well-grown bulk crystal and then the slice is bonded onto a larger substrate. The issue in this case is to develop a workable bonding method that is robust to thermal mismatch. With such a thin slab, even a comparatively small applied electro-optical voltage can cause a significant change in index¹¹. 'Slicing' of a complex oxide, which is relatively brittle, is not easy, and the authors have used an approach that makes use of high-energy (195 keV) helium ions to accomplish the task. In their method, the ions penetrate to a depth of about 680 nm and then come to a stop by rapidly losing most of their energy in binary lattice collisions. This high concentration of interstitial helium causes stress in the lattice and, in the presence of a temperature change,

cleaves off a thin slab. Bonding the thin film to a standard LiNbO₃ substrate with a polymer adhesive before slicing, enables very thin slabs to be formed.

With this 'slice', the authors fabricate a ring-type resonator, whereby light is trapped to follow a circumferential path, except that a small proportion of light leaks out or is coupled to a nearby straight waveguide. The ring is easily defined in their thin material by etching. By varying the voltage and hence the ring index the degree of outcoupling is also varied. With this geometry, a relatively low voltage, that is 100 V, was required for switching. Straightforward materials engineering should reduce this voltage for switching to an even more acceptable level.

The central result is then that the high-performance qualities of ion-sliced LiNbO₃ have been shown to be amenable to forming a voltage-tunable ring filter and then the ring is bonded onto a 'mother' substrate.

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BIOPHOTONICS

An eye for detail

Generating high-resolution images of the eye's retina and blood supply is important for diagnosing common eye disorders, such as glaucoma and age-related macular degeneration.

At present, optical-coherence tomography (OCT) is a popular technique that uses broadband light, typically centred around 830 nm or 1.3 μm , to produce two-dimensional image slices of the eye's retina at different depths. Although such schemes work well, their performance is ultimately limited by a lack of penetration or by strong water absorption.

To get around these problems, researchers in Japan have now developed a high-speed OCT system that operates at a wavelength of 1 μm (a local low-loss window for water absorption) and is able to image deeper into the layers at the back of the eye (*Opt. Express* **15**, 6121–6139; 2007).

In particular, by combining their swept-source (SS-OCT) approach with some clever image-analysis software, Yoshiaki Yasuno and co-workers have been able to use two-dimensional image slices from different depths to generate high-contrast three-dimensional images of the blood vessels servicing the optic nerve (pictured).

At the heart of the SS-OCT system is a high-speed scanning laser that uses a polygon-mirror-based wavelength tuner to scan the output between 1,020 nm and 1,090 nm at a scan rate of 28 kHz — equivalent to 2.95 nm μs^{-1} .

The result is that the SS-OCT system is capable of generating 28,000 scans

per second, with a depth resolution of 10.4 μm and a sensitivity of 99.3 dB.

The work is the result of a collaboration between the University

of Tsukuba, Yamagata Promotional Organization for Industrial Technology and Tokyo Medical University.

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