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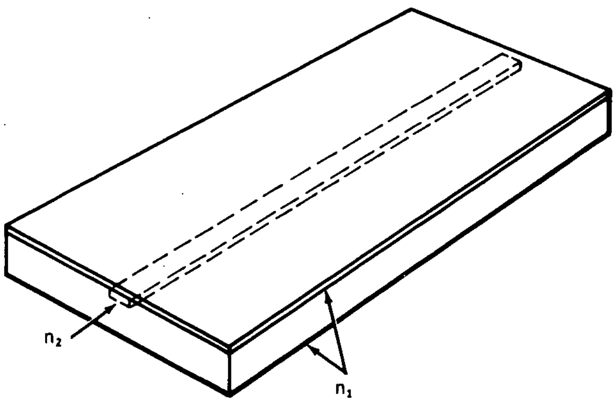
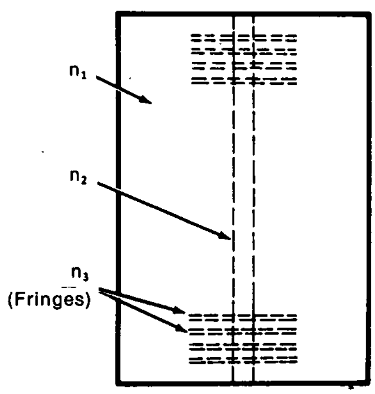
Acoustically Controlled Integrated Laser for Communications Systems





Basic Integrated Optics Element

Thin-film and integrated-circuit techniques are rapidly catching on in laser communication technology. Although much work remains to be done, new integrated optical elements, have already been produced. These include elements for modulation, for generating and changing the carrier frequency, and for scanning and focusing the laser carrier beam.

A typical element is based on a dielectric waveguide which has an index of refraction n_2 surrounded by a region with an index n_1, as shown in the illustration. In a two-dimensional analysis, the relationship between n_1 and n_2 is given by

$$n_1 = n_2 (1-\Delta)$$

where

$$\Delta \cong 3/4(\lambda/a)^2$$

where λ is the free-space wavelength of the laser carrier frequency, a = half width of the n_2 region, and $(\lambda/an_2) \ll 1$.

The element is fabricated by selectively exposing a light-sensitive photoresist placed on a sheet of glass. This is followed by washing and selectively depositing (if needed) a more durable material as a mask. Then diffusion, bombardment, or ionic replacement is used to change the index of refraction of the glass, creating the n_2 channel imbedded in the n_1 substrate. Finally, a layer of n_1 material is sputtered on the entire top surface.

Current photolithographic techniques used in fabricating integrated circuits are capable of producing channel widths from 2μm to 5μm. Using this technology, complex masking patterns may be made to produce sophisticated optical circuits, for lasers.

(continued overleaf)

The basic element shown in the figure can be used as a resonator when mirrors are placed at the ends of the waveguide. A similar function is achieved using partially reflecting transverse grating, spaced in the waveguide at odd halfwave multiples. These lines are fringes of increased index of refraction and provide very small changes in the refractive index. By adding a small concentration of neodymium ions and a pump, the resonant cavity becomes a laser.

The fringes can also be generated by applying an acoustic wave to the substrate. An acoustic wave creates fringes by producing periodic stresses in the substrate and in the film. The laser carrier frequency is then changed by simply changing the acoustical frequency. When two acoustical sources are applied off the beam axis, the beam can be scanned at very rapid rates.

Note:

Requests for further information may be directed to:

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Patent status:

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