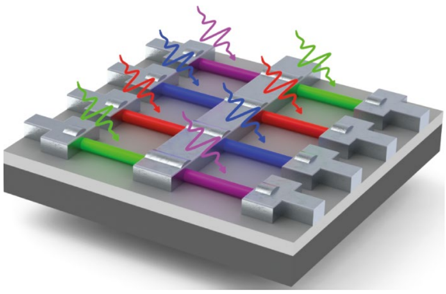
research highlights

SILICON PHOTONICS

Nanowire detectors

Nano Lett. **18**, 190–201 (2018)



Credit: American Chemical Society

The broadband nature of silicon detectors means that while they are capable of detecting visible light they are unable to distinguish between distinct colours without the use of colour filters, adding complexity. Now, a team of Israeli scientists from Tel Aviv University and Technion have fabricated silicon nanowire detectors (20 × 300 nm in size) that are only sensitive to specific colours. The spectral selectivity originates from covalently attaching different organic fluorophores that absorb light of a specific wavelength and inject electrons into the nanowire. These photoinduced electrons change the conductivity of the nanowire, a change that can be electrically sensed in a field-effect transistor configuration. A variety of nanowire detectors functionalized with Alexa-610, Alexa-555, Alexa-488 and Alexa-430 fluorophores, so that they responded to red, green, blue and violet light, respectively, were fabricated. *OG*

https://doi.org/10.1038/s41566-018-0099-2

IMAGE SENSORS

Monolithic mid-IR array

Optica **4**, 1498–1502 (2017)

Mid-infrared image sensor chips are useful for sensing gases that have absorption bands in the 3–5 μm spectral window such as methane, carbon dioxide, carbon monoxide and nitrous oxide. However, present designs are expensive as a photodetector array made from HgCdTe or InSb needs to be flip-chip bonded to silicon read-out electronics. Now, scientists in the UK claim to have made the first monolithic mid-IR imaging array based on on-chip integration of InSb photodetectors with GaAs read-out circuitry. Arrays that operate at room temperature and support video-rate imaging have been fabricated and tested with a variety of mid-IR sources including a glow bar and a quantum cascade laser emitting light at 4.57 μm. At this wavelength, a responsivity of 5,000 V W^{-1} and a specific detectivity of 6.12×10^7 cm $Hz^{1/2}$ W^{-1} are obtained. While these devices are limited in their fill factor of ~14% and array size of up to 8 × 8 pixels, the team says that devices with values as large as 60% and 64 × 64 pixels, respectively, should be possible. *OG*

https://doi.org/10.1038/s41566-018-0100-0

QUANTUM DOTS

Dark exciton study

APL Photon. **2**, 121303 (2017)

Matter qubits based on the spin of so-called dark excitons (DEs) are promising for applications in quantum information processing but are hard to extract. Now, Tobias Heindel and co-workers from Germany and Israel have fabricated microlenses above pre-selected InGaAs quantum dots (QDs) and demonstrated all-optical preparation and read-out of the DE spin. A layer of self-organized InGaAs QDs capped with 400 nm of GaAs was fabricated on a distributed Bragg reflector with 23 AlGaAs–GaAs mirror pairs. Microlenses were fabricated by shaping the capping layer via 3D in situ electron-beam lithography. Optical experiments were performed in a confocal micro-photoluminescence set-up at temperatures in the range of 4–20 K. The sample was excited using a wavelength-tunable continuous-wave Ti:sapphire laser at a wavelength between 850 and 880 nm. Correlations between photons emitted from different spectral lines were studied by means of polarization-sensitive intensity cross-correlation measurements. *NH*

https://doi.org/10.1038/s41566-018-0101-z

NONLINEAR OPTICS

Optical coin toss

Phys. Rev. X **7**, 041050 (2017)

Random bit sequences are important for cryptography, but hardware-based generators can introduce unwanted bias. Now, Tobias Steinle and collaborators in Germany have demonstrated an all-optical random bit generator by exploiting the bistable output of an optical parametric oscillator (OPO). In this scheme there are only two possible states, 'distanced' by more than 400 standard deviations, that can be regarded as 0 and 1 without ambiguity. The authors achieve the bistability using a lithium niobate-based OPO pumped by a mode-locked Yb:KGW oscillator (450 fs pulse duration, 1,032 nm centre wavelength) and the output was detected by a reverse-biased InGaAs photodiode. The system was pumped into the 'period-2' (P2) state (which gives pulses with alternating pulse energy, peak power and spectral properties) and the OPO was switched by an optical chopper for the random bit stream generation. At present, the random bit rate is limited by the 10 kHz chopper, but the relaxation time of the process is on the order of several hundred nanoseconds and by using a faster chopper, rates of 1 MHz, or even higher with a faster pump laser repetition rate, are possible. *DFPP*

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MAGNETO-OPTICS

Ultrafast optical Faraday effect

Phys. Rev. B **96**, 224301 (2017)

Michael Wismer and colleagues from Germany and the USA have now predicted an ultrafast optical Faraday effect in an achiral transparent dielectric. The phenomenon could be attractive for studying chiral dynamics with attosecond temporal resolution. In the pump–probe measurements performed by the researchers, a 5 fs circularly polarized few-cycle infrared (IR) pump pulse impinges at normal incidence along the optical axis of a sapphire crystal. A weak 2.5 fs linearly polarized ultraviolet pulse is used to probe the induced optical Faraday effect. Analysis shows that under a strong 1 V $Å^{-1}$ IR field, the induced chirality vanishes for probe delays longer than the duration of the IR pulse and the ellipticity of the probe pulse has an oscillatory dependence on the pump–probe delay. The team attributed the ultrafast Faraday effect to the relaxation of time-reversal symmetry due to a transient transfer of angular momentum from light to matter. The findings may be useful for developing ultrafast all-optical circular-polarization modulators, isolators and circulators. *RW*

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