The theoretical and experimental studies of the characteristics of the X-cut annealed Proton-exchanged Lithium Niobate Symmetric Directional Coupler

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Abstrak

ABSTRACT
The combination of the coupled mode and normal mode theories has been used to formulaic the theoretical performance represented by the coupling length and crosstalk parameters of the X-cut APE-LN SDC fabricated using the benzoic acid as the proton source, where in this case the matrix effective refractive index (MERI) method is applied for solving the symmetric and antisymmetric propagation constants of the normal modes propagating in this device. The corresponding near field method has been used to experimentally determine its crosstalk.

The actual performance of this device is characterized by comparing the theoretically calculated with the experimentally determined crosstalk parameters. A software computer program has been developed in order to numerically characterize the entire characteristic and performance of the SDC under study.

For the SDC under study, the best crosstalk obtained at the operating wavelength lamda =1.3 micrometer is ~0.21 dB for the interaction length L = 6 mm and the gap separation g = 5 mm. Its coupling length is ~ 1.33 mm. The propagation constant of the corresponding individual single-mode X-cut APE-LN channel waveguide making up this SDC is beta = 10.37901 micrometer, and thereby its effective refractive index is N cπ= 2.14743330.

It has been shown that the fabricated SDC is very lossy. It has been deduced that its bad performance predominantly caused by the side diffusion effect, corresponding to the fabrication problem, where in this case the substrate sample has been not coated first with the buffer layer when the deposition of substrate sample with the aluminum mask was to be performed in the fabrication stages.

Moreover, in this case only the simple annealing has been performed. The successive annealing process in order to reduce the coupling loss has been not applied yet. Under the assumption that the fabrication tolerances are such that the practical devices with coupling loss below 0.25 dB are feasible, the fabricated SDC under study is a 3 dB coupler.