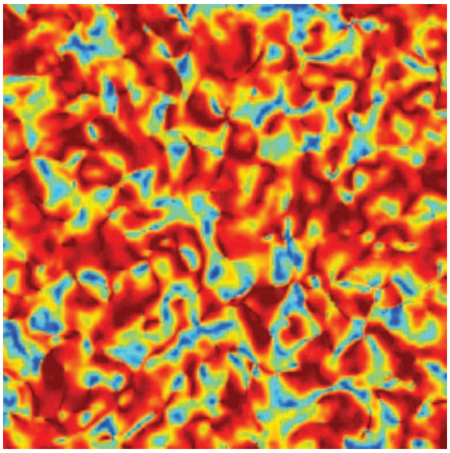
COMPLEX MEDIA

Repolarization

Opt. Express **19,** 21313–21320 (2011)



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Shining polarized light into a medium that exhibits complex scattering is well-known to cause depolarization of the incident beam. Jacques Sorrentini, Myriam Zerrad, Gabriel Soriano and Claude Amra from the Institut Fresnel at the Université d'Aix-Marseille in France have now shown that such media can also locally increase the polarization of an incident depolarized beam. The team considered a coherent and depolarized beam illuminating a scattering medium whose properties are defined by the Jones matrix. Instead of using time-consuming exact theories to model the scattering behaviour, the team employed an approach based on obtaining speckle patterns from the Fourier transform of random phasor matrices. The theoretical results are in good agreement with experiments, which used MgF_2 as the scattering medium and unpolarized red light (632.8 nm) from a He–Ne laser. Using four Stokes images to measure the scattered light, the researchers showed that the scattering medium caused the incident degree of polarization to increase from 4% to around 75%. *DP*

OPTICAL MEMORY

Rephasing stored light

New J. Phys. **13,** 093011 (2011)

Using two-pulse photon echoes to slow down light in an ensemble of cold atoms may allow photon storage with ultrawide bandwidths for optical information processing and memory. However, achieving these goals will require researchers to overcome issues of low photon retrieval efficiency and short storage times. Joonseong Hahn and Byoung Ham from Inha University in South Korea now claim to have observed a 15-fold improvement in photon echo efficiency using an optical locking scheme, which the authors call atom phase-controlled optical deshelving. The researchers used rare-earth Pr^{3+}-doped Y_2SiO_5 housed in a liquid helium cryostat at ~5 K. They controlled the characteristics of the light pulses by employing the acousto-optic modulated output from a ring-dye laser, together with digital delays and radiofrequency switching. Avalanche photodiodes for detecting the output light demonstrated the rephasing of two-pulse photon echoes and provided a measured storage (spin dephasing) time of around 9 μs. The researchers say that the storage time could be significantly extended by using optically dense media and external d.c. magnetic fields. *DP*

OPTOELECTRONICS

Blue–violet reflectors

Appl. Phys. Lett. **99,** 151101 (2011)

Distributed Bragg reflectors that provide high reflectivity in the blue–violet spectral range and are lattice-matched to GaAs substrates are needed for making short-wavelength vertical-cavity surface emitting lasers (VCSELs) and investigating cavity polariton physics. Building on previous work that aimed to realize green VCSELs, Sebastian Klembt and colleagues from the University of Bremen in Germany and the Romanian Academy in Romania now present blue–violet distributed Bragg reflectors that exhibit reflectivities exceeding 99% over a bandwidth of 40 nm. The reflectors are constructed from 21 Bragg-pair layers of high- and low-index group II–VI semiconductors. The Bragg pairs, lattice-matched to the GaAs substrate and grown by molecular beam epitaxy, consist of a 41-nm-thick high-refractive-index ZnMgSSe layer and 2.8-nm-thick low-refractive-index superlattice of MgS and ZnCdSe. The researchers comprised the high-index layer from ZnMgSSe instead of ZnSSe (as in previous work) to shift the onset of optical absorption to shorter wavelengths. They found this onset to occur at 3.25 eV (382 nm) and measured a refractive index step of 0.43. According to the team, the high refractive index step and lattice matching the high- and low-refractive-index layers are both key to constructing high-quality reflectors from a low number of Bragg pairs. *RW*

TERAHERTZ PHOTONICS

Nanowire emitters

Phys. Rev. B **84,** 115421 (2011)

Nanoscale emitters of terahertz radiation would be useful for a variety of applications, including investigations into the physical properties of nanostructured materials. Denis Seletskiy and co-workers of the University of New Mexico, Sandia National Laboratories and Air Force Research Laboratory in the USA have now shown that InAs nanowires may be suitable nanoscale sources of terahertz radiation. The researchers first prepared gold nanoparticles as InAs growth precursors on the GaAs substrate surface and then used metal–organic vapour phase epitaxy to fabricate InAs nanowires perpendicular to the substrate. The nanowires were 10–20 μm tall and had diameters that tapered from 450 nm at the base to 60 nm at the tip. Terahertz wave generation was achieved by illuminating the nanowires at an incident angle of 45° with 820 nm, 60 fs pulses from a Ti:sapphire laser. The researchers measured spectra of up to 5 THz through a linear autocorrelation technique. Taking into account the fact that the filling factor of the nanowires was only around 0.03, the radiation power was about

SOLAR CELLS

Benefit of strain

Nano Lett. **11,** 4812–4817 (2011)

Applying strain could provide a new way to enhance the performance of solar cells, according to a team of scientists at Georgia Tech in Atlanta, USA. Ya Yang and co-workers have shown that the open circuit voltage of solar cells made from ZnO nanowires and the organic semiconductor P3HT on a flexible polystyrene substrate increases under compressive strain. The mechanism for the enhancement is thought to be the piezotronic effect, whereby an applied strain modifies the energy bandgap of the solar cell's p–n junction through the creation of piezoelectric polarization charge. In their experiments, the researchers found that a compressive strain of −0.4% enhanced the open circuit voltage of the cell by nearly 30% from 0.2 V to 0.26 V, while the short circuit current remained almost constant. The researchers modelled the effect with Lippman theory to help understand and predict the phenomenon. They say these findings could be used to help optimize the performance of solar cells made from wurtzite structured materials. *OG*

15 times larger than that of a bare planar InAs substrate. The researchers suggest that the presence of a low-energy acoustic surface plasmon mode was responsible for terahertz emission. *NH*

LIQUID CRYSTALS

Light-driven colour change

Adv. Mater. http://dx.doi.org/10.1002/adma.201103362 (2011)

The development of cholesteric liquid crystals that offer dynamic colour tuning of their reflection across the visible spectrum would be of great interest for many applications in imaging, display technology and electronics. Unfortunately, this task has so far required the use of three distinct liquid crystal films, each serving the red, green or blue regions separately and being switched on or off electronically. In contrast, using light as a means of tuning reflectivity is attractive because it offers remote, spatial and temporal control. So far, however, reports of such light-driven colour changes are dynamic and continuous; that is, the material remains a particular colour only for as long as the controlling light is incident on it. Quan Li and co-workers at Kent State University in the USA have now synthesized two light-driven chiral molecular switches with very high helical twisting powers that quickly and reversibly modulate their structural reflection from blue to red, via green, when irradiated with light of ultraviolet or visible wavelengths. Such wavelength-selective reflection provides a simple and easy way of simultaneously achieving red, green and blue reflection colours in a single light-driven self-organized thin film. The researchers say that this work will encourage the development of light-driven chiral molecular switches or motors for a range of practical applications. *JB*

SEMICONDUCTOR LASERS

Green power boost

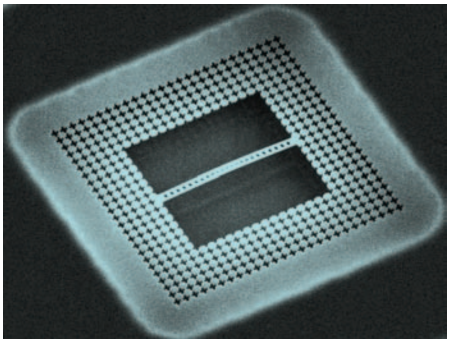
Appl. Phys. Express **4,** 102103 (2011)

Efficient electrically driven green semiconductor lasers are in strong demand for applications such as full-colour laser projectors and displays. Attention has been particularly focused on GaN-based devices grown on *c*-plane substrates, which have so far provided the highest wall-plug efficiencies. Scientists from US firm Corning have now shown that a GaN laser grown on a semipolar plane substrate is an attractive alternative that provides continuous-wave output powers of up to 60 mW at 10 °C and 35 mW at 60 °C for a drive current of 350 mA, without any signs of roll off. This study also demonstrates that semipolar devices offer the benefits of a reasonable injection efficiency and a temperature-independent slope efficiency. In addition, this device does not seem to require the electron blocking layer often employed in *c*-plane devices. The disadvantage, however, is that the reported emission wavelength range of Corning's latest devices is 508–522nm — still slightly lower than that ideally needed for display applications, which desire a wavelength as close to 535 nm as possible. *OG*

OPTOMECHANICS

Ultimate cooling

Nature **478,** 89–92 (2011)



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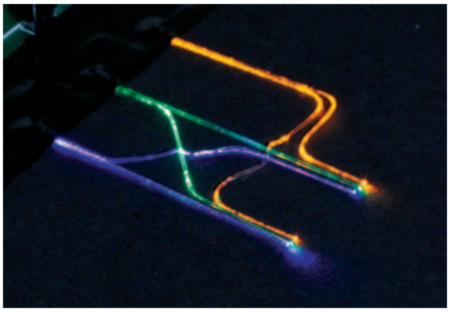
The field of optomechanics, in which light is used to influence the behaviour of miniature mechanical devices, has taken a significant step forward with the recent news that researchers have successfully laser-cooled a nanomechanical oscillator to its quantum ground state. Although physicists are keen to explore the quantum behaviour of a mechanical oscillator, the effects are hidden from view at normal temperatures and can only be accessed at very low temperatures, which are difficult to reach. A team from Caltech in the USA and the University of Vienna in Austria have now used photonics to reach the quantum regime in an experiment that operates at an environmental temperature of 20 K — around 1,000 times higher than previous experiments. Jasper Chan and colleagues fabricated a silicon nanobeam cavity and placed it into a helium cryostat at a temperature of 20 K. They then fed light from a tunable laser into the nanobeam via a tapered fibre nanoprobe. By tuning the laser wavelength to a slightly longer frequency than the resonance of the nanobeam optical cavity, the light can be used to perform optically induced damping of the mechanical motion, thereby cooling the oscillator to its quantum ground state. The researchers say that experiments for preparing and measuring the non-classical quantum states of the mechanical system are now within reach. *OG*

WAVEGUIDES

Liquid flexibility

Adv. Mater. http://dx.doi.org/10.1002/adma.201102411 (2011)



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Integrated optical systems require waveguides that are able to channel light along defined pathways with minimal loss and negligible crosstalk. Traditional techniques for fabricating channel waveguides, such as soft lithography, direct lithographic patterning or photoresist-templated etching, are limited to in-plane configurations or require repeated developing or etching steps to produce multiple layers of waveguides. Jennifer Lewis and co-workers in the USA have now developed a technique for fabricating optical waveguides in arbitrary planar and non-planar configurations through a technique called photocurable liquid core–fugitive shell printing. The researchers first encapsulate a hybrid organic–inorganic fluid within a viscoelastic ink shell made from an aqueous triblock copolymer solution, which acts as a sacrificial support for the core fluid. They then print the core fluid and viscoelastic fugitive ink shell simultaneously while curing the waveguide using an ultraviolet LED. The intensity of the ultraviolet light can be varied in the range of 1–19 mW cm^{-2}, with a higher curing intensity leading to lower optical loss. Waveguides printed through this technique exhibit low optical loss throughout the visible spectrum. The researchers say that this approach offers a flexible way of producing waveguide networks for integration with high-bandwidth next-generation optical systems and optical sensor arrays. *JB*

Written by James Baxter, Oliver Graydon, Noriaki Horiuchi, David Pile and Rachel Won.