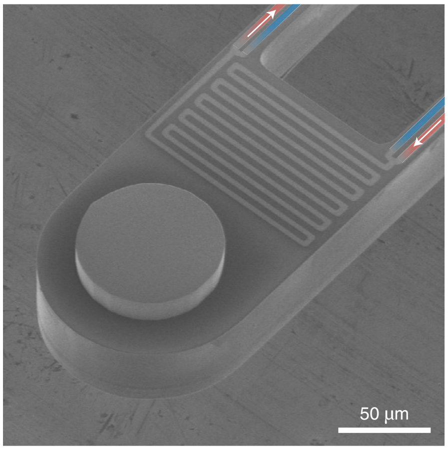
NANOPHOTONICS

Cooling without lasers

Nature **566**, 239–244 (2019)



Credit: Springer Nature Limited

While coherent laser radiation is usually required in optical cooling schemes such as Doppler cooling, recent work has suggested that optical cooling may be possible simply using a conventional photodiode instead. The idea, however, requires precisely parallel nanogaps of vanishingly small gap widths. And, the measurement of the cooling itself is also a challenge. Now, Linxiao Zhu and colleagues at the University of Michigan, USA, claim to have experimentally achieved this feat and report room-temperature, high-vacuum (10^{-6} torr) optical cooling in a nanocalorimetric device adjacent to a photodiode. The team place the planar surface of the calorimeter at nanoscale distances from the planar surface of a photodiode with extreme precision using a custom nanopositioner that enables the gap angle and distance to be controlled with 2.5-nm resolution. For a sufficiently small enough gap (less than 10 nm or so), optical near-field coupling occurs and cooling of the calorimetric device results due to enhanced transport of photons across the gap. Additionally, the photodiode is held under reverse bias to suppress photon emission. In the future, such nanophotonic cooling may enable new opportunities for on-chip solid-state refrigeration of optoelectronics. *DFPP*

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NONLINEAR OPTICS

Hyper-Rayleigh scattering

Phys. Rev. X **9**, 011024 (2019)

Chiral molecules and nanostructures are known to exhibit interesting polarization phenomena such as optical activity (rotation in the polarization of a linear light beam as it passes through a medium) and circular dichroism (differential absorption of left- and right-handed circularly polarized light). Now, Joel Collins and co-workers from the UK, Germany and Belgium have observed circular dichroism in second-harmonic hyper-Rayleigh scattering (HRS) for the first time. For the observation, silver nanohelices with a helical diameter (50 nm) much smaller than the wavelength of illumination (720–780 nm) and a wire radius of 12.5 nm were suspended in water. Left- or right-circularly polarized pulses were focused inside a glass cuvette filled with the liquid sample. The observed HRS signal was markedly stronger than the signal from multi-absorption effects. Importantly, clear differences in HRS intensity between left- and right-circularly polarized pulses was observed: (1) right-circularly polarized pulses generated HRS from the sample with left-handed nanohelices more strongly than the left-circularly polarized pulses; and (2) the magnitude relation in the HRS intensity changed when the sample with left-handed nanohelices was measured. *NH*

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ORGANIC LIGHT-EMITTING DIODES

Efficient copper complex

Science **363**, 601–606 (2019)

The use of copper complexes to make efficient blue organic light-emitting diodes (OLEDs) has taken a step forward with the demonstration of a two-coordinate Cu(I) complex that offers almost perfect luminescence efficiency. Rasha Hamze and co-workers from the University of California, USA, report that their Cu(I) emitters, CAAC–Cu–amide complexes, emit light with a quantum efficiency of >99% thanks to the absence of non-radiative decay. Blue OLEDs based on the compounds doped in a host of UGH3 emit blue light at around 460 nm and feature a turn-on voltage of around 3 V with a maximum external quantum efficiency of about 9% at a drive current density of 2 mA cm^{-2}. *OG*

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GHOST IMAGING

On-chip approach

Opt. Express **27**, 3817–3823 (2019)

Ghost imaging is being explored for many applications such as remote sensing at low light levels, time-resolved 3D imaging and flow cytometry. However, existing ghost imaging systems can be bulky because of the spatial light modulator that is usually employed to generate the required illumination pattern. Now, Yusuke Kohno and co-workers from Japan have reported the use of a large-scale silicon photonic optical phased array (OPA) chip as an alternative solution. Their OPA chip (4 mm × 4 mm footprint) features 128 phase shifters and makes it possible to perform ghost imaging with over 90 resolvable points in one dimension, without the need for any calibration. The extension to 2D imaging was also reported by using an off-chip diffraction grating and a tunable laser to cover another axis. With the possibility of integrating grating couplers and a light source on the same chip, the team say that a single-chip, ultra-high-speed, 2D ghost imaging module could be realized in the future. *RW*

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INTEGRATED OPTICS

Low-loss solution at short wavelengths

APL Photon. **4**, 026101 (2019)

Silicon, with a bandgap at 1.1 µm, strongly absorbs visible and ultraviolet light and thus is not a suitable material for constructing integrated optical circuits that operate in these regions. However, it now appears that aluminium oxide (alumina) with a bandgap of between 5.1 and 7.6 eV (~163–243 nm) could be a promising contender. Gavin West and colleagues from the USA have demonstrated a low-loss integrated photonics platform from alumina that operates in the visible and near-ultraviolet regime. Using atomic layer deposition of alumina followed by reactive ion etching, the team was able to create waveguides with steep, smooth sidewalls. Propagation losses were measured to <3 dB cm^{-1} and <2 dB cm^{-1} at 371 nm and 405 nm, respectively. The team also fabricated ring resonator structures with a 500 nm waveguide width and 90 µm radius, and obtained intrinsic quality factors higher than 470,000 at 405 nm. The thermo-optic coefficient of the resonator was 1.68×10^{-5} RIU °C^{-1}, which was comparable to that of silicon nitride at telecom wavelengths. The team pointed out that lower loss is possible by reducing the sidewall roughness. *RW*

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