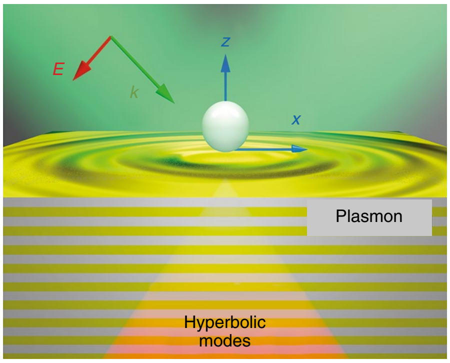
OPTICAL MANIPULATION

Metasurface with pull

ACS Photon. **5**, 4371–4377 (2018)



Credit: American Chemical Society

Using light to manipulate small particles has proven an indispensable tool for ‘tweezing’, sorting and force measurements. To achieve effective optical traps with high ‘stiffness’, researchers often go to great lengths to tailor light fields, for example by using holographic elements. Now, Aliaksandra Ivinskaya and colleagues from Russia, the USA, the UK and Israel predict that small particles can be manipulated using a plane wave of light and a simple flat surface of an anisotropic media supporting hyperbolic modes. Their hyperbolic metamaterial is composed of metal and dielectric layers and is potentially less affected by losses and offers more broadband capability than purely plasmonic approaches. In their theoretical study a small dielectric sphere near a hyperbolic metamaterial is considered. The particle is sufficiently small to provide the required momentum to excite both surface plasmon and bulk hyperbolic waves from incident plane waves. Strong optical pulling forces were predicted over the 400–800 nm wavelength range thanks to the broadband high density of states of hyperbolic modes. *DFPP*

https://doi.org/10.1038/s41566-018-0333-y

NANO-OPTICS

The photonic candle

Opt. Express **26**, 31706–31716 (2018)

By adding a nanoscale central hole to the core of an optical fibre scientists in Jena, Germany have realized a convenient lens-free scheme for focusing light exiting the fibre. Henrik Schneidewind and co-workers fabricated silica glass fibres with a 4-μm-diameter GeO_2-doped core and a 400-nm-diameter hollow bore. Measurements and simulations show that the intensity distribution of visible (650 nm) light leaving the fibre starts with an annular shape close the fibre end (distance <3 μm), but then evolves into a bright spot for distances of 4–15 μm, before diverging. A spatial plot of this intensity profile versus distance resembles the shape of a candle’s flame, thus inspiring the team’s name for the innovation of ‘photonic candle’. The team says that the scheme’s key attraction is its simplicity. No post-processing or nanostructuring is required for the focusing, it is simply a case of a high-quality flat cleave of the fibre end. Potential applications that may benefit from the approach include optical trapping, bioanalytics or experiments in quantum optics. *OG*

https://doi.org/10.1038/s41566-018-0335-9

WAVELENGTH CONVERSION

Compact and efficient

Optica **5**, 1438-1441 (2018)

Although periodically poled lithium niobate (PPLN) waveguides are a popular choice for constructing optical wavelength converters due to their large χ^2 nonlinear coefficient, long device lengths and high pump powers are often needed. Now, Cheng Wang and colleagues from the USA and Hong Kong have fabricated a nanostructured PPLN waveguide and used it to enable efficient nonlinear wavelength conversion in smaller device geometries. The device is fabricated on an x-cut magnesium-oxide-doped lithium-niobate-on-insulator substrate, with metal poling finger electrodes patterned on top. The poled region has a width and length of 75 μm and 4 mm, respectively. Each poled region has three ridge waveguides and a poling period of 4.1 μm. The device yielded second-harmonic generation at 1,550 nm with an efficiency more than an order of magnitude higher than the previous record in PPLN waveguides. *RW*

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SEMICONDUCTOR LASERS

Ultrawide tunability

Appl. Phys. Lett. **113**, 201105 (2018)

The ability to tune the wavelength of a laser over a broad spectral range is desirable for many photonics applications. Now, Xiaowei Wang and co-workers from the USA demonstrate room-temperature, efficient, wide tuning of 250 nm using tensile-strained nanomembranes of InGaAs, a popular active material for making infrared diode lasers. The nanomembrane is formed by a 100-nm-thick InGaAs film grown by molecular beam epitaxy and lattice-matched to an InAlAs layer on InP. After fabrication, a thin layer of photoresist is spin-coated onto the InGaAs film and the film is subsequently released from the underlying sacrificial materials resulting in a free-standing membrane. The nanomembrane has lateral dimensions of about 5×5 mm^2 and is bonded to a 125-μm-thick flexible film of polyimide. It is mounted on a rigid cell that is pressurized with a controlled gas flow to introduce biaxial tensile strain. The team measured a large red shift in the peak light emission from 1,650 nm to 1,900 nm at the highest measured pressure of 620 kPa that caused a biaxial tensile strain of over 1.1%. *RW*

https://doi.org/10.1038/s41566-018-0336-8

SILICON PHOTONICS

Electro-optic integration

Nat. Mater. https://doi.org/gfh3qg (2018)

Silicon is a popular material for constructing nanoscale optical devices, but has the drawback of not having an electro-optic Pockels effect due to its centrosymmetric crystalline structure. Now, Stefan Abel and co-workers from Switzerland, the USA and Spain have developed a fabrication process to allow materials with a large Pockels effect to be integrated with nanoscale silicon photonic devices. The team epitaxially grew single-crystalline $BaTiO_3$ on a silicon substrate. Then, a 5- to 10-nm-thick Al_2O_3 layer was deposited on the $BaTiO_3$ layer in order to bond the $BaTiO_3$ layer and another silicon wafer covered with SiO_2. Using these multilayers, optical waveguides and plasmonic phase modulators were fabricated supporting data modulation up to 50 Gbit s^{-1}. The scientists experimentally measured that the Pockels coefficients in the structures were $r_{42} = 923 \pm 215$ pm V^{-1} and $r_{33} = 342 \pm 93$ pm V^{-1}. *NH*

https://doi.org/10.1038/s41566-018-0334-x

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