced by the polarization of an incident light wave and the refractive index gradient of the sample material, respectively. The SHEL can be observed as a displacement of optical beams that carry angular momenta. Jinli Ren and co-workers from Peking University in China now report that the complex refractive index of a magnetic medium strongly affects the SHEL. The researchers irradiated a 100-nm-thick cobalt film on a glass substrate with a red (632.8 nm) HeNe laser beam. They measured the SHEL displacement as a function of the incident angle for the two electric field polarizations: parallel (P-polarization) and perpendicular (S-polarization) to the plane of incidence. The maximum displacements were 10 nm for P-polarization and 20 nm for S-polarization. However, these values were smaller than those expected from numerical simulations for an air–cobalt interface. The researchers therefore calculated the effective complex refractive indices by considering the thickness of the cobalt film, and found that the real part of the complex refractive index strongly affects the displacement for P-polarization, whereas the imaginary part strongly affects that for S-polarization. *NH*

OPTICAL MANIPULATION

Active tractor beams

Phys. Rev. Lett. **109,** 163903 (2012)

Optical tractor beams pull illuminated material in a direction along the beam, towards the light source. Such upstream transportation has been realized with solenoidal waves, although it is accompanied by circular motion, which is not always desirable. David Ruffner and David Grier from New York University in the USA have now experimentally demonstrated active optical tractor beams that can push or pull micrometre-scale objects with purely linear motion. The researchers formed an 'optical conveyor belt' by superimposing several coherent co-axial Bessel beams to create a series of periodic optical traps along the beams' common axis. By systematically varying their axial wave numbers and relative phase, the researchers were able to transport a trapped particle in either direction along the axis. The beams were formed by imprinting an appropriate phase profile onto the wavefronts of a Gaussian beam using a computer-addressable spatial light modulator. A linearly polarized bean with a wavelength

PHOTODETECTORS

Nanoscale quantum-dot junctions

Nano Lett. **12,** 5740–5743 (2012)

To date, research into the use of colloidal quantum dots (CQDs) as photosensitive materials has been primarily focused on their application in thin-film devices. In such systems, the extraction efficiency of photogenerated charge is dominated by the charge mobility. Now, Ferry Prins and co-workers from Delft University of Technology in The Netherlands have reported a different type of photodetector in which CQDs directly bridge nanometre-spaced electrodes. In this CQD junction, charge mobility no longer plays a role because charge extraction requires only two individual tunnelling events. Located on top of an Si/SiO_2 substrate, the 10-μm-wide Ti/Au/Cr/Cr_2O_3 electrodes were fabricated and separated by a gap of 4 nm. A single layer of PbSe QDs measuring 4 nm in size was then deposited on top of the electrodes. The photoconductive response was seen to depend strongly on the wavelength of the incident light and closely resemble the absorption spectrum of the PbSe QDs, which demonstrates that the photoconductance is driven by optical excitation inside the QDs. For an excitation wavelength of 532 nm, the photocurrent increased linearly with laser power and saturated at an irradiance of more than 50 W cm^{-2}. At an irradiance of 2 W cm^{-2}, the external quantum efficiency was 10.9 and 38 electrons per photon for a bias of 750 mV and 1.5 V, respectively. The rise and fall response times of the photocurrent were 200 ns and 300 ns, respectively. *NH*