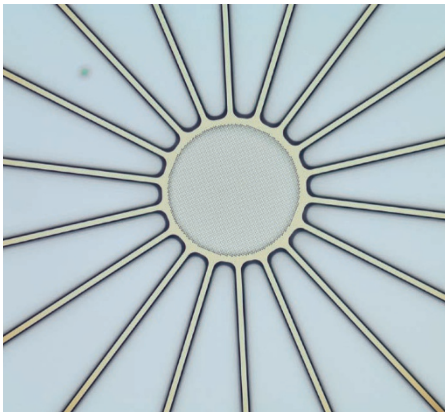
OPTOMECHANICS

Reaching room temperature

Phys. Rev. Lett. **116,** 147202 (2016)



APS

Many goals of the optomechanics community involve quantum mechanics, for example, squeezing of optical and mechanical modes, or ground-state cooling. These types of experiment are technically non-trivial and are typically conducted at cryogenic temperatures due to limitations of optomechanical resonators currently available. Now, Richard Norte, João Moura and Simon Gröblacher, working at Delft University of Technology in The Netherlands, have proposed and demonstrated an on-chip mechanical resonator with suitable characteristics for room-temperature optomechanical experiments to reach the quantum regime. Mechanical quality factors as high as 10^8 were reached by using ultrathin (down to 15 nm thickness) Si_3N_4 membrane 'tethers' under high tensile stress, close to breaking point (6.4 GPa). Previous works have noted difficulty in simultaneously achieving high mechanical quality and strong optical reflectivity required for room-temperature optomechanical quantum regime experiments. Typically, high optical reflectivity requires sufficiently thick dielectric media, limiting the mechanical characteristics. The team solved this problem by incorporating hole-array photonic crystal 'mirrors' with a reflectivity of >99%, which are tethered by stressed SiN beams. The team hopes that the concept will be applied to silicon-based quantum networks operating at room temperature. *DP*

SPECTROSCOPY

Temporal flexibility

Opt. Lett. **41,** 1498–1501 (2016)

Transient absorption spectroscopy is widely used to study short-lived substances. The usual pump–probe and continuous-wave approaches for studying the absorption response of a sample, however, suffer from limited temporal regimes of operation and resolution. Tatsuo Nakagawa and collaborators from Unisoku and Nihon University in Japan have now devised a method based on a randomly interleaved pulse train (RIPT), thus combining continuous-wave and pulsed strategies. The scheme requires two asynchronous radiation sources, in this case a picosecond laser (producing the pump beam) with repetition frequency R_{rep} = 1 kHz and a supercontinuum light source (generating probe pulses) with R_{rep} = 20 MHz. Pump–probe delays are evaluated passively through repeated pumping cycles. The researchers determine pump–probe delays with better than 10-ps accuracy, and demonstrate measurement time windows ranging from less than a nanosecond up to the microsecond scale. The experimental transient absorption spectra for C_{60} shows that the RIPT method gives access to previously unobserved excited states for this substance; the researchers also acquire spectra over visible to near-infrared wavelengths. Furthermore, this technique makes it possible to correct transient absorption spectra for fluorescence contamination. *GD*

MICROCAVITIES

Slow-light benefits

Phys. Rev. Lett. **116,** 133902 (2016)

The development of optical microcavities with high *Q*-factors and thus long photon storage times would be useful for realizing high-performance optical filters, delay lines and sensors. A French team of researchers have now demonstrated a microcavity with a photon lifetime of 2.5 ms, corresponding to a *Q* factor of 3×10^{12}, at a wavelength of 1,530 nm by harnessing slow-light effects. Vincent Huet and co-workers introduced a slow-light effect by exploiting coherent population oscillations in an erbium-doped fluoride glass whispering-gallery-mode microresonator. The result is a very strong refractive index dispersion and group delay that thus slows down the signal light, increasing the photon storage time of the cavity from 210 ps to 2.5 ms. The team says that the principle could be extended to suit devices intended for on-chip integration to create miniature ultrapure optical or microwave generators. *OG*

OPTICAL ANTENNAS

Reconfigurable resonance

Nano Lett. **16,** 2680–2685 (2016)

Optical nanoantennas have potential applications in optomechanics, sensing and active plasmonics. However, a limitation is that their resonance frequency of operation is usually fixed by their size, shape and composition. Now, Kai Chen and co-workers in Germany have demonstrated reconfigurable nanoantennas operating in the visible spectral range. Plasmonic nanoantennas were made from a pair of closely spaced, parallel single-crystal gold wires by focused-ion beam milling. The antennas were suspended 300 nm above the bottom of a trench in a glass substrate. As a voltage was applied, equal charges were induced on both antenna wires. The resulting equilibrium between the repulsive Coulomb force and the restoring elastic bending force changed the gap between the antenna wires from 40 nm at 0 V to 70 nm at 20 V, tuning the antenna's spectral response. White-light scattering spectra of the nanoantenna without an applied voltage showed a resonance peak at 730 nm that shifted to a shorter wavelength of 713 nm at 40 V. *NH*

GENERAL RELATIVITY

Gravity of photons

New J. Phys. **18,** 023009 (2016)

Almost 90 years ago, Richard Tolman, Paul Ehrenfest and Boris Poldolsky published a paper titled 'On the gravitation field produced by light' (*Phys. Rev.* **37,** 602–615; 1931), which suggested that, via weak-field general relativity theory, a cylindrical pulse, or 'pencil', of light causes no acceleration to a co-propagating test ray. One consequence of the analysis is that a light pulse does not self-interact with its own gravitational field. However, they noted that if the test ray is instead counter-propagating it can bend the trajectory of light, an effect similar to the bending of light by gravitational fields of celestial bodies. Now, Dennis Rätzel, Martin Wilkens and Ralf Menzel from the University of Potsdam, Germany, have theoretically proposed that the gravitational field of a linearly polarized light pulse is 'modulated' by the electric field strength. However, in the case of circularly polarized light, no modulation is expected. The team theoretically investigated the gravitational effect on different test particles showing that both attraction and repulsion effects from the pulse trajectory may occur. *DP*

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