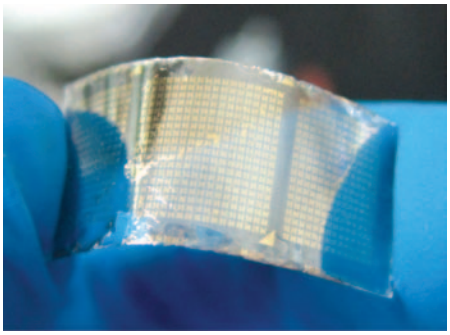
MATERIALS

Topological electrodes

Nature Chem. **4,** 281–286 (2012)



Topological insulators, materials that have a conductive surface but an insulative interior, have attracted much attention in recent years owing to their intriguing properties. Scientists have now shown that topological insulators could be used as transparent flexible electrodes for next-generation optoelectronics operating in the near-infrared regime. Hailin Peng and co-workers from Peking University, the University of Oxford and Stanford University fabricated thin, multilayer Bi_2Se_3 nanostructures onto mica substrates by van der Waals epitaxy. The resulting nanosheets functioned as transparent conductors with sheet resistances as low as 330 $\Omega\,\square^{-1}$ and transparencies exceeding 70% for wavelengths of 1–3 μm. Tests indicated a high degree of mechanical robustness, with the nanosheet electrodes proving durable to 1,000 bending cycles. The researchers say that the Bi_2Se_3 electrodes could prove useful for applications such as infrared imaging and sensing, near-infrared solar cells and optoelectronic devices for optical communication. *OG*

X-RAYS

Orbital angular momentum

Appl. Phys. Lett. **100,** 091110 (2012)

Erik Hemsing and colleagues from the University of California Los Angeles in the USA have presented evidence of the helical microbunching of charge within an electron beam. Previous theory suggested that such beams could be realized in principle, but an experimental demonstration was lacking until now. The ability to induce microbunching may ultimately lead to the development of high-gain, high-mode-generation free-electron lasers capable of emitting light with orbital angular momentum. For this to be possible, the electrons must be arranged with a spiral period equal to the wavelength of light emitted from the free-electron laser. Theory suggested this could be achieved by tuning the laser such that it imparts energy to the electrons through a second-harmonic interaction, which can have an azimuthal dependence on the laser mode profile. The researchers passed a short 3 ps electron bunch (enery of around 12 MeV) from the Neptune Inverse Free Electron Laser through a 1.9-cm-period helical undulator together with a 10.6 μm, 100 ps pulse from a CO_2 laser. They measured the coherent transition radiation emitted from the electron beam by focusing the output into a liquid-nitrogen-cooled mercury cadmium telluride detector. The data confirmed the existence of microbunching and gave a measure of the process efficiency. *DP*

PLASMONICS

Laser-written conductors

Adv. Func. Mater. http://dx.doi.org/10.1002/adfm.201102665 (2012)

Shining green laser light onto nanostructured gold or silver films coated with amorphous carbon can induce a phase transformation that makes the carbon highly conductive, according to researchers from the Georgia Institute of Technology in the USA. The nanostructures exhibit a plasmonic resonance that strongly absorbs 514 nm laser light, causing intense localized heating of the carbon and a resulting phase change into a nanocrystalline or disordered graphitic phase, as confirmed by Raman spectroscopy and atomic force microscopy. Conductive force microscopy suggests that the changed state offers an electrical resistivity that is at least seven orders of magnitude lower than the initial insulating surface or unexposed regions. In contrast, tests with a reference silicon substrate showed no changes in morphology or conductivity, which indicates the importance of the metal nanostructures for the phase change. The researchers suggest that the technique might be useful for fabricating complex patterns of metal–carbon electrical interconnects. *OG*

QUANTUM DOTS

Superior single photons

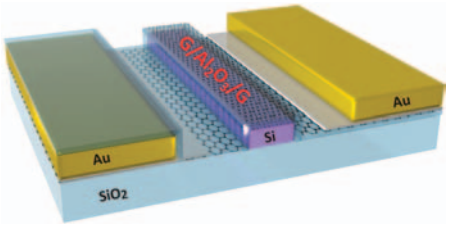
Phys. Rev. Lett. **108,** 093602 (2012)

Clemens Matthiesen and co-workers from the University of Cambridge and the University of Rochester have reported the emission of highly coherent (sub-natural linewidth) single photons from InAs quantum dots. The researchers used a confocal microscope to collect optically excited resonant fluorescent spectra at a temperature of 4 K. The InAs quantum dots were embedded in a Schottky diode heterostructure, which allowed their excitonic energy levels to be tuned through the d.c. Stark effect. To combine the processes of absorption and emission into a single coherent event, the researchers decreased the excitation power so that the Rabi frequency was less than a fifth of the spontaneous emission rate. Strong antibunching in the intensity-correlation measurement suggests that the generated photons were non-classical in nature. The researchers measured a coherence time of 22 ns — 30 times longer than the lifetime of the quantum dot transition — through field-correlation measurements using a Michelson interferometer. The single photons exhibited a linewidth of 7 MHz, which is a metric inherited from the excitation laser. *NH*

OPTOELECTRONICS

Double-layer graphene boost

Nano Lett. **12,** 1482–1485 (2012)



The strength of graphene's optical absorption can be tuned by controlling its charge carrier density, which makes it promising for use as a miniature broadband optical modulator. Ming Liu and co-workers from the University of California in Berkeley and Lawrence Berkeley National Lab in the USA have now presented a device design that comprises a 400-nm-wide, 40-μm-long silicon wire waveguide covered by a graphene–Al_2O_3–graphene sandwich, which functions as a p–oxide–n junction. Grating couplers with a period of 780 nm are used to couple 1,537 nm light in and out of the device. The researchers report a modulation depth of up to 6.5 dB and a peak transmission of –25 dB, with most of the loss being due to the grating couplers. Their measurements also indicate that the modulator has a 3 dB bandwidth of 1 GHz and a modulation depth of around 0.16 dB μm^{-1} per unit length at a drive voltage of approximately 5 V. The researchers say that using multiple pairs of double-layer graphene could further reduce the footprint and energy consumption of the device. *RW*

BIOPHOTONICS

Glucose detection

Biomed. Opt. Express **3,** 667–680 (2012)

Diabetes is a widespread disease that affects 346 million people around the world and causes an estimated 3.4 million deaths every year. Although glucose levels can be