LIGHT SOURCES

Chip-based thermal emitter

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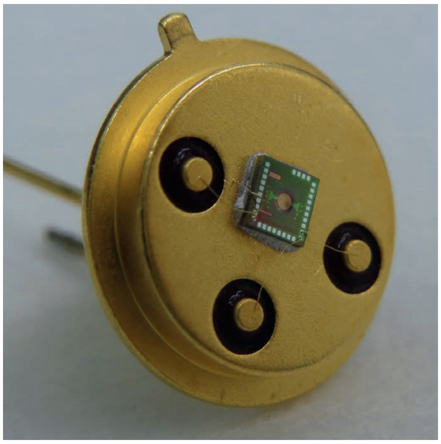

ACS

An on-chip narrowband thermal light emitter operating in the mid-infrared wavelength range has been developed by scientists in Switzerland. The device, which could help simplify gas sensing, combines microelectromechanical system (MEMS) heater technology with metamaterial emitter structures. From bottom to top, the emitter consists of a complementary metal-oxide–semiconductor (CMOS) substrate, a MEMS hotplate, a metamaterial perfect emitter (MPE) structure with cross-shaped top resonators, and an Al_2O_3 sealing layer. The metamaterial unit cell dimensions (rectangular array with a periodicity of 2.243 μm, top resonator length of 963 nm, and top resonator width of 187 nm) were designed for maximum emissivity at a resonance wavelength of 4.04 μm with a full-width at half-maximum of 254 nm, which corresponded to a quality factor of 15.9. The MPE area was 4 mm × 4mm, containing 3.2×10^6 unit cells. The emitter and a thermopile detector were both located in a measurement container filled with CO_2. The sensitivity of the MPE sensor system was 1.7×10^{-4}% per ppm, which is a 5-fold increase in relative sensitivity compared with a conventional blackbody emitter. *NH*

TERAHERTZ SCIENCE

Ultrafast pulse switching

APL Photon. **2,** 036106 (2017)

The gating time of conventional electro-optical switches is on the order of several nanoseconds and is limited by the response time of the Pockels effect. To achieve a gating time on the femtosecond timescale, Mostafa Shalaby and co-workers from Switzerland have now developed a diamond-based terahertz (THz)-driven optical modulator, using a thin disk of diamond (0.5 mm thick, 4.5 mm diameter). Intense THz pulses (field strength of 83 MV cm^{-1} with a spectral peak at 3.5 THz) from the Swiss free-electron laser facility were sent through the diamond disk collinearly with infrared 50-fs pulses centred at 800 nm. The phase retardation of the 800-nm pulse induced by the Kerr nonlinearity was proportional to the THz peak intensity. A polarizer was used to filter out the polarization of the switched pulse. Gating with a time response of 125 fs was obtained. This gating technique was also employed to perform 3D imaging of THz pulses. The 2D intensity profiles of the THz pulse were measured by a CCD sensor as a function of the delay time between the THz pulse and the 800-nm pulse. The reconstructed 3D pulse resembled a cigar-like shape. *NH*

OPTICAL PHYSICS

Transparent perfect mirror

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Transparent 'perfect' mirrors — one-way mirrors that transmit or reflect light completely depending on the direction of view — are useful for security, privacy and camouflage purposes. However, current designs are not perfectly reflective. Now, Ali Jahromi and colleagues from the USA and Finland have demonstrated a new design based on a non-Hermitian configuration — an active optical cavity — that may overcome this limitation. At a critical value of prelasing gain that is termed Poynting's threshold, all remnants of the cavity's structural resonances disappear in the reflected signal. At this point, the reflection becomes spectrally flat and light incident on the cavity is 100%-reflected at all wavelengths continuously across the gain bandwidth independently of the reflectivities of the cavity mirrors. Thus, the device at Poynting's threshold becomes indistinguishable from a perfect mirror. The researchers have confirmed these predictions in an integrated on-chip active semiconductor waveguide device and in an all-optical-fibre system. They note that Poynting's threshold is, however, dependent on polarization and incidence angle, and that observing the reflection of coherent pulses may reveal the cavity structure via its decay time. Since the concept of Poynting's threshold is a universal wave phenomenon, it can be exploited in many areas including microwaves, electronics, acoustics, phononics and electron beams. *RW*

QUANTUM OPTICS

Cosmic random numbers

Phys. Rev. Lett. **118,** 140402 (2017)

Cosmic photons emitted by celestial objects can be used to create a highly effective optical random number generator (RNG) and perform improved tests of Bell's inequalities. Scientists in China pointed a 1-m-diameter telescope at a variety of cosmic radiation sources, ranging in brightness (magnitude between 4.85 and 13.5) and distance (between 756 and 7.49×10^8 light years), and used a CCD camera and a single-photon avalanche diode to detect the emission and measure the arrival time. As the generation time of the photons is random, it dictates that arrival time is as well. The tests took place at the Astronomy Observatory at Xinglong, China. Photon-counting signal rates were sufficient to generate raw random bits at a rate exceeding 10^6 s^{-1} that pass the standard NIST statistical tests, demonstrating that the method is not only effective but is as efficient as laser-based RNGs. By using two such telescope set-ups in different labs and combining their outputs it is possible to make a cosmic-based Bell test with greater confidence than usual against loopholes, a feat accomplished in a separate experiment by scientists in Vienna (J. Handsteiner *et al.*, *Phys. Rev. Lett.* **118,** 060401; 2017). *OG*

TOPOLOGY

Laser-induced superconductor

Phys. Rev. B **95,** 134508 (2017)

Motivated by recent findings on realizing topological phases in graphene by laser light, Kazuaki Takasan and co-workers from Kyoto University, Japan, have proposed a possible way to realize topological superconductivity in well-known materials. They discovered that topological superconductors can be realized in *d*-wave superconductors, such as cuprate, when irradiated by circularly polarized laser light. Essentially, they applied Floquet theory to a model of *d*-wave superconductors with Rashba spin–orbit coupling under irradiation of the laser light. They discovered that the system acquires a topologically non-trivial nature. They pointed out that their proposal has two advantages for experimental realization: first, in theory, the topologically non-trivial states can be realized by the infinitesimal intensity of laser light; second, the laser-induced magnetic field does not induce vortices that suppress the superconducting states. Thus, the proposed scheme provides a promising way to dynamically realize a topological superconductor in cuprates. *RW*

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