SPECTROSCOPY

Single-shot in the VUV

Optica **4,** 871–878 (2017)

The ability to perform single-shot intensity autocorrelation measurements and pump–probe spectroscopy in the vacuum-ultraviolet (VUV) region of the electromagnetic spectrum has been demonstrated by scientists in Hamburg, Germany. The team have tested their scheme at a wavelength of 162 nm using an ultrashort, fifth-harmonic pulse of a Ti:sapphire laser and captured an intensity autocorrelation trace that allowed the pulse duration to be determined as 18.4 ± 1 fs (full-width at half-maximum). The autocorrelation measurement was performed using an all-reflective set-up that consists of a silicon wedge mirror that acts as a beamsplitter to split the VUV pulse into two paths and then uses sets of spherical and plane mirrors to focus and route the counter-propagating split pulses so that they meet at a common focus in the vicinity of pulse of a noble gas jet of Kr or Xe. Non-resonant two-photon ionization of the gas serves as an autocorrelation signal and is captured by an ion-imaging time-of-flight spectrometer. A proof-of-principle pump–probe experiment using the 162 nm VUV pulses was also performed to study the dissociation dynamics of O_2. *OG*

QUANTUM INFORMATION

Single-photon subtraction

Phys. Rev. X **7,** 031012 (2017)

Young-Sik Ra and co-workers from Collège de France have developed a mode-tunable coherent single-photon subtractor based on sum-frequency generation.

A femtosecond laser (central wavelength of 795 nm) was divided into two as input and gate beams with Hermite–Gaussian (HG) time–frequency modes. The two beams were focused onto a BiBO crystal to generate a frequency up-converted photon via sum-frequency generation. When the up-converted photon was detected by a single-photon detector, subtraction of a single photon from the input beam was heralded. The choice of the gate-beam mode determined the time–frequency modes of single-photon subtraction. To characterize single-photon subtraction with various choice of the gate-beam modes, the subtraction matrix of each single-photon subtraction was measured by employing coherent-state quantum process tomography. The subtraction matrices in the HG modes directly showed the coherence between different HG modes. A high mode selectivity (typically larger than 0.9) and low imperfections (dark count contribution around 1% and optical loss around 2%) of the single-photon subtractor showed its direct applicability to generate multimode non-Gaussian states. *NH*

NANOANTENNAE

Superdirectivity

Phys. Rev. X **7,** 031017 (2017)

The realization of highly directional antennae with needle-like radiation patterns would be useful for communication between multiple transmitters and receivers, and researchers have long considered ways to achieve such a feat. Recently, significant progress has been made with the realization of micro- or even nanoscale directional antennae based on dielectric and metallic nanoparticles. However, in miniaturized systems it has proven difficult to achieve extreme directivity due to the physical limitations and difficulty in fabricating structures. Now, Richard Ziolkowski from University Technology Sydney in Australia has theoretically demonstrated how to achieve true needle-like radiation from currents driven on a spherical surface. Importantly, limitations on how small the sphere can be, and still achieve good directivity, are defined. Ziolkowski investigated a variety of Huygens source set-ups and superdirective radiation is predicted from an annular array of dielectric resonators. This design of dielectric resonator antenna is a good candidate for experimentally realizing a Huygens multipole system as it should be feasible to fabricate. The antenna concept may have applications not only for communications but also for subwavelength imaging. *DP*

PHOTODETECTORS

Slim semiconductor

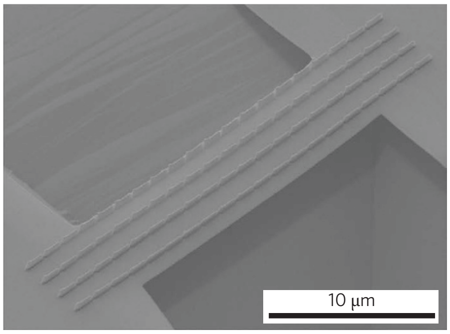
Sci. Adv. **3,** e1602783 (2017)

The use of ultrathin layers of semiconductor is potentially attractive for realizing fast, miniaturized optoelectronic devices; however, the absorption of light in such ultrathin layers can be very inefficient. Now, researchers in the USA have made photodetectors from nanomembranes of single-crystal Ge that are only tens of nanometres thick, yet yield good absorption and performance. The key to the advance is using a membrane transfer-printing method to put the thin crystalline Ge films directly onto optical nanocavities that enhance the light–matter interaction. The optical cavities themselves are formed by a dielectric layer of Al_2O_3 sandwiched between the Ge and a thin silver 'mirror' on silicon. The Ge is thinned down to desired thicknesses between 10 to 60 nm, confirmed by atomic force microscopy. For a 20-nm-thick Ge film photodetector, an absorption of ~16% of the light at a wavelength of 733 nm would be typical, however, the team achieved a much greater value of 81% in their cavity-enhanced design. The photodetector was fabricated with a 17-nm-thick gallium-doped (p-type) Ge film and delivered a photoresponsivity of up to 4.7 A W^{-1}. The dark current is small due to the low volume of the semiconductor used; with a normalized photocurrent to dark current of ~10^5 mW^{-1}. The approach is not limited to Ge and in principle can be applied to other semiconductors. *DP*

OPTOMECHANICS

Wavelength meter

Appl. Phys Lett. **111,** 013102 (2017)



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By adding a gold nanofin photonic absorber to a high *Q*-factor nanomechanical resonator scientists in Japan have made a highly sensitive wavelength detector with subpicometre resolution. The miniature device built by Etsuo Maeda and Reo Kometani from the University of Tokyo has a wavelength sensitivity of ~0.2 pm in a 10-nm range in the near-infrared (1,545–1,555 nm). Incident light in this spectral window is absorbed by the gold nanofin array and induces thermal stress, resulting in a frequency shift of the eigenfrequency of a silicon nanomechanical resonator underneath, on the scale of up to 40 kHz. The exact wavelength of the incident light is determined precisely by measuring the size in the shift in mechanical resonant frequency using a laser Doppler vibration meter. Importantly, the device operates at the transmission wavelength of optical communications systems. *OG*

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