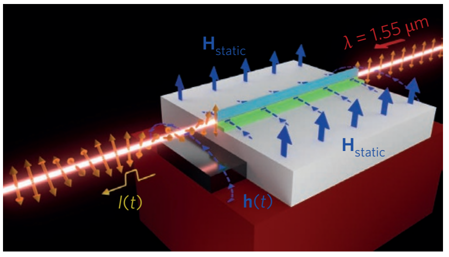
OPTICAL DEVICES

Nanoscale rotator

ACS Photon. http://doi.org/bvg4 (2016)



AMERICAN CHEMICAL SOCIETY

The rotation of the polarization of light by magneto-optical materials is well exploited by macroscale devices such as optical isolators, however, demonstrations in nano-optics or plasmonics are lacking due to issues such as dissipation and phase-matching. Now, Curtis Firby and colleagues from Canada have proposed an integrated magnetoplasmonic Faraday rotator. They predict 99.4% polarization conversion over an 830-μm-long device using low-loss modes that can propagate over a distance of 1 mm. The proposed structure, designed for 1,550 nm wavelength operation, is a 450-nm-wide ridge waveguide with multilayers stacked vertically within. A 25-nm-thick silver layer is surrounded by two 20-nm-thick SiO_2 layers. A high-index 'hat' for the ridge is formed by a 725-nm-thick layer of TiO_2 while the bottom high-index ridge region is a 320-nm-thick Bi:YIG rib on top of a 260-nm-thick Bi:YIG platform. The team designed the waveguide structure such that transverse electric and transverse magnetic modes are phase-matched and low-loss but with sufficient mode overlap in the Bi:YIG medium to cause the polarization rotation. The design could lead to miniature integrated circuitry that is capable of modulating polarization at speeds as fast as 10 GHz. *DP*

HIGH-HARMONIC GENERATION

Selective filtering

Light Sci. Appl. **5,** e16170 (2016)

A simple scheme for selecting a particular high harmonic in the vacuum-ultraviolet and extreme-ultraviolet regions could prove useful for creating a spectrally pure source of short-wavelength light for applications in spectroscopy, holography and microscopy. When intense ultrashort pulses interact with a jet of a noble gas, a number of short-wavelength high harmonics are created and filtering them can be difficult. Researchers from ETH Zurich in Switzerland have now shown that it is possible to use the generating medium itself as a filter for one particular harmonic if the set-up is arranged in a non-collinear geometry that introduces a phase mismatch for adjacent harmonics. A filter contrast of up to 10^4 for the selected harmonic is possible with the scheme. Working with a 400 nm driving field focused to intensities of 10^{12}–10^{13} W cm^{-2} and various gases (Xe, Kr, Ar and Ne), the team observed selective emission of 133 nm, 80 nm or 56 nm light using the approach. *OG*

2D MATERIALS

Electron–hole interaction

Nat. Phys. http://doi.org/bvg6 (2016)

High-harmonic generation (HHG) is an important nonlinear optical phenomenon occurring in a material on the attosecond timescale. However, the effect of electron–hole interactions on the generation process is still unknown. Now, Hanzhe Liu and co-workers from the SLAC National Accelerator Laboratory and Stanford University in the USA have analysed the role of electron–hole interactions by investigating HHG in a 2D material, an isolated monolayer MoS_2 crystal. The sample was excited at normal incidence by 160 fs mid-infrared pulses at a photon energy of 0.3 eV, well below the direct bandgap of around 1.8 eV. Linearly polarized pump pulses with intensity up to 2.5 TW cm^{-2} at a 1 kHz repetition rate were sent to the sample. The output spectrum exhibited distinct peaks corresponding to the generation of harmonics. Both even and odd harmonics were observed from the isolated monolayer MoS_2, while only odd harmonics were observed from an equivalent layer in the bulk MoS_2. In the monolayer, the emergence of even harmonics is a consequence of the broken inversion symmetry, while the odd harmonics were enhanced due to the strong Coulomb interaction between electrons and holes. *NH*

NANO-OPTICS

Exceptional plasmonics

Phys. Rev. B **94,** 201103(R) (2016)

The coexistence of two energy levels and eigenstates to form so-called exceptional points (EPs) has been predicted and demonstrated in various physical systems including 2D microwave cavities and coupled atom–cavity systems. However, EPs in 3D plasmonic systems are elusive so far. Ashok Kodigala, Thomas Lepetit and Boubacar Kanté at the University of California San Diego, USA, have now theoretically shown that EPs can occur in 3D systems of coupled plasmonic nanoresonators. This is achieved by tailoring suitable near-field and far-field interactions to yield the required field distributions. The specific 3D system studied consists of three rectangular bars of gold with carefully designed dimensions so that they are resonant at an excitation vacuum wavelength of 1.55 μm (that is, frequency of 193.5 THz). The bars are placed close together and their relative positions adjusted, and the resultant mode coupling analysed by a non-Hermitian effective Hamiltonian approach. The theoretical results show that appropriate placement of the bars resulted in mode symmetry enabling an EP at a frequency of ~212 THz. *DP*

OPTICAL MICROSCOPY

Out-of-focus benefits

Optica **3,** 1422–1429 (2016)

A current bottleneck in imaging is the limited amount of information that can be digitally captured from an optical system. An assessment of recent literature on coherent microscopy and digital holographic imaging by Hongda Wang and collaborators has highlighted this point by revealing the mismatch between the pixel count of common image sensor chips (less than 4 megapixel) and the space–bandwidth product (SBP) of conventional microscope objectives (8–25 megapixel). To remedy the situation, the authors developed a computational imaging method that makes use of a stack of defocused images with a wide field of view (FOV) to improve the system's SBP and to create high-resolution images. The team use an illumination source at 532 nm, a standard bright-field microscope, a 1.45 megapixel charge-coupled device (CCD) sensor and a demagnification camera adapter (0.35×). A stack of out-of-focus intensity images is generated by vertically scanning the objective lens with respect to the sample plane and an iterative algorithm processes the information within them to recover high-resolution images. A stack of 3–5 out-of-focus images is sufficient to enhance the SBP of the system by a factor of ~8. *GD*

Written by Gaia Donati, Oliver Graydon, Noriaki Horiuchi and David Pile.