A Study of the Cross Section of a Distributed Bragg Reflector on Lithium Niobate Waveguide

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Distributed Bragg reflector (DBR) as the cavity mirror of an erbium-doped lithium niobate ($LiNbO_3$) waveguide laser can be used to have high reflectivity and narrow bandwidth [1]. However, the reflectivity of the traditional erbium-doped $LiNbO_3$ waveguide laser produced by etching the groove directly on it is limited. One of the methods to improve the reflectivity is deposing a corrugated structure of high index overlay on $LiNbO_3$ waveguide (Fig.1) [2]. For the corrugated high index overlay (CHIO) structure, usually, a rectangular shape groove is assumed. However, due to the chemical etching process, the shape of the groove is not an exact rectangle but a trapezoid. In this work (NSC88-2215-E-002-010), a silicon CHIO structure with trapezoid groove is studied by considering both the effect of the duty cycle and the slope of the hypotenuse of the trapezoid groove θ.

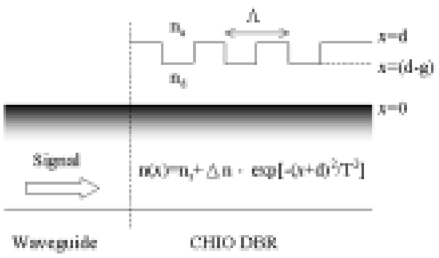

Fig. 1 The CHIO structure

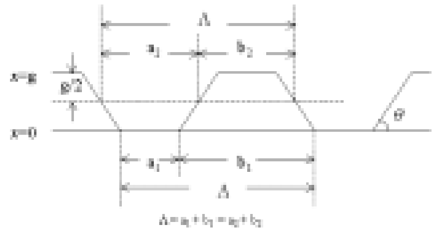

Fig. 2 The groove cross section

The proposed CHIO structure is analyzed by the coupled-mode theory. The insertion loss, which is due to the energy profile mismatch between the waveguide and the DBR section, is also considered. Thus, the maximum reflectivity is fixed to an effective reflectivity R_{eff}. For convenience, the parameters of the CHIO structure a_1 and b_1 are defined as shown in Fig. 2. From the calculated results, it is found that R_{eff} is dependent on θ. To know whether θ or the cross section of the groove affects more the reflectivity, an alternative set of parameters a_2 and b_2 are redefined as shown in Fig.2. With such a new definition of the groove parameters, the relation between R_{eff} and the silicon layer thickness are shown in Fig.3. This figure shows that R_{eff} is almost independent of θ.

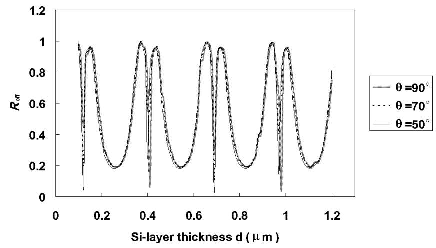

Fig. 3 R_{eff} vs. θ

It is then of interest to know the effect of the groove cross section on the effective reflectivity. As shown in Fig.4, when the duty cycle changes and the θ is fixed, the value of R_{eff} changes. However, when the duty cycle is fixed and the θ is allowed to change, the value of R_{eff} almost is unchanged. Note that the cross section of the groove (Fig. 2) is dependent on the duty cycle but independent of θ. Thus, it is can be seen that the effective reflectivity is more sensitive to the cross section than θ of the groove.

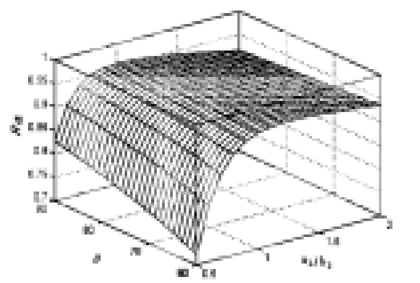

Fig. 4 R_{eff} vs. duty cycle and θ

Moreover, a simulated reflection spectrum obtained by using the optimal parameters shows that when θ is smaller, the reflection spectrum has narrower bandwidth. Thus, a perfect rectangular shape of the groove is not necessary. Details of the application of the trapezoid groove will be of great interest in the future.

[1] J. Sochtig, *Electronics Letters*, vol. 31, no. 7, pp. 551-552, 1995.
[2] C. P. Hussell, *IEEE Photonics Technology Letters*, vol. 9, no. 5, pp.636-638, 1997.