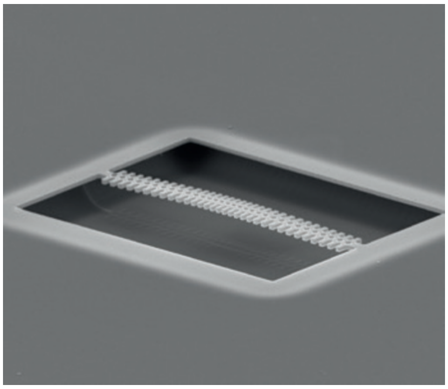
OPTOMECHANICS

Simultaneous bandgap

Nature Commun. **5,** 4452 (2014)



NPG

Cavity optomechanics explores the interactions that occur between electromagnetic and mechanical waves when they are tightly confined within a resonator. One kind of structure that supports simultaneous localization of light and vibration is an optomechanical crystal — a periodic structure that exhibits a bandgap for both photons and phonons. Now, an international team from Spain, France and Morocco report a one-dimensional silicon optomechanical crystal with a complete phononic bandgap and demonstrate for the first time experimentally the excitation of acoustic modes at a frequency 4 GHz. The optical and mechanical *Q*-factors of the structure are on the order of 10^4 and 10^3, respectively. The team observed six confined optical modes with wavelengths between 1,470 nm and 1,600 nm within their structure with vacuum coupling rates ranging from kHz to MHz. The advantage of this scheme is that it is compatible with on-chip integration and that the optical and mechanical properties of the design originate from different geometric features of the structure and thus can be designed independently. *MM*

LASERS

Pulse shortening

Opt. Lett. **39,** 4792–4795 (2014)

The popularity of pulsed lasers in various research fields has triggered much interest in the development of schemes for shortening the duration of laser pulses. While a plethora of lasers that generate femtosecond or nanosecond pulses exist, the options for those seeking picosecond pulses are more limited. Yu-Chung Chiu and co-workers from the National Tsinghua University in Taiwan have now proposed an optical parametric scheme for simultaneously shortening laser pulses and changing their wavelength. The authors employ a passively *Q*-switched Nd:YAG laser (emitting 560 ps pulses at 1,064 nm) and use a nonlinear optical crystal of periodically-poled lithium niobate to perform phase-matched optical parametric generation and obtain pulses of just 80 ps at 1,546 nm. Furthermore, by using a non-poled lithium niobate crystal instead, the researchers generated pulses at 1,070 nm with nearly zero wavelength conversion that had their pulse length shortened by a factor of 3.6 compared with the original pulse lengths of 560 ps. The researchers note that their converted pulses have a smooth temporal shape and no unwanted satellite pulses were observed following conversion. *MM*

SUPERCONTINUUM

Reaching the mid-infrared

Opt. Express **22,** 19169–19182 (2014)

Mid-infrared supercontinuum sources have attracted much attention as they offer high power densities over a broad bandwidth and are therefore deemed suitable for a range of spectroscopy-related applications. The 1–4 μm spectral range is easily covered by fibres made from fluoride glasses (such as ZBLAN) or telluride. Now, an international collaboration between universities and companies from Denmark, Germany and the UK has explored theoretically the possibility to extend emission to much longer wavelengths by employing chalcogenide step-index fibres, based on As-Se/Ge-As-Se (core/cladding) glasses, pumped by a Pr^{3+}-doped fibre laser (4 MHz repetition rate, 50 ps pulse width). Design simulations revealed that fibres with a numerical aperture (NA) of 1 and a core diameter of 10 μm were able to generate a flat spectrum up to 10.7 μm in wavelength and operation could be extended to 12.5 μm by reducing the core diameter to 8 μm. However, for larger diameter (20 μm or more) fibres with a NA between 0.5 and 1, lower nonlinearity required pumping at higher powers (~4.7 kW) to generate a supercontinuum out to 10.6 μm. This latter scheme may prove useful for designing fibres that can handle higher power densities. *MM*

QUANTUM OPTICS

Single-photon transistor

Phys. Rev. Lett. **113,** 053602 (2014)

The idea of gating the flow of single photons is not new. However, a single-photon transistor that is able to not only gate flow, but also exhibit gain would be even more useful as it would allow the construction of a network of cascaded devices. A number of experiments have shown gain, but for gating with just a single-photon unity gain remained elusive. Now, Daniel Tiarks and a team from Germany have demonstrated an all-optical transistor controlled by a single photon (on average) with a gain of 20. The team optically trapped 150,000 ^{87}Rb atoms at a temperature of 0.33 μK and used a signal laser beam with a wavelength of 795 nm and two control beams at 474 nm. According to the authors, the improved response compared with previous work is largely due to targeting relatively small principal quantum numbers ($n = 69$). This led to the ability to increase the length of the target pulse by about two orders of magnitude, enabling the higher gain. And, the authors

QUANTUM OPTICS

Black phosphorus potential

Nature Commun. **5,** 4458 (2014)

Single-layer, two-dimensional materials such as graphene, molybdenum disulphide and tungsten diselenide are attracting attention for their usefulness in photonics. However, scientists in the USA believe that a stable allotrope of phosphorus called black phosphorus (BP) may also turn out to be useful as a layered, thin-film material. BP has a small bandgap of 0.3 eV, which is well-suited to applications in near- and mid-infrared optoelectronics and conveniently services the space between zero-gap graphene and large-gap transition metal dichalcogenides. It also features in-plane anisotropy that could prove useful for realizing thin-film infrared polarizers or plasmonic devices. The team fabricated samples of BP and then used polarization-resolved infrared spectroscopy and angle-resolved conductivity measurements to investigate its properties. Studies of a 15-nm-thick layer of BP indicated a Hall mobility of 1,000 and 600 $cm^2 V^{-1} s^{-1}$ in the *x* and *y* directions within the plane, respectively, at a temperature of 120 K. Field-effect transistors made using 5-nm-thick BP were fabricated and seen to provide an on–off current ratio of 10^5, a mobility of 205 $cm^2 V^{-1} s^{-1}$ and good current saturation characteristics at room temperature. *OG*