GRAPHENE

Plasmons and magnetism

Nano Lett. **12,** 2470–2474 (2012)

Morphological defects in graphene layers grown on SiC can result in a strong plasmon resonance in the terahertz region, according to Iris Crassee and co-workers from Switzerland, France, Germany, Spain, Czech Republic and the USA. Furthermore, the presence of the plasmons can affect the magneto-optical response of the material — particularly the Faraday rotation. The researchers began by growing graphene epitaxially on SiC using an approach that results in uniformly distributed defects caused by a combination of substrate 'terraces' and post-graphitization thermal relaxation. They then used atomic force microscopy to show that the defects are oriented predominantly in one direction across the entire sample, and that electromagnetic absorption is 1.7 times higher when the electric field is perpendicular to the terraces, which suggests that the terraces assist plasmon excitation. The researchers probed the magneto-optical response using Fourier-transform infrared spectroscopy with a split-coil superconducting magnet at a temperature of 5 K in magnetic fields of up to 7 T. They observed a strong response at around 1.6 THz in the absence of a magnetic field, and resonance splitting in the presence of a magnetic field. Although similar plasmons have been observed on lithographically nanostructured graphene, the approach of Crassee and co-workers does not require special patterning and is a natural by-product of the growth process. *DP*

OPTOFLUIDICS

Reconfigurable hybrid

Lab Chip http://dx.doi.org/10.1039/c2lc40191f (2012)

In the field of optofluidics, a number of hurdles currently prevent the practical integration of liquid-state elements into traditional high-speed solid-state photonic systems. Among two most critical are the need for a continuous supply of liquid to the device and the difficulty in shuttling light between the liquid- and solid-state sections. Erica Jung and David Erickson in the USA have now presented an integrated system that solves both of these problems. By establishing a direct coupling between liquid- and solid-state waveguides and employing a fluid recirculation system, their scheme consumes 200 times less liquid than today's state-of-the-art devices. Although too slow to be used for direct signal modulation, this configuration offers a number of important advantages for waveguiding, such as the ability to route light of arbitrary wavelength. Solid-state techniques, in contrast, usually make use of an optical resonance, which narrows the range of wavelengths that can be modulated. The device developed by Jung and Erickson can be operated continuously for over 20 h without performance degradation or the need for liquid replenishment. The researchers say that their system represents an important step towards the development of practical optofluidic photonic systems. *JB*

SUPERCONTINUA

Broader than ever

Nature Commun. **3,** 807 (2012)

Jens Biegert and co-workers from Spain, the UK and France have developed a high-energy-density supercontinuum that spans 3.3 octaves from the blue to the mid-infrared. The researchers made their supercontinuum by focusing femtosecond-duration mid-infrared pulses into a 2-mm-thick YAG crystal. Filamentation of the pulses resulted in a supercontinuum with a spectrum spanning 450–4,500 nm — allegedly the broadest ever produced by filamentation in a bulk material. The supercontinuum also featured good shot-to-shot reproducibility and a spectral energy density of between 2 pJ nm^{-1} and 10 nJ nm^{-1}, making it amenable for practical applications that require an intense broadband light source. The researchers say that the generation process preserves the carrier-to-envelope phase and that the smooth nature of the spectrum indicates the absence of complex pulse-splitting. *OG*

SLOW LIGHT

Enhancement revisited

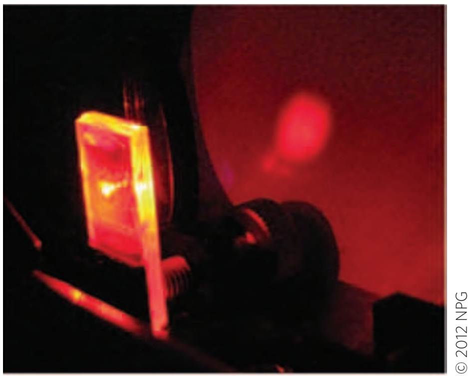
Phys. Rev. Lett. **108,** 183903 (2012)

The use of slow-light in periodic structures is an appealing technique for enhancing inherently weak light–matter interactions. However, Jure Grgić and co-workers in Denmark have now raised concerns regarding the magnitude of the anticipated enhancement. The researchers numerically analysed the modification to the dispersion relation in the gain media of periodic structures such as coupled-resonator optical waveguides, Bragg stacks and photonic crystal waveguides. They found that the photonic density of states is not affected regardless of whether the net gain factor is positive (gain) or negative (loss). They also discovered that when the gain is increased, the group index decreases to a constant value at the Brillouin zone edge. Considering all these factors together, the researchers conclude that the slow-light enhancement is considerable for a low gain factor but may not be present in all cases. For quantum-dot-based materials, whose gain factor is in the range of 10–45 cm^{-1}, a slow-light enhancement factor of around 60–130 is anticipated. *NH*

COLLOIDAL NANOCRYSTALS

Single-exciton lasing

Nature Nanotech. **7,** 335–339 (2012)



CdSe-based colloidal quantum dots (CQDs) are used in applications ranging from fluorescent biolabels to prototype light-emitting diodes. However, losses due to non-radiative Auger recombination and requirements for high packing densities have so far hindered the development of lasers based on CDQs. Cuong Dang and co-workers in the USA have now demonstrated a low-threshold vertical-cavity surface-emitting laser (VCSEL) based on core–shell CdSe/$Zn_{0.5}Cd_{0.5}S$ CQDs. First, they used high-temperature organometallic synthesis to prepare CQDs spin-coated on fused silica substrates. The CQDs had diameters of 4.2 nm, 3.2 nm and 2.5 nm for red, green and blue emission, respectively, and had a packing density of around 50%. The researchers used absorption and photoluminescence measurements to confirm single-exciton gain. A blue-shift of the lowest excitation absorption peaks with respect to the photoluminescence reduced the self-absorption of emitted photons, thereby lowering the threshold for amplified spontaneous emission. Using the variable stripe length method, the researchers measured gains of 95 cm^{-1} and 60 cm^{-1} for red- and green-emitting CQD films, respectively. The red-emitting CQD-VCSEL exhibited an optical pumping threshold as small as 60 μJ cm^{-2} at the 400 nm pump wavelength, which indicates that the device's low-loss resonator design allows a stimulated emission threshold close to the fundamental single-exciton limit. *NH*

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