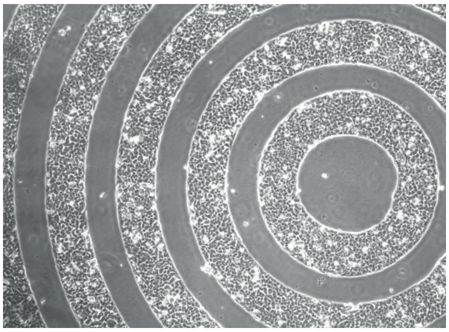
BIOPHOTONICS

Cell oscillators

Phys. Rev. X **6,** 031001 (2016)



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Optogenetics and lithography has been used to create concentric ring-like patterns of cells that act as optically controlled natural oscillators for electrical waves. A team of scientists from Harvard University and the Howard Hughes Medical Institute engineered a human embryonic kidney (HEK) cell line with four transgenic components — an inward rectifier potassium channel ($K_{ir}2.1$), a voltage-gated sodium channel ($Na_v1.5$), a blue light-activated channelrhodopsin (CheRiff) and a red light-excited fluorescent voltage indicator (QuasAr2). On stimulation with blue light, unidirectional electrical waves are excited in rings of 2, 3 or 4 mm diameter that were created by using soft lithography to encourage cell growth in annular patterns. These waves serve as a topological bit of information with data stored in the direction of electrical circulation. Importantly, the wave can be stopped or the direction reversed by illumination with a bar of light crossing the ring. Tests with oscillations in concentric rings indicate that these cellular ring oscillators will run stably in excess of 2 hours, and that the oscillation frequency drifts by less than 5 Hz from a value of around 2.3 Hz. *OG*

SQUEEZED LIGHT

Resonance fluorescence

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Quantum optics and 'squeezed' light have been leveraged in applications ranging from improving the measurement precision of gravitational wave detectors to bioimaging. Some other directions have remained more theoretical; researchers previously predicted that resonance fluorescence is modified when the light exciting the atomic system is squeezed and this could be used to characterize light–atom interactions. David Toyli and colleagues from the US and Canada have now experimentally demonstrated this phenomenon. The team coupled squeezed microwaves to a superconducting artificial atom and developed techniques to measure the fluorescence in weak and strong regimes. The fluorescence linewidth was reduced by 3.1 dB compared with a conventional vacuum. Moreover, the Mollow triplet spectrum was shown to depend strongly on the phase of the driving and squeezed vacuum fields. Good agreement between the experimentally measured spectra and the almost 30-year-old predictions was found. The approach may create new directions for microwave quantum photonics such as characterizing squeezing and a new tool for studies on multimode strong coupling and ultrastrong coupling. *DP*

QUANTUM DOTS

Photon sorter

Nat. Nanotech. http://doi.org/bncj (2016)

A device that can sort photons in terms of photon number and polarization has been developed by scientists in the UK. Anthony Bennett and co-workers constructed their photon sorter from a pillar microcavity featuring a single InGaAs quantum dot emitting at 1.332 meV. The transition between the trion state and a single hole was activated by a weak non-resonant optical pump. This weak illumination yields excitons, allowing a hole to be captured into the ground state of the transition. The changes of single- and multi-photon components in the reflected beam were measured using autocorrelation spectroscopy. When the input was blue-detuned from the transition, a single photon was added in phase with the coherent light. On the other hand, when the input was red-detuned, resonantly Rayleigh scattered light was subtracted from the coherent light. Photon sorting by polarization was implemented by using the spin of the hole. Only when the spin of the hole was aligned along the cavity axis, was polarization correlation observed. The results pave the way for semiconductor optical switches operated by single quanta of light. *NH*

PLASMONICS

True silver

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Silver is typically the metal of choice for many plasmonics applications thanks to its relatively low dissipation at optical wavelengths, in particular the He–Ne laser wavelength of 632.8 nm. In much of the visible regime, the ratio of the imaginary to real part of silver's permittivity is considered to be small, leading to low-loss plasmonics. Now, Yajie Jiang, Supriya Pillai and Martin Green at the University of New South Wales, Sydney, Australia report that existing literature on the optical constants of silver are inconsistent leading to inappropriate assumptions sometimes being made for the optical loss in plasmonics experiments as a result. While the optical constants of silver films depend on deposition parameters, such as deposition rate and annealing conditions, the team have shown a way to fabricate silver films with consistent optical constants by exploiting silver nitride membranes. Most importantly, they have carefully characterized the optical constants of the films using multiple-angle, spectrometric ellipsometry and shared the fabrication recipe to enable researchers to replicate the films. The team hopes that the improved data set of silver's optical constants will reduce underestimation of loss when practical applications of plasmonic structures are evaluated. *DP*

QUANTUM OPTICS

Randomness from vacuum

Appl. Phys. Lett. **109,** 041101 (2016)

Previous realizations of quantum random number generators (QRNGs) have relied on phenomena ranging from the vacuum-state fluctuations of the electromagnetic field to phase noise measurements. Now, Yicheng Shi and collaborators have combined a QRNG based on vacuum fluctuations with a fast randomness extractor to produce uniformly distributed random bits at a rate around 480 Mbit s^{-1}. The vacuum fluctuations were measured with a balanced homodyne detector where the vacuum field was mixed with a field generated by a local oscillator (a continuous-wave laser); two photodiodes detected the optical output signals and performed current subtraction. The total noise associated with this photocurrent difference was then fed into an analog-to-digital converter to obtain 16-bit samples. To generate random numbers that are unpredictable as well as uniformly distributed, the digital output was further processed with a randomness extractor based on a linear feedback shift register. *GD*

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