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DIELECTRIC OPTICAL BRANCHING WAVEGUIDE

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Glass thin-film optical branching waveguide is fabricated by sputtering. It is found that the dielectric branching waveguide has functions of mode filtering and mode conversion. Figure 1 is a schematic diagram of thin-film branching waveguide and its experimental setup. The waveguide is a sputtered glass film of 1.56 in refractive index. The middle layer is a sputtered SiO_2 film. During the sputtering, the mask is set slightly above the substrate so that the edge of SiO_2 layer is tapered. The taper is at a slope of 1 in 500. The substrate is a vycol glass. Figure 2 shows some transverse electric field distribution of TE modes in the branching waveguide. The thickness of arm no.2 and no.3 are the same. The only difference between two arms is that the arm no.3 is surrounded by SiO_2 of 1.457 in refractive index, but the arm no.2 is bordered by the air. However, it seems that TE01 and TE02 modes in arm no.1 are converted to the TE01 mode of arm no.3 and no.2 respectively. TE03 and TE04 modes in arm no.1 are converted to the TE02 mode in arm no.3 and no.2 respectively. Figure 3 is one of the experimental results in case that the thickness of arm no.2 and no.3 is 0.8 μm and the distance between two arms is 1.5 μm. Figure 3(a) shows the output of prism no.2 as a function of incident angle of He-Ne laser light into prism no.1. Figure 3(b) is the output of prism no.3, while the prism no.2 is not attached to arm no.2. Figure 3 (c) is the output of prism no.1 as a function of incident angle of laser light to prism no.2. TE02 mode is only observed from prism no.1. These results show that the branching waveguide has functions of mode filtering and mode conversion. Figure 4 shows the propagation constant of TE modes in arm no.2 and no.3 as a function of waveguide thickness; in case that two arms are assumed to be independent. The propagation constant of mode in arm no.2 is smaller than that of the same mode in arm no.3. Figure 5 is the propagation constant of TE modes in a branching waveguide as a function of distance between arm no.2 and no.3. This means that TE01 mode in arm no.1 is converted to the TE mode of the largest propagation constant in arm no.2 and no.3. TE02 mode in arm no.1 is converted to the TE mode of the second largest propagation constant in two arms. Figure 6 is the amplitude of propagating modes and converted modes in branching waveguide as a function of distance between arm no.2 and no.3. The radiation loss and mode conversion loss is small in a long tapered branch. Figure 7 is one example of application of branching waveguide to a mode conversion element. The combination of electro-optical crystal and branching waveguide will realize the optical switching element and the mode switching element. The concept of dielectric branching waveguide gives many possibilities to integrated optical circuitry.

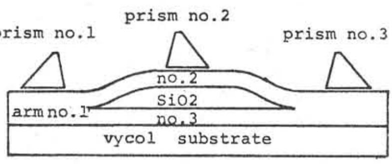

FIG.1 Schematic diagram of branching waveguide and experimental setup

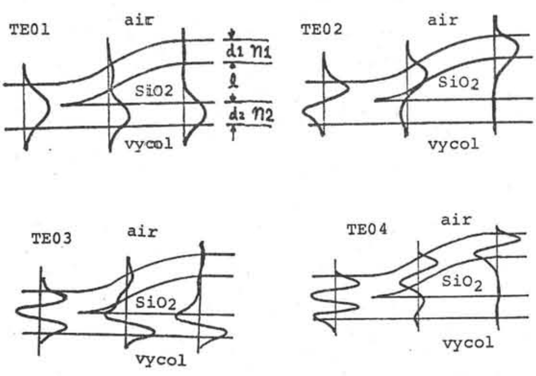

FIG.2 Transverse electric field distribution of TE modes in the branching waveguide

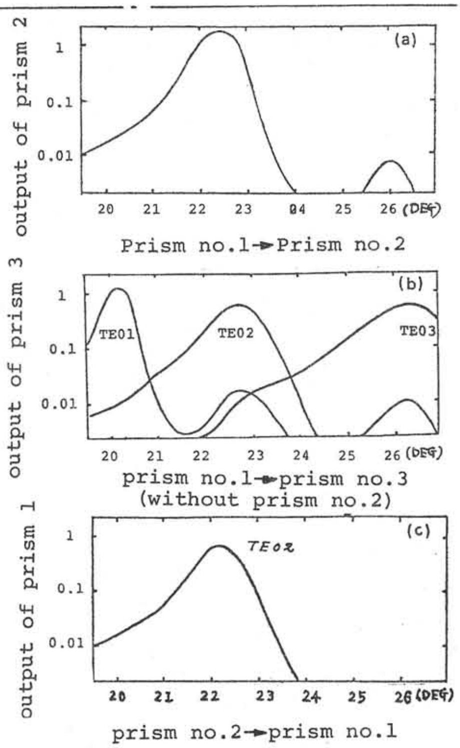

FIG.3 Output of prisms as a function of incident angle of He-Ne laser beam into the input prism.

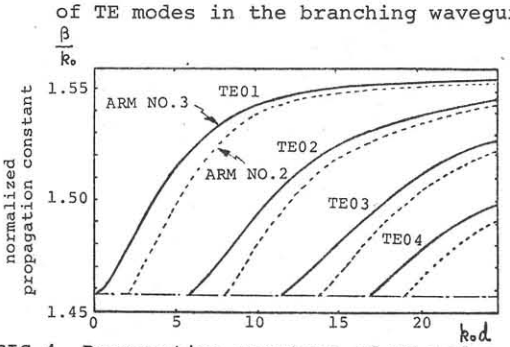

FIG.4 Propagation constant of TE modes in a thin-film waveguide as a function of film thickness,

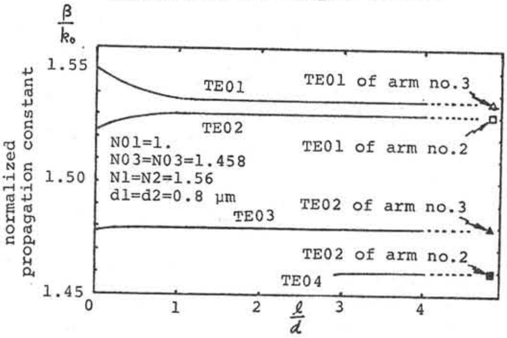

FIG.5 Propagation constant of TE modes in a branching waveguide as a function of distance between arm no.2 and no.3.

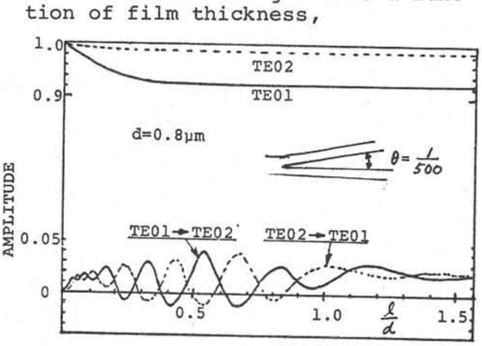

FIG.6 Amplitude of propagating modes and converted modes in branching waveguide as a function of distance between arm no.2 and no.3.

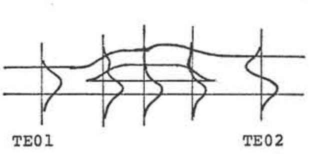

FIG.7 A mode conversion element as one of the application of branching waveguide.