INTERFEROMETRY
Low-velocity measurement
Opt. Lett. **38,** 2949–2952 (2013)

The measurement precision of parameters such as phase, beam deflection, pulse arrival time, Doppler shift and velocity are all fundamentally limited by the so-called Cramér–Rao bound (CRB) of information theory. Now, Gerardo Viza and co-workers from the University of Rochester, USA, and Weizmann Institute of Science, Israel, have developed a 'weak-values' technique for measuring ultraslow velocities. Their scheme combines standard interferometry with time-domain analysis to make it possible to measure velocities as slow as 400 fm s^{-1}. A laser beam with a wavelength of 780 nm was modulated by an acoustic optical modulator to generate a non-Fourier-limited Gaussian pulse. The pulse was sent through a Michelson interferometer with a slowly moving mirror in one arm. The piezoresponse of the moving mirror was 27 pm mV^{-1}. The arms of the interferometer were approximately 1 mm long to ensure long-term phase stability. Calibration was performed by recording the number of photons entering the interferometer using a photon-counting module. Instead of performing a direct spectral measurement, the velocity was obtained by measuring the induced time shift of the non-Fourier-limited pulses. The uncertainties in the experimental measurements of the velocity reached the CRB. *NH*

DIODE LASERS
Excimer replacement
Appl. Phys. Lett. **103,** 051114 (2013)

There is a pressing need to find convenient and effective ways to generate deep ultraviolet light for techniques such as photoemission spectroscopy and semiconductor lithography. Frequency conversion of the output of continuous-wave diode and solid-state lasers is one approach, but reaching wavelengths shorter than 200 nm has proved problematic because of the limitations of nonlinear crystals. Now, Matthias Scholz and co-workers from Germany and China have produced a continuous-wave laser source that can achieve a high output power of over 15 mW at 193 nm. Their scheme quadruples the frequency of the 772-nm output of a diode laser in two stages; both stages consist of an enhancement cavity containing a crystal — a lithium triborate crystal in the first stage and a potassium fluoro-beryllo-borate crystal in the second stage. The researchers demonstrate that this laser can produce a stable output of 8 mW over a period of 80 h and that its short-term noise characteristics are superior to those of excimer lasers by one order of magnitude. It is thus a promising replacement for ArF excimer lasers for both scientific and commercial applications, potentially offering superior coherence properties, spectral density, reliability and ease of use. *SP*

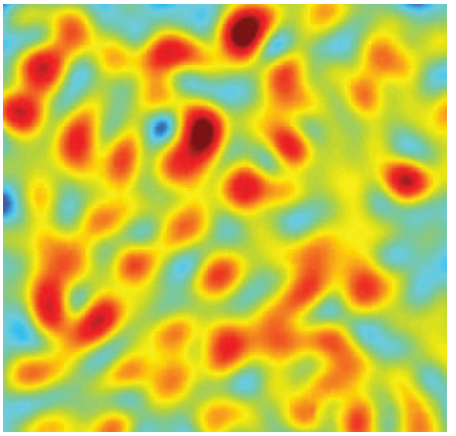
ARTIFICIAL PHOTOSYNTHESIS
Plant-like efficiency
Jpn. J. Appl. Phys. **52,** 08JF07 (2013)

Artificial photosynthesis holds out the attractive promise of using sunlight to convert atmospheric CO_2 into organic fuels. Now, Masahiro Deguchi and co-workers in Japan have demonstrated that the process can be performed with an efficiency of 0.13%, comparable to that of natural photosynthesis in plants. This result was achieved by optimizing a previously reported photoelectrochemical CO_2 conversion system that uses an AlGaN/GaN heterostructure photoelectrode to create electron–hole pairs for driving H_2O oxidation and CO_2 reduction. The team improved the efficiency of this system by a factor of 2.1 through using suitable electrolytes and through reducing energy losses by lowering the system resistance. This system has the advantages of not requiring an external bias or sacrificial materials. The researchers anticipate that the efficiency can be further increased by improving the catalysts and electrolytes used. *SP*

METAMATERIALS
Heating up
Opt. Mater. Express **3,** 1101–1110 (2013)

A means for rapidly and controllably heating thermal phase-change materials is potentially useful for future data storage technology. Tun Cao and co-workers from China, the UK and Singapore have theoretically shown that metamaterials can be used to deliver energy rapidly to the phase-change material $Ge_2Sb_2Te_5$. They proposed sandwiching a thin layer of $Ge_2Sb_2Te_5$ between two sheets of a metamaterial-based electromagnetic absorber, which is composed of a two-dimensional periodic array of miniature gold squares and is designed to absorb mid-infrared radiation strongly. Modelling predicts that when combined with the absorber, $Ge_2Sb_2Te_5$ will be heated to its melting temperature of 900 K in just 3.4 ns when an optical power of just 0.6 mW is focused. The team notes that a $Ge_2Sb_2Te_5$ layer without the absorber will not reach the melting temperature under the same illumination conditions. In the model, the thicknesses of the phase-change material, the top gold layer and the bottom layer are respectively taken to be 40 nm, 40 nm and 80 nm to suppress transmission through the structure. This method can potentially reduce the power requirements for photonic devices based on a thermal phase change, paving the way for realizing ultrafast photothermally tunable photonic devices. *DP*

COMPLEX MEDIA
Subtle sensing
Phys. Rev. Lett. **111,** 033903 (2013)



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The ability to detect features smaller than the diffraction limit of light would greatly enhance applications ranging from semiconductor device inspection to the detection of carcinogenesis in human cells. Several approaches for realizing optical detection on this scale have been demonstrated in recent years, but each has its limitations (for example, requiring labelling or fluorescence). Optical detection is especially challenging in systems with low refractive-index contrasts, such as biological cells. Now, Lusik Cherkezyan and colleagues from Northwestern University in the USA have shown that interferometric spectroscopy of scattered light can quantify the statistics of refractive index fluctuations on the subdiffraction length scale. In other words, it should be possible to detect very small changes in cells simply by analysing scattered light in the far field. The team developed the necessary theory for quantitatively determining the refractive-index fluctuations in weakly scattering systems from spectrally resolved far-field microscope images. The minimum size of detectable features is limited by the signal-to-noise ratio of the detector. Comparison with numerical solutions obtained using Maxwell's equations revealed very good agreement for a variety of sample and instrument parameters. *DP*

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