Cover story

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When it comes to the processing, communication and storage of data, photonic technologies seem to have all the answers. Photonics does, however, have one major drawback: the weak interaction between light and matter. In this issue, Domenico Pacifici and colleagues show how surface plasmon polaritons may provide a solution, by demonstrating that these quasiparticles can be used to create a miniature all-optical modulator. The modulator consists of a silver substrate that is coated with a layer of CdSe quantum dots and features a small groove and an aperture. In their experiment, the team shine an infrared signal and a visible probe beam simultaneously onto the device. Varying the power of the incident visible control beam adjusts the power of the infrared beam that emerges from the aperture. **[Letter p402; News & Views p368]**

MICRO-CONTROL

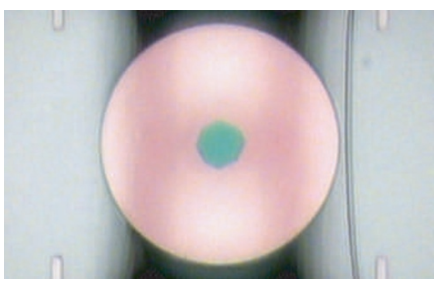
Lithium niobate has established itself as the material of choice in nonlinear optics. Large nonlinear coefficients and optical properties that are highly sensitive to electric fields have seen $LiNbO_3$ used for a wide range of applications from optical modulators and wavelength-division multiplexing to entangled-photon generation. The aim now is to incorporate this material into miniature optical integrated circuits, harnessing these useful properties on a smaller scale than before. In this issue, Andrea Guarino and colleagues have created the first microring resonators in thin $LiNbO_3$ films. Microring resonators can trap light of a particular wavelength. The primary advantage of using $LiNbO_3$ is that the resonant wavelength can be altered by applying an electric field, but previous attempts at this have run into problems with film quality and cracking. Now, the team use an adhesive polymer to improve the quality of their films, allowing them to create a 10-μm-diameter ring with a resonance at a wavelength of 1.55 μm. By applying 100 V across two electrodes, this resonant wavelength is shifted by 105 pm, and the researchers have several ideas about how to further reduce the required voltage.
[Letter p407; News & Views p365]

TERAHERTZ LIGHT ON THE MOVE

Quantum-cascade lasers are a promising technology for small, solid-state terahertz sources. Injected electrons travel through a stack of thin semiconductor layers, losing energy in small steps — just like a ball rolling down stairs — emitting long-wavelength photons as they do so. The semiconductor GaAs is commonly used in these devices, and now, Sukhdeep Dhillon and co-workers have taken advantage of the nonlinear optical properties of GaAs to create a device that can mix terahertz light with a laser beam at telecommunication wavelengths, 1.3–1.6 μm. Such wave mixing is already important in microwave photonics, and the approach enables the key properties of the terahertz radiation — the wavelength, phase and amplitude — to be transferred over long distances. This is difficult to achieve in free space because water absorbs so strongly at long wavelengths. A reverse process could be used to reconstruct the terahertz light at the far end. The device constructed by Dhillon *et al.* combines the terahertz source, nonlinear material and the required waveguide in a single compact structure, opening up a new way of manipulating terahertz light.
[Article p411; Interview p426]

LIGHT SHOWS ITS STRENGTH

The effect of the force exerted by photons striking a surface is usually unnoticeable. This, however, is not the case when the structure involved is very small. Matt Eichenfield and colleagues at the California Institute of Technology have created a miniature optomechanical system that uses optical fields to move a suspended waveguide. A silica fibre, with a diameter of about one micrometre, is suspended between two fixed points, and runs near the edge of a cylindrical optical cavity. Light passing along the fibre couples into the cavity where the field builds up. This then attracts the dangling waveguide. The researchers can see this movement under a microscope, but the movement can also be detected from changes in the optical properties of the system. The efficiency with which light is coupled from the waveguide to the cavity is related to their separation — as the distance shrinks the coupling changes and this affects the transmission along the waveguide. Passing 2.5 mW of optical power along the fibre causes a 1.1-μm displacement. The team highlights the usefulness of this effect by demonstrating a simple all-optical tunable filter.
[Article p416; News & Views p370]



The build up of an optical field in a microdisk attracts a suspended waveguide.

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QUICK AS A FLASH

Semiconductors seem to be the ideal medium for many laser applications: semiconductor structures can be fabricated on the micro- and even nanoscale; they allow for direct electrical control; and they are easily mass produced making them cost effective. Semiconductor quantum dots — nano-sized particles capable of confining electrons in a similar way to atoms — look set to continue this revolution owing to their unique optical properties. In this issue, Edik Rafailov and colleagues review the idea of using quantum dots in ultrafast optoelectronic devices. The advantages are numerous: fast carrier dynamics, low carrier diffusion, controllable electronic structure, insensitivity to temperature fluctuations and broad gain bandwidth. All of these qualities make an attractive gain material for mode-locked lasers. Over the past decade there has been a steady improvement in the performance of such devices; state-of-the-art devices can produce pulses as short as 400 ps and peak powers of the order of 100 mW. Also, these optical pulses can be generated at repetition rates of a few hundred gigahertz. Rafailov *et al.* explain the science underlying these impressive devices and provide a round-up of recent results. **[Review p395]**