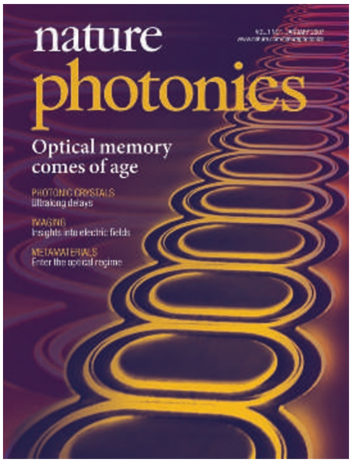

COVER STORY

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Computer speed may ultimately become limited by the bandwidth of electronic components and the electrical wiring that connects them together. Fortunately, photonics looks set to provide a solution through all-optical circuitry that can route and process optical data at very high speeds. A crucial component in such hardware of the future is likely to be the optical buffer — a kind of memory that temporarily stores optical data bits to prevent signal congestion at a switch, or the input/output of a device. Such buffers are now a step closer to becoming practical thanks to the work by Fengnian Xia and co-workers from IBM. The silicon-microring-based buffers produced by the researchers are compatible with data rates of up 20 Gbit s^{-1}, and are able to buffer 10 bits in an area smaller than 0.1 mm^2. These optical buffers are also compatible with silicon processing techniques, making them promising candidates for future optical networks on a chip. **[Article p65; Interview p72]**

ALL POLARIZATIONS WELCOME

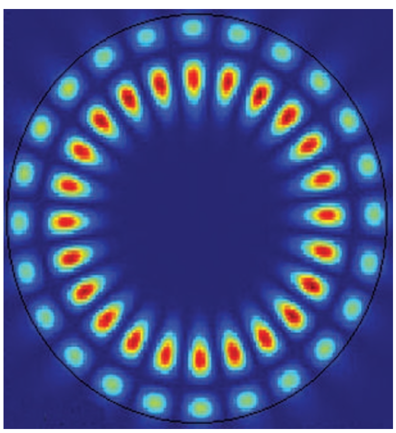
Advances in semiconductor fabrication technology now allow scientists to confine light on an optical-wavelength scale and make all kinds of sophisticated microphotonic devices. Unfortunately, such devices have a tendency to behave differently depending on the polarization state of an incoming light signal, limiting their practical usefulness. Now, Tymon Barwicz and colleagues have demonstrated an 'on-chip' and integrated approach to making such devices polarization-independent. The concept underlying their scheme is polarization diversity. Rather than passing the input signal directly into a device, the light is instead split into two beams of orthogonal polarization, and passed through two identical devices and then recombined afterwards. The net effect is that the device becomes almost perfectly immune to the polarization of the input signal. The team demonstrate the idea on an optical chip by creating a high-performance add–drop filter with a polarization-dependent loss of less than 1 dB across a wide band of wavelengths. The fact that such complicated structures can circumvent the most fundamental of problems bodes well for the long-term prospects of microphotonic circuits. **[Letter p57; News & Views p17]**

MAPS OF LIGHT

Light is a vector — at any position, its electric field has both an intensity and a direction. Now, for the first time, K. G. Lee and co-workers have imaged both of these components on a nanometre scale. Their technique allows an experimental investigation into the fundamental nature of light; an insight that is particularly relevant today as optical devices are miniaturized down to dimensions on a similar magnitude to the wavelength of light itself. This vector mapping is accomplished by a customized version of scanning near-field microscopy. A glass fibre with a small tip, such as a gold nanoparticle, on the end, is scanned above the surface, scattering near-field light into the far field where it can be analysed. The technique is used to investigate relatively simple light effects, such as total internal reflection in a glass prism, to more complex phenomenon — the generation of surface-plasmon polaritons as light passes through a slit. Being able to capture such vector maps of light could lead to improvements in the design of all kinds of nanophotonic devices and gain a better understanding of the interaction of light with biomolecules. **[Letter p53; News & Views p13]**

MICRODISK LASERS WARM UP

The blue-emitting GaN laser caused a great stir of excitement in the world of photonics when it was first reported. Now, Adele Tamboli and colleagues have demonstrated the first microdisk laser made from GaN to operate continuously at room temperature. Their optically pumped devices are as small as 1.2 μm in diameter and operate at a wavelength of 428 nm. Significantly, they exhibit an extremely low lasing threshold that is several orders of magnitude smaller than previous reports or other device designs, such as vertical cavity surface light-emitting lasers. The key to this advancement is careful control over device fabrication and the creation of very small microdisks. For example, the team replaced standard photolithography with the much higher resolution electron-beam lithography and worked hard to ensure that the device surfaces were very smooth. Sidewall smoothness is important as the optical modes of the laser are concentrated around the disk edge so that any roughness results in optical losses. These impressive results highlight the importance of even very small structural imperfections when optical devices are reduced in size to the scale of optical wavelengths. **[Letter p61]**



A theoretical simulation of the modes inside a GaN microdisk laser.

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CLEVER CAVITIES

Photonic crystals can control the flow of light, even to the point of slowing it down. Now, Takasumi Tanabe *et al.* have demonstrated a number of important photonic-crystal effects directly in the time domain. Using silicon, the researchers create a so-called waveguide-width modulated photonic-crystal nanocavity. The quality factor of this cavity, a measure of how long light is trapped, is in excess of one million, the highest reported for any cavity of its size. Time-domain experiments, as opposed to those in the wavelength domain, provide direct proof that this equates to the entrapment of photons for approximately 1 ns. Similarly, when light pulses are passed through the cavity, they are delayed, with very little distortion to the pulse shape. A measured delay time of 1.45 ns represents another record for photonic-crystal systems. A final intriguing aspect of this work is the ability to alter the optical properties of the cavity while the light is trapped inside, which opens the fascinating possibility of altering the wavelength of the stored photons. **[Letter p49]**

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