optoelectronic circuits for balanced, polarization-insensitive coherent detection.

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ULTRA-LOW-POWER INTEGRATED ACOUSTO-OPTIC FILTER

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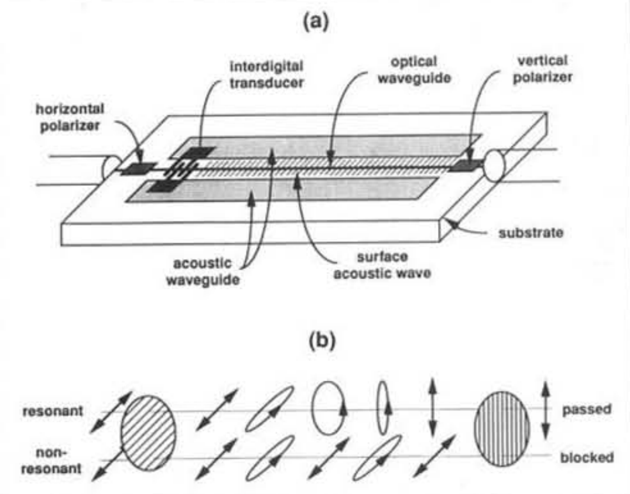
The acousto-optic filter has gained increasing attention in wavelength-division multiplexed optical communication because it offers the unique and powerful capacity to extract many different wavelength channels (simultaneously and independently) from one optical fiber and divert all or part of each signal to a second fiber. This parallel-processing capability means that each wavelength in a fixed fiber network has an independently configurable matrix of interconnections.[1]

The problem with commercially available bulk-crystal components, in which a large volume acoustic wave interacts with a wide optical beam, is their notoriously high power consumption. By employing the miniaturization techniques of integrated optics and integrated acoustics, we[2] and others[3] have systematically decreased the size and dimensionality of *both* the optical and acoustic beams, until both beams have become more or less one-dimensional waveguided modes. The net effect of all this size reduction (except, it should be stressed, in the irreducible dimension of interaction length) is a dramatic reduction in the power requirement for optical filtering.

To date, we have demonstrated nearly complete polarization conversion (resulting in wavelength selection without excess loss) with only 8 mW of applied RF power.[2] This is about 250 times less power than commercial bulk-optic filters require, and 25 times less power than integrated



(a) SCHEMATIC OF THE ACOUSTO-OPTIC FILTER EMPLOYING GUIDED SURFACE ACOUSTIC WAVES TO FLIP THE POLARIZATION STATE OF A NARROW BAND OF GUIDED OPTICAL WAVELENGTHS, AND (b) POLARIZATION EVOLUTION ALONG THE DEVICE FOR RESONANT AND NON-RESONANT WAVELENGTHS.

optic filters, which do not have acoustic waveguides. The acoustic transducers can support about 1 watt of power, allowing for up to 100 channels to be switched at a time.

The integrated acousto-optic filter is shown schematically in the accompanying figure. An incoming optical beam is fiber-coupled into a several-micron-wide titanium-indiffused optical channel on a lithium niobate substrate, prepared in a specific polarization state (shown horizontal here). A miniature radio-frequency transducer imbedded in a 100 μm-wide acousto waveguide, the walls of which are also formed by deep titanium indiffusion, generates a confined surface acoustic wave. For those wavelengths that experience phase-matched photoelastic polarization conversion (*i.e.*, for that narrow band of wavelengths for which the interaction provides constructive accumulation of polarization change along the device), the incoming polarization is flipped [to vertical in Part (b) of the figure] and passes through an orthogonal beam-blocking polarizer before exiting the filter. Unselected (nonresonant) wavelengths are blocked. Polarization-independent versions of this filter, employing polarizing beamsplitters instead of pass-or-fail polarizers, also have been made in low-power configurations during the last year.[3]

With continued improvements in switching power and other measures of performance, including wavelength crosstalk and ease of manufacture, the acousto-optic filter may well have a central role in future broadband, wavelength-multiplexed optical networks.

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