OPTICAL ENCRYPTION
Polarization keys
Opt. Express **23,** 655–666 (2015)

An optical encryption scheme for images that makes use of random polarization vector keys has been developed by researchers in Spain and the USA. The system uses a Mach–Zehnder interferometer. Both of the arms of the interferometer feature translucent liquid crystal displays that act as spatial light modulators (SLMs), making it possible to encode the polarization state at each point of the light's wavefront. In this way, a random polarization distribution created by appropriate programming of the SLM can be thought of as an encryption key. In addition, one of the arms features the plain text image. Light linearly polarized at 45° enters the interferometer through a polarizing beam splitter and light existing the system, following the recombination of the arms, is imaged by a CCD camera. An authorized user knowing the polarization key can retrieve the plain text image. *OG*

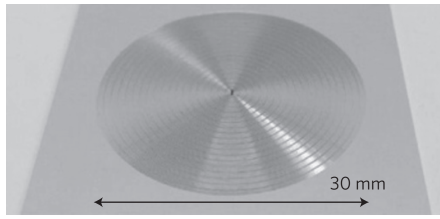
PLASMONICS
Near-infrared nanolaser
ACS Photon. **2,** 165–171 (2015)

The development of efficient and truly subdiffraction-sized laser sources for nanophotonics is still a core goal of plasmonics research. Now, researchers in Japan at the University of Tokyo have demonstrated lasing in GaAs–AlGaAs core–shell nanowires with 150 nm diameters positioned in contact with a silver film. Near-infrared lasing, with emission in the ~800–850 nm wavelength range, was achieved under optical pumping at temperatures up to 125 K. The team emphasizes that some previous plasmonic nanowire lasing demonstrations employed thin films of low-index dielectric material between the metal and the high-index semiconductor wire to mitigate loss and quenching effects by using 'hybrid' plasmon waveguide modes. Instead, the researchers used nanowires directly in contact with the metal film and argue that the result is a better overlap between the optical mode and the gain media (semiconductor wire). The fundamental mode experiences very high losses, so the team concentrated on achieving lasing of higher-order modes that are less lossy but exhibit more field penetration into surrounding (less lossy) media. A low lasing threshold of 1.0 kW cm^{-2} was achieved at a temperature of 8 K. The team attributed this low value not only to the use of higher-order modes but also to a smooth silicon substrate and a single-crystalline silver film. *DP*

IMAGING
Expansion microscopy
Science **347,** 543–548 (2015)

By combining a polyelectrolyte gel — a polymer that swells when it comes into contact with water — with a fluorescent label, scientists at the Massachusetts Institute of Technology in the USA have created a new type of high-resolution biological imaging that they call expansion microscopy. Adding the gel label and water to cultured human kidney cells or brain slices from a mouse caused the samples to expand in volume by about a factor of four, thus making it possible to perform super-resolution imaging using optical microscopy and resolve features that are ordinarily spaced closer than the diffraction limit of visible light. The team report a lateral resolution of ~70 nm using the technique. Importantly, the gel's expansion is isotropic and does not introduce any distortion of the sample's anatomy. In addition, expanded specimens are largely transparent as they mostly consist of water. The team believe that by modifying the material properties of the polymer, in particular the density of its cross-links, imaging with even higher resolutions may be possible in the future. *OG*

TERAHERTZ PLASMONICS
Bessel beamformer
Appl. Phys. Lett. **106,** 021101 (2015)



AIP

Bessel beams — non-diffracting beams with a self-healing wavefront — at terahertz frequencies could prove useful for applications such as deep focal imaging and communications. To date, such beams have mostly been generated by bulky axicon lenses. Now, Yasuaki Monnai and colleagues in Japan, Germany and Australia experimentally demonstrate a means that is more amenable to integration. The approach relies on a planar metal structure featuring a tightly packed series of concentric grooves that couple light to surface waves, known as spoof surface plasmon polaritons. Furthermore, a secondary series of more widely spaced concentric deeper grooves act as scatterers that convert these radial surface waves into plane waves propagating in free space. The period of the scatterers is designed to be shorter than the wavelength of the surface waves so that the free-space plane waves can be tilted towards the central axis, and the interference of these waves creates a Bessel beam. The structure is excited through a small central slit. Using structure, the team generate a Bessel beam with a frequency of 0.29 THz with non-diffractive behaviour maintained over a distance of 20 wavelengths from the aperture. As the excitation slit can be replaced with a solid-state terahertz oscillator, the beamformer could be part of an integrated terahertz system. *RW*

OPTICAL METROLOGY
Thermometry
Phys. Rev. Lett. **114,** 023001 (2015)

Neutral atoms in tight optical traps are indispensable tools for state-of-the-art experiments involving optical lattice clocks and many-body physics, which are performed at ultracold temperatures. However, current thermometry techniques are unreliable for a small number of molecules and break down in the nanokelvin temperature regime. To overcome these technical limitations, Mickey McDonald and colleagues at Columbia University in the USA have now developed a thermometry technique based on the frequency shift in a one-dimensional optical lattice. The team investigated narrow optical transitions of Sr_2 molecules that were created from laser-cooled ^{88}Sr atoms through photoassociation. The molecules were trapped and probed in the Lamb–Dicke and resolved-sideband regimes of an optical lattice. They found that the temperature of molecules could be determined with a resolution on the order of microkelvin from the spectrum of one of the optical transition lines, the light shift and the axial trap frequency. Their technique improved the precision of the temperature measurement by a factor of 1.5 with respect to traditional optical thermometry techniques. It can be used not only for narrow optical transitions, but also for other transitions in the radio frequency and microwave regimes. Moreover, according to the authors, "this approach should be applicable down to nanokelvin temperatures." *NH*

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