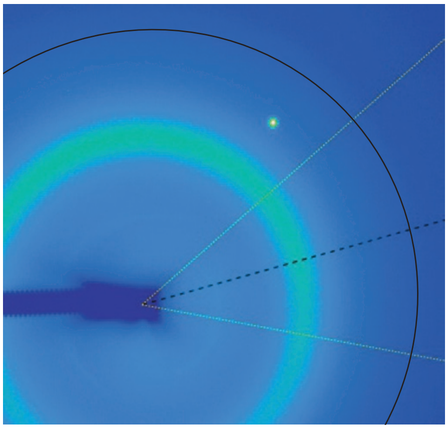
OPTICAL FIBRES

Silicon engineering

Nature Mater. http://doi.org/wx6 (2014)



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Silicon has dominated the microelectronics revolution but, despite its potential, it has performed poorly as an emitter or detector at telecommunications wavelengths. Now, an international team from the UK, Russia, Czech Republic and the USA are tackling this problem by providing a way of engineering the bandgap energy of crystalline silicon. The team fabricated silicon optical fibres using a high-pressure chemical deposition method and then crystalized the core material using a continuous wave laser. This process induces substantial radial tensile stress, up to an estimated 6 GPa, which can be tuned by adjusting the laser irradiation time. The result is a convenient and straightforward way of modifying the optoelectronic properties of silicon. The maximum bandgap reduction observed was 0.5 eV — a reduction from the default value of 1.1 eV to a value of 0.6 eV. The absorption edge of the silicon therefore increased to more than 2 μm. The researchers predict that their method will be useful for other geometries or materials, constituting an important step towards the merging of optical and electronic functionalities within the same material platform. *MM*

SPONTANEOUS EMISSION

Real-time control

Nature Nanotech. **9,** 886–890 (2014)

Cavity quantum electrodynamics using semiconductors has attracted considerable attention as a convenient solid-state means for studying quantum systems. Real-time control of the radiative processes would offer an additional and useful degree of freedom for exploring the quantum properties of such a system. Chao-Yuan Jin and co-workers from Eindhoven University of Technology in The Netherlands and the Max Planck Institute for the Physics of Complex Systems in Dresden, Germany have now demonstrated such control for the first time, using a photonic crystal cavity with an embedded quantum dot that is coupled to an adjacent Fabry–Pérot cavity. By changing the refractive index of the Fabry–Pérot cavity, one of its modes can be brought into resonance with the mode of the photonic crystal. As a result, the *Q* factor decreases as the vacuum field is redistributed and the coupling and loss rates are modified. The main control was achieved by increasing the power (and thus the local heating) and inducing a redshift, and the dynamical control was demonstrated through free-carrier injection into the Fabry–Pérot cavity using pulsed excitation and zero detuning as a starting point. Such tunability is deemed to be extremely useful for modifying the properties of the quantum system (Rabi oscillations, for example) while leaving the cavity population undisturbed. *MM*

NANO-IMAGING

Nanoscale microscopy

Proc. Natl Acad. Sci. USA **111,** 14669–14674 (2014)

The scaling of spin-based quantum information devices to a large number of closely spaced units is an important requirement if such devices are to be used for control and readout of nanoscale qubits. However, traditional data acquisition and interrogation methods for determining the electron spin of these devices, such as the scanning probe method, are limited in terms of their spatial resolution and field of view. Now, Matthias Pfender and colleagues at the University of Stuttgart in Germany have demonstrated an optical super-resolution technique with wide-field parallel image acquisition for use with the nitrogen–vacancy (NV) centre in bulk diamond — an important quantum system. The researchers combined the stochastic reconstruction microscopy (STORM) technique with optically detected magnetic resonance (ODMR). The NV colour centres were exposed using microwaves and lasers with wavelengths of 532 nm and 594 nm. The frequency of the microwaves was repeatedly switched from the centre of one of the NV spectral lines to the other in synchronization with the CCD frames. To take advantage of the high spectral resolution of ODMR, the microwave power was reduced. With conventional ODMR, spatial information is not accessible using NV spin resonance spectra. However, STORM combined with ODMR allows spin resonance spectra to be assigned to individual NV centres, tagging their locations. Consequently, two NV centres with different crystallographic orientations confined within tens of nanometres were individually resolved. *NH*

OPTOMECHANICS

Plasmonic Lorentz force

Opt. Mater. Express **4,** 2355–2367 (2014)

There have been many theoretical studies of the optomechanical behaviour of plasmonic nanoparticles. However, those that only take the nanoparticle polarizability into account are not able to explain the mechanical behaviour associated with the geometry and size of nanorods and nanoparticles. Now, Matthew Moocarme and co-workers from the City University of New York in the USA have found that significant mechanical forces are also produced by a surface plasmon that is widely neglected.

LASERS

Fast photonic crystal devices

Phys. Rev. Lett. **113,** 163901 (2014)

A miniature photonic crystal laser capable of being modulated at terahertz speeds has been designed by scientists in Denmark. Jesper Mork and co-workers say that their photonic crystal Fano laser uses a mirror based on a Fano resonance between a photonic crystal cavity and a photonic crystal defect waveguide. The Fano mirror has a narrow reflection band centred at the nanocavity resonance. The other mirror that forms the laser cavity is made by a simple termination of the defect waveguide. Inducing small amplitude changes in the nanocavity resonance allows the laser to be modulated at frequencies that are well beyond the carrier dynamics and bandwidth of conventional lasers. In contrast, introducing larger changes in the resonance yields the generation of a train of ultrashort pulses. It is thought that the laser design may prove useful for conducting fundamental investigations of the nonlinear dynamics of coupled lasers that share a common mirror. The laser's modulation bandwidth can be increased by reducing the length of the cavity, which leads to a rise in the laser threshold gain, reduces its output power and increases its relative intensity noise. *OG*