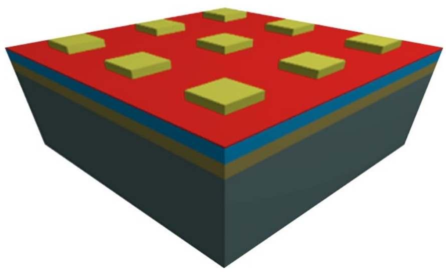
METAMATERIALS

Broadband absorption

ACS Photon. http://doi.org/ck72 (2018)



Credit: American Chemical Society

The ability to engineer the absorption of light is important, especially for devices such as solar cells and photodetectors, for example. An epsilon-near-zero (ENZ) material, which has a permittivity that approaches zero near a specific wavelength of light, can exhibit very strong absorption but only in a narrowband region around this wavelength. Now, Joshua Hendrickson and colleagues in Ohio and Alabama, have found a way to increase the absorption bandwidth of an ENZ material by an order of magnitude, achieving a 240-nm-wide band with >98% absorption centred at the telecom 1,550 nm wavelength. This broadband behaviour was enabled by coupling the ENZ mode to a gap plasmon resonance in a structure that consists of (from the bottom up) a TiN metal ground plane, SiO_2 dielectric spacer layer, indium tin oxide (ITO) nanofilm, and finally, an array of gold squares. The authors also emphasize that the idea can be tailored to other spectral regions by structural scaling and appropriate choice of ENZ material. *DFPP*

https://doi.org/10.1038/s41566-018-0146-z

SPECTROSCOPY

Nanoparticle identification

Angew. Chem. Int. Ed. **56**, 14178–14182 (2017)

An optical scheme for checking the composition of individual nanoparticles with masses on the scale of attograms has been demonstrated by scientists in Spain. The approach, developed by Pablo Purohit, Francisco Fortes and Javier Laserna from the Universidad de Malága, combines optical trapping with laser-induced breakdown spectroscopy (LIBS) and has been tested with a variety of copper nanoparticles. A powder sample of the nanoparticles is dispersed into an aerosol by the use of an air plasma schock wave and a single nanoparticle is then suspended in an optical trap. A single laser shot from a pulsed Nd:YAG laser is then directed onto the trapped nanoparticle and serves to excite a LIBS optical emission spectrum that is collected and analysed by a fibre-coupled spectrometer. Results indicate that the scheme is able to identify the chemical composition of copper nanoparticles with masses and sizes as small as ~33 attograms and 25 nm, respectively. *OG*

https://doi.org/10.1038/s41566-018-0147-y

MID-INFRARED OPTICS

On-chip spectroscopy

APL Photon. **3**, 021301 (2018)

Spontaneous parametric down-conversion (SPDC) spectroscopy is attracting attention as it offers a means for performing mid-infrared (mid-IR) spectroscopy without the need for dedicated sources and detectors in the mid-IR, which can be expensive and are limited in performance. Instead, the scheme harnesses the principles of nonlinear optics to split a short-wavelength pump photon into a pair of photons (a long-wavelength (mid-IR) idler photon and a short-wavelength signal (visible or IR) photon) using a nonlinear crystal. Correlations between the signal and idler photons mean that collecting information about one also provides information about the other. As a result, the short-wavelength signal photon can be read out using affordable, high-performance detection equipment while the mid-IR idler photons probe the sample. To date, demonstrations of the technique have relied on the use of bulk nonlinear crystals, but scientists in Australia and Germany have now shown that it should be possible to create an integrated on-chip version using lithium niobate waveguides to perform the SPDC. Their experiments with pump wavelengths in the 740–780 nm range and Ti-diffused $LiNbO_3$ waveguides suggest that idler wavelengths as long as 2.5 μm can be generated. An on-chip system employing such waveguides would not only be compact but should also offer a high SPDC efficiency of up to 9×10^6 photon pairs per second for just 0.5 mW of pump power. *OG*

https://doi.org/10.1038/s41566-018-0149-9

QUANTUM OPTICS

Topological data analysis

Optica **5**, 193–198 (2018)

A six-photon quantum processor has been used to perform topological data analysis in a proof-of-principle experiment. Built by scientists in China and Australia, the processor, which makes use of three pairs of entangled photons generated in beta barium borate crystals, was programmed with a quantum algorithm that calculates the Betti numbers of data points. Betti numbers are important metrics used in topological analysis of datasets and can help extract useful information about the underlying structure of noisy or incomplete data. In this case, the algorithm was applied to a dataset of three data points. While the current demonstration is only performed with a small-scale quantum processor and a small number of data points, the research team believe that with a larger processor employing more qubits, the scheme could be extended to analysis of much larger datasets. *OG*

https://doi.org/10.1038/s41566-018-0148-x

SPINTRONICS

Optical spin transfer

Nano Lett. http://doi.org/ck73 (2018)

All-optical switching of a material between antiferromagnetic and ferromagnetic behaviour is important for information processing and recording technology. Now, by investigating a wide range of multisublattice magnetic materials, John Dewhurst and co-workers from Germany have unveiled the microscopic mechanism for the switching. A laser pulse with a duration of 25 fs and an energy fluence of 16 mJ cm^{-2} was sent to a multilayer material system consisting of two monolayers of Mn and four monolayers of Co. The time evolution of the ground-state magnetic moment of each layer and the flow of optically induced spin-selective charge were measured. Following exposure to the optical pulse, the magnetic moment of one of the Mn monolayers changed and the multilayer consequently became demagnetized at a time of 29 fs after pulse irradiation. The German scientists further investigated Fe/Mn multilayers using a laser pulse of duration of 12.5 fs and found that the demagnetization occurred around 12–15 fs. These results seem to demonstrate that optically induced charge flow is the key to controlling spin dynamics. *NH*

https://doi.org/10.1038/s41566-018-0150-3

Oliver Graydon, Noriaki Horiuchi and David F. P. Pile