flexible control of such highly promising optomechanical systems. *MM*

LIGHT-MATTER INTERACTION

Light-driven fan

Phys. Rev. Lett. **112,** 235001 (2014)

Twisted relativistic light pulses with a strong torque and an ultrahigh orbital angular momentum density can in principle be created by shining light pulses onto a specially design thin metal foil, report scientists in China. Theoretical analysis and simulations by Yin Shi and co-workers at the Shanghai Institute of Optics and Fine Mechanics predict that when intense pulses with planar wavefronts strike a metal foil having a spiral of fan blades of stepped height, the pulses obtain a helical wavefront on reflection. The relativistic laser beam exerts a strong torque on the foil, which is transferred to the reflected light, resulting in a twisted light beam. This proposal both sheds light on the dynamics of high-intensity laser–plasma interactions and paves the way to revealing new, exciting applications using twisted, intense laser pulses. *MM*

SEMICONDUCTOR LASERS

Monolithic terahertz source

Appl. Phys. Lett. **104,** 221105 (2014)

To date, the production of continuous-wave terahertz (THz) sources based on intracavity difference-frequency generation from mid-infrared quantum cascade lasers operating at room temperature has proved elusive. A critical problem is that, to achieve a large nonlinear susceptibility for frequency conversion, the active region of the quantum cascade laser requires high doping, which elevates the lasing threshold current density. Now, Quan-Yong Lu and colleagues from Northwestern University in the USA have overcome this problem and demonstrated a room-temperature continuous-wave THz source based on difference-frequency generation in quantum cascade lasers. They designed quantum-well structures based on $In_{0.53}Ga_{0.47}As/In_{0.52}Al_{0.48}As$ material system for two mid-infrared wavelengths. The average doping in the active region was about 2.5×10^{16} cm^{-3}. A buried ridge, buried composite distributed-feedback waveguide with the Čerenkov phase-matching scheme was used to reduce the waveguide loss and enhance heat dissipation. As a result, single-mode emission at 3.6 THz was observed at 293 K. The continuous-wave THz power reached 3 μW with a conversion efficiency of 0.44 mW W^{-2} from mid-infrared to THz waves. Using a similar device design, a THz peak power of 1.4 mW was achieved in pulse mode. *NH*

RANDOM MEDIA

Controlling disorder

Nature Mater. **13,** 720–725 (2014)

Francesco Riboli and colleagues in Italy and Switzerland have experimentally realized control of the spectral properties of individual photonic modes in a two-dimensional disordered photonic structure. The researchers fabricated 320-nm-thick GaAs waveguides containing three dense layers of InAs quantum dots. Random patterns of holes were etched, and the fill factor was varied between 0.13 and 0.35 and the hole diameter was varied from 180 nm to 250 nm until strongly localized optical modes were obtained. The structures were designed to support localized modes at wavelengths around ~1,300 nm. The researchers exploited the fact that the resonant frequency of the modes is sensitive to the parameters of the surrounding media, and it can therefore be selectively perturbed by introducing a near-field probe tip. Perturbation can also be induced by local sub-micrometre-scale oxidation. In a sample supporting spatially overlapping modes with different resonant frequencies, local tuning pushed modes into spectral superposition. Frequency crossing and anti-crossing were observed, with the latter indicating mode interaction. The researchers claim optically isolated regions can thus be connected by such modes, which might offer new options for controlling light propagation, such as transmission channels in strongly scattering media. *DP*

NONLINEAR OPTICS

Chemical potential effect

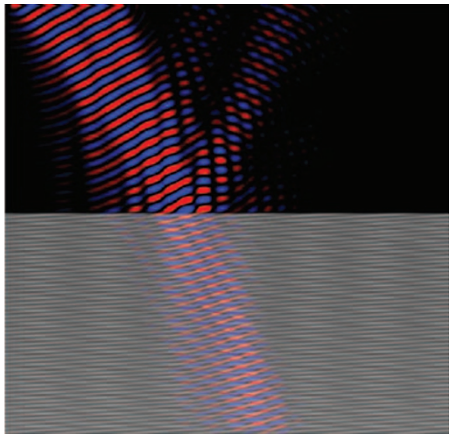
New J. Phys. **16,** 053014 (2014)

With its strong optical coupling, broadband absorption and electronic properties, graphene is a natural candidate for use in optically controlled devices in photonics. However, its nonlinear optical properties have not been fully investigated. Now, Jin Luo Cheng and co-workers from the University of Toronto and Vrije Universiteit Brussel have theoretically investigated the linear and third-order nonlinear optical conductivity of doped graphene and conducted calculations for third-harmonic generation, the Kerr effect and parametric frequency conversion. The researchers performed zero-temperature perturbative calculations for the tight-binding model. They fully accounted for both the interband and intraband motion of the electrons, which were perturbed by an incident field. They obtained a formula that exhibits divergences resulting from resonances between the photon energy and the chemical potential. The results obtained varied greatly for different frequency combinations. The researchers state that, "combined with the tunability of the chemical potential by an external gate voltage or chemical doping this should lead to novel approaches for controlling the nonlinear optical properties of graphene." *NH*

SENSORS

Photonic sugar detector

Nano Lett. **14,** 3587–3593 (2014)



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An international team of scientists in the UK, USA, Brazil and Australia has demonstrated a photonic nanosensor that is promising for point-of-care screening of diabetes and diagnosis of urinary tract infections. The nanosensor can be easily and rapidly fabricated by using a 6 ns laser pulse (wavelength, 532 nm) to produce a Bragg diffraction grating consisting of silver nanoparticles distributed within a hydrogel. The presence of glucose causes the hydrogel to swell, thereby modulating the spacing of the silver-nanoparticle distribution as well as the refractive-index contrast between the nanoparticles and the hydrogel. These changes systematically shift diffracted light to longer wavelengths as the glucose concentration rises; the nanosensor operates over the wavelength range 510–1,100 nm. Furthermore, the nanosensor can be reused at least 400 times without affecting its accuracy. Readouts can be obtained within 5 min, and the sensor can be reset in about 10 s. In terms of diagnosing glycosuria from urine samples, the authors claim that the nanosensor exhibited superior performance to commercial glucose test strips and equivalent performance to fully automated analysers. *SP*

Written by Noriaki Horiuchi, Maria Maragkou, Simon Pleasants and David Pile.