EXTREME ULTRAVIOLET

Vortex beam generation

Phys. Rev. Lett. **114,** 173901 (2015)

A scheme for generating intense vortex beams in the extreme ultraviolet that carry high values of orbital angular momentum (OAM) has been unveiled by scientists in China. Xiaomei Zhang and co-workers from the Shanghai Institute of Optics and Fine Mechanics and the Shanghai Jiao Tong University report that vortex harmonic beams with high azimuthal modes can be generated when a linearly polarized Laguerre–Gaussian driving beam interacts with a thin solid film. The plasma that results from the interaction acts as a nonlinear medium and the OAM of the driving beam is transferred to the harmonics. A benefit of the approach is that unlike other media such as glass, which has a low damage threshold, the plasma is able to interact with very intense pulses. As the vortex harmonics are on the attosecond timescale they could prove useful for probing the electronic dynamics on the atomic scale. *OG*

QUANTUM COMMUNICATION

Twisted beam benefit

New J. Phys. **17,** 033033 (2015)

The orbital angular momentum (OAM) modes of photons are potentially useful for high-dimensional quantum key distribution (QKD) systems, offering advantages over polarization encoding, including an increase in information capacity and increased resilience against eavesdropping. However, the idea has largely remained impractical mostly due to the difficulty in efficiently sorting single photons using an OAM basis. Now, Mohammad Mirhosseini and co-workers from the USA, Austria, the UK and Canada have demonstrated a proof-of-principle experiment that uses a seven-dimensional alphabet encoded in the photons' OAM modes and angular position (ANG). A collimated beam from a He-Ne laser is processed by a binary hologram from a digital micro-mirror device to generate OAM and ANG modes at a rate of 4 kHz. The international team of scientists also used a mode sorter capable of sorting single photons based on their OAM and ANG content with a separation efficiency of 93%. The result was communication with an information capacity of 2.05 bits per shifted photon, which is more than twice the maximum allowable capacity of a two-dimensional QKD system. The symbol error rate was measured to be 10.5%, which was sufficient for proving unconditional security against coherent and individual eavesdropping attacks for an infinite key. *NH*

PEROVSKITES

Nanowire lasing

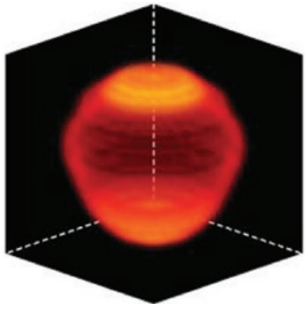
Nature Mater. http://doi.org/4bg (2015)

Lead halide perovskites ($CH_3NH_3PbX_3$) — the inorganic–organic hybrid material system that is currently receiving great attention in the solar cell research community — may also prove highly useful for making efficient lasers. Haiming Zhu and co-workers from Columbia University and the University of Wisconsin–Madison in the USA have now constructed nanowire lasers from single-crystal perovskites that operate at room temperature with very low lasing thresholds and high quality-factors ($Q \sim 3{,}600$). The impressive performance is attributed to the long carrier lifetimes and low non-radiative recombination rates — exactly the same properties that make perovskites so attractive for making solar cells. A further benefit is that the wavelength of emission can be tuned across the visible and near-infrared. Perovskite nanowires (~10 micrometres in length) were placed on a Si/SiO_2 substrate in a dry N_2 atmosphere and optically pumped with 405 nm pulsed laser light. Emission from the nanowires was observed at around 787 nm, and rose dramatically in strength and also spectrally narrowed from a full-width at half-maximum value of 44 nm to 0.22 nm for a pump fluence greater than 600 nJ cm^{-2}. By changing the amount of methylammonium iodide, bromide and chloride in the precursor solution used to make the perovskite nanowires, the team managed to tune the emission colour from around 500 to 800 nm. *OG*

CATHODOLUMINESCENCE

Nanoscale tomography

Nature Nanotech. **10,** 429–436 (2015)



NPG

Detailed three-dimensional spectral maps of the radiative properties of metal–dielectric nanostructures have been produced by a collaboration of groups from the USA and the Netherlands. Ashwin Atre and co-workers from Stanford University and the FOM Institute AMOLF combined the concepts of tomography and cathodoluminescence spectroscopy to interrogate the optical properties of a gold-coated polystyrene 'nanocup' — a three-dimensional crescent-shaped plasmonic structure that is useful for harvesting light. Cathodoluminescence spectroscopy was performed using a scanning electron microscope. As the electron beam was scanned over the sample a spectrum was collected at subsequent points, allowing the capture of two-dimensional cathodoluminescence maps spanning the visible and near-infrared (~500–900 nm). Tomography was then used to reconstruct three-dimensional datasets from the maps. The team says that the approach is useful for achieving nanoscale visualization of the properties of metal–dielectric nanoresonators. *OG*

QUANTUM CASCADE LASERS

Electrical frequency tuning

Appl. Phys. Lett. **106,** 131107 (2015)

Spectroscopy techniques require the sweeping of emission frequency across molecular lines to gather information about a sample. Although electrical frequency tuning of terahertz quantum cascade lasers (QCLs) has been demonstrated, it is always accompanied by an unwanted change in output power and to date only limited tunability has been achieved. Now, Dana Turčinková and co-workers from Switzerland and France have demonstrated continuous electrical tuning of a single-mode QCL operating at 3 THz.

The devices were made of a $GaAs/Al_{0.15}Ga_{0.85}$ material system and based on a two-section interdigitated third-order distributed feedback (DFB) cavity. The two sections were independently pumped with electrical currents. The measurements were performed in pulsed operation at a heat-sink temperature of 10 K. The effective index of the DFB lasing mode decreased with increasing current difference between the two sections. It followed that the laser wavelength, determined by the Bragg diffraction condition, decreased concomitantly. As an example, a continuous tuning over a frequency range of 4 GHz was achieved for a fixed optical output power of 0.7 mW. The tuning range is expected to improve by using another active-region design with a higher gain or stronger Stark effect. *NH*

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