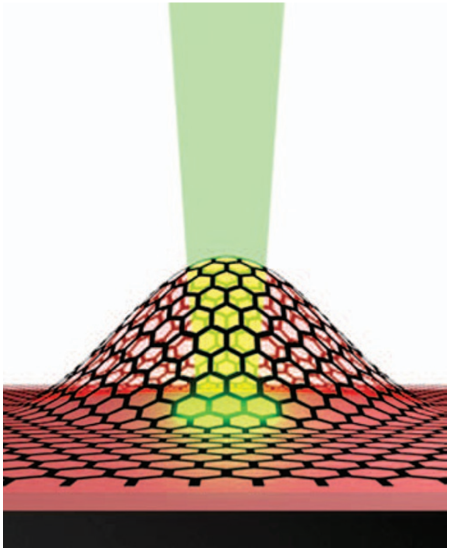
GRAPHENE PHOTONICS

Molecular engine

Nano Lett. **14,** 2677–2680 (2014)



A molecular piston engine driven by light has been estimated to be capable of generating internal pressures of around 22 MPa. It also shows no degradation after 10,000 cycles. The engine is based on a nanometre-thick sheet of fluorinated (CIF_3) graphene, which acts as a highly elastic piston. Illumination with 532 nm laser light breaks the ionic bonds between CIF_3 molecules and graphene, leading to delamination and rapid increases in pressure and volume. This results in a bump or blister forming on the sheet surface, akin to the motion of a miniature piston. When the laser is turned off, the sheet relaxes to its flat state and the CIF_3 molecules chemisorb back onto the graphene, ready for the whole process to start again. The cycle is analogous to that of a miniature internal combustion engine. The developers — Jong Hak Lee and co-workers from the National University of Singapore and the Siberian Branch of the Russian Academy of Sciences — say that the high Young's modulus of graphene, ultrastrong adhesion and gas impermeability are expected to make the engine highly durable and efficient. *OG*

SILICON PHOTONICS

Tackling imperfections

Opt. Express **22,** 12122–12132 (2014)

Fabrication imperfections can play havoc with the performance of high-contrast silicon photonic devices, with even only small deviations in geometry strongly affecting the operation wavelength. Now, Timo Lipka and co-workers from Hamburg University of Technology in Germany report that amorphous silicon devices can be successfully tuned or trimmed after fabrication to the preferred response by using ultraviolet radiation to alter the refractive index of the illuminated structure. The team demonstrated the scheme's utility by using fibre-coupled 405 nm radiation to tune the wavelength response of Mach–Zehnder interferometers and microring resonators. For compact ring resonators, a tuning range of 8 nm was achieved with an accuracy of 20 pm. Trimming adjustments were made at rates of up to 10 GHz. The devices did not show any significant degradation in operational capability after trimming. This post-fabrication passive approach avoids the need to use extra components and feedback circuitry, which are required by integrated, active adjustment schemes that involve microheaters, for example. *OG*

NANOPHOTONICS

Single emitter scanning

Nano Lett. **14,** 2623–2627 (2014)

Fluorescence lifetime microscopy is a popular tool for biomedical imaging. Now, scientists in Germany have taken the approach and in a 'tour de force' experiment engineered it to operate on the nanoscale so that it can determine the local density of photonic states surrounding a probe. Andreas Schell and co-workers from Humboldt University of Berlin in Germany attached a single-quantum emitter (a 30 nm nanodiamond with a nitrogen–vacancy defect) to the tip of an atomic force microscope and scanned it across a silver nanowire. By measuring changes in the emitter's spontaneous emission lifetime as a function of position, they were able to glean information about the local density of states with a nanoscale resolution. The researchers say that their 'scanning single-quantum emitter fluorescence lifetime imaging' will prove useful not only for understanding fundamental quantum optical processes but also for characterizing novel nanophotonic and plasmonic devices. *OG*

METAMATERIALS

Perfect reflection

Appl. Phys. Lett. **104,** 171102 (2014)

Perfect reflectors are desirable for protecting surfaces against high-power irradiation, creating low-loss mirrors in laser cavities and improving the signal-to-noise ratios in bioimaging and nanosensing applications. Now, researchers from Vanderbilt University and SRI International in the USA have designed and fabricated broadband near-perfect reflectors that operate in the telecommunications wavelength band by utilizing all-dielectric metamaterials that exploit Mie resonances. They used a single-negative metamaterial consisting of silicon cylinders (height, 500 nm; diameter, 400 nm) positioned in a 660-nm-period array on a silicon-on-insulator wafer. This reflector exhibited an average reflectance of more than 98.0% over the infrared wavelength range 1,355–1,555 nm. The researchers also investigated the relationship between the degree of disorder of the metamaterial and its reflectance; they found that the near-unity reflectance is maintained provided the cylindrical resonators are not positioned so close to each other that they mutually interact. This raises the possibility of fabricating large-area reflectors using inexpensive, high-throughput fabrication techniques, such as nanosphere lithography and self-assembly. *SP*

INFRARED IMAGING

Nanoscale resolution

Proc. Natl Acad. Sci. USA **111,** 7191–7196 (2013)

Infrared spectroscopy is a powerful method for characterizing compounds and solids, but the long wavelength of infrared radiation has limited the spatial resolution of infrared spectroscopic imaging. Now, by combining infrared scattering-scanning near-field microscopy with broadband infrared synchrotron radiation, researchers in the USA have realized spectroscopic imaging over the whole mid-infrared wavelength range (700–5,000 cm^{-1}) with a sub-40-nm spatial resolution and a high sensitivity. They refer to this technique as synchrotron infrared nanospectroscopy. Using a modified commercial Fourier-transform infrared spectrometer, the researchers were able to obtain images on a timescale of minutes. They demonstrated its effectiveness by using it to investigate a variety of samples, including surface phonon polaritons in SiO_2, surface-adsorbed dried proteins and $CaCO_3$ polymorph heterogeneity in a mussel shell. Unlike many other nanoscale microscopy techniques, synchrotron infrared nanospectroscopy can be used to investigate nanoscale phenomena in soft matter under ambient conditions. The near-field confinement of infrared radiation results in tip-limited spatial resolutions, which are two to three orders of magnitude better than those of Fourier-transform infrared spectroscopy. Furthermore, the high spectral irradiance and spatial coherence of synchrotron radiation enable vibrational spectroscopy to be performed with a high signal-to-noise ratio across the whole mid-infrared wavelength range. *SP*