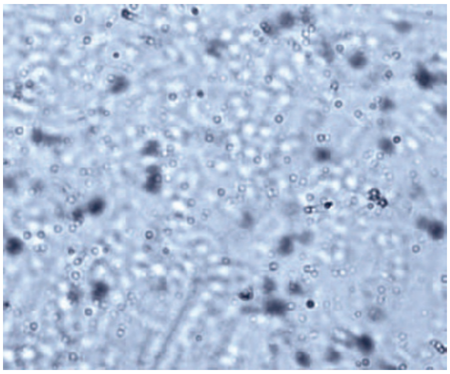
WIDE-FIELD IMAGING

Sorting sperm

Lab Chip **11,** 2535–2540 (2011)



UTKAN DEMIRCI

The ability to select the healthiest and most motile sperm from a sample could bring tremendous benefits to assisted reproductive technology. The current challenge is to image and track a large number of sperm cells simultaneously. Xiaohui Zhang and co-workers in the USA have now used a lensless CCD integrated inside a microfluidic chip to record the motility of sperm cells *in situ* as they move inside a microfluidic channel. The device's field of view is almost 20 times that of a conventional microscope, which facilities the sorting and tracking of a population of sperm. The chip consists of a 1.5-mm-thick PMMA layer, a 50-μm-thick directed self-assembly layer and a glass coverslip. The researchers placed a CCD sensor underneath the chip and inserted a protective glass film between the two layers. They then cut a 7-mm-long channel out of the directed self-assembly layer and created inlet and outlet ports of sizes 0.65 mm and 2 mm, respectively, on the PMMA layer. The sperm inside the channel diffracted and transmitted light when the chip was illuminated from above. Shadows generated by diffraction were imaged using the CCD to identify and track the most motile sperm, and those that reached the outlet were then extracted from the channel. This set-up allows for both horizontal and vertical configurations, similar to the swimming-up clinical method. The researchers are confident that this simple and portable device will be useful for fertility clinics and possibly even for use at home. *RW*

HONEYCOMB CRYSTALS

Slowing down light

Phys. Rev. A **84,** 015801 (2011)

Honeycomb photonic crystal — the photonic analogue of graphene — has been actively studied for its range of interesting optical phenomena. Recent work by Chunfang Ouyang and colleagues from Fudan University in China now shows that the light states at the zigzag edges of photonic graphene have a sinusoidal dispersion similar to photonic crystal coupled-resonator optical waveguides. The structure under study is a honeycomb lattice of dielectric rods in air. The researchers theoretically show that by tuning the radii of the inner rods, the curve of sinusoidal dispersion can be made very flat to obtain simultaneously low group velocity and low group velocity dispersion. Because the edge states are below the light line in vacuum, the researchers say that their approach does not have intrinsic radiation loss and exhibits a larger group velocity bandwidth product (0.24) than that of photonic crystal coupled-resonator optical waveguides (0.09). *RW*

LIGHT-EMITTING DIODES

Phonon-assisted emission

Appl. Phys. B doi:10.1007/s00340-011-4596-y (2011)

Near-infrared LEDs emitting at wavelengths of 1–1.7 μm are commonly made from InGaAsP in a complex double-layer heterojunction structure comprising an InGaAsP active layer and an InP carrier confinement layer. Unfortunately, InP is highly toxic and In is a rare element. Silicon, although non-toxic and ubiquitous, is indirect-bandgap semiconductor and therefore exhibits low emission efficiency. Tadashi Kawazoe and co-workers at the University of Tokyo in Japan have now fabricated a highly efficient, broadband near-infrared LED from boron-doped bulk-crystal silicon whose homojunction structure is considerably simpler than double-heterojunction designs. They fabricated their device by annealing a silicon p–n junction with a forward current while irradiating the device with near-infrared light. This process produced stimulated-emission light through a two-step phonon-assisted process triggered by the optical near-field at the inhomogeneous domain boundary of boron, thus allowing the annealing rate to be controlled in a self-organized manner. For an input electrical power of 11 W, the device achieved an external power conversion efficiency of 1.3%, an external quantum efficiency of 15% and a total optical power of 1.1 W. *JB*

SILICON PHOTONICS

Electronically tunable delays

Opt. Express **19,** 11780–11785 (2011)

Tunable optical true-time delay lines are essential components in optical communication networks and optical coherence tomography set-ups. However, these devices are often bulky, slow or have low time resolution. Silicon is an attractive material for such applications, but previous studies based on relatively slow thermo-optical tuning have shown what seems to be an inherent trade-off between loss level and device size. Saeed Khan and co-workers from the University of Central Florida in the USA have proposed an electronically tunable optical true-time delay line to avoid this trade-off. Their approach is based on a silicon-on-insulator rib waveguide sandwiched in a p–n junction. Apodized gratings are used to increase the time delay and the free-carrier plasma effect to tune the delay of the waveguide at a fixed wavelength. Three designs of apodized gratings were studied: Gaussian profile in mesa and grooved structures, and chirped raised-cosine type. They found that the grooved-type device has the highest tuning range (660 ps) with the lowest loss (<2.2 dB), which corresponds to a loss per unit time delay of around 3.3 dB ns^{-1} — significantly lower than current state-of-the-art technologies. It is also said to be able to operate at bit rates of >20 Gbit s^{-1} with a tunable delay of around 40 ps and a loss of <10 dB. *JB*

QUANTUM OPTICS

Kondo quenching

Nature **474,** 627–630 (2011)

The Kondo effect — a phenomenon that involves an interaction between a confined spin and the spins of an electronic reservoir — is commonly used to shape how the electrical resistivity of a metal changes with temperature, particularly at very low temperatures. The scattering of conduction charges creates a resistance minimum at a non-zero temperature and ensures finite resistance at absolute zero temperature. Christian Latta and collaborators from Switzerland, Germany and the USA have now shown the first optical signatures of the Kondo effect using a charge-tunable quantum dot. Using a gate voltage to tune the charge state of the dot, the researchers observed photoluminescence spectra, an absorption line shape and a voltage dependence of the peak absorption energy — all of which agree with theoretical predictions. They also found that photon absorption can turn off the exchange interaction between the quantum dot electron and the electron reservoir; that is, when the local scattering potential for the reservoir is turned off, the Kondo effect is quantum-quenched. *DP*