Design of Bragg Grating Fabry-Perot Laser centered at 1310 nm

Zachary Chafe, *ELEC 413, University of British Columbia*

***Abstract*—This document details the process of designing a Fabry-Perot laser resonator centered at 1310nm, with an emphasis on maximizing the Q factor**

I. Introduction

II. Theory

Lasers work on the principle of stimulated emission. A simple laser can be constructed using two mirrors and a Fabry-Perot cavity. Light enters the Fabry-Perot cavity and bounces between the two mirrors, constructively interfering until it begins to lase.

Bragg gratings can be substituted for mirrors to create better lasers. Bragg gratings have a periodic shape, with rectangular ones having alternating regions of different thicknesses. The geometrical changes result in a changing effective index which causes reflections that, when constructed correctly, compound to create a laser.

For this report, a Bragg grating Fabry-Perot laser will be designed centered at 1310nm

III. Modelling and Simulation

A strip waveguide was used with a width of 350nm and a thickness of 220nm. Modeling was done using a width of 335nm to account for shrinking in the fabrication process.

Lumerical Mode was used to create this heat map of the first TE polarized mode profile

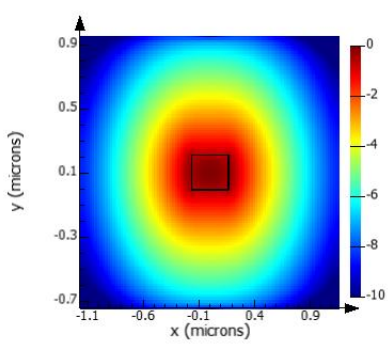

Fig. 1: First TE Mode Profile

Mode simulations also demonstrated the following wavelength dependency for n_{eff}:

$$n_{eff}(\lambda) = 2.38 - 1.67(\lambda - \lambda_0) + 0.00554(\lambda - \lambda_0)^2 \quad (1)$$

In addition, the following graphs were created to demonstrate the wavelengths effect of n_{eff} and n_g

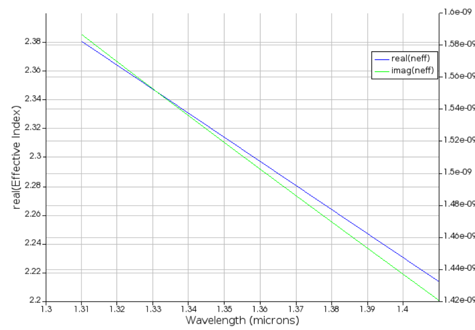

Fig. 2: n_{eff} vs λ

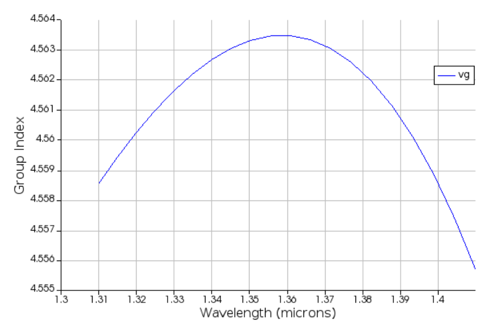

Fig. 3: n_g vs λ

Following that the period was determined using

$$Period = \frac{\lambda}{2n_{eff}} \quad (2)$$

These parameters were then used in Lumerical FDTD to determine tentative values for kappa, bandwidth, and central wavelength. Still left to be done is to sweep the values for different dW and periods to generate graphs that determine the optimal value for these parameters

With those parameters, the transfer matrix method was used to generate graphs that characterized the transmission and reflection of the waveguide.

Changes in loss, number of periods, and cavity length all changed the response of the waveguide. Tentative values for the number of periods and cavity lengths are found in table 1, along with all the parameters selected for the base model. The transmission and reflection values graph that correspond to table 1's parameters is shown in figure 4

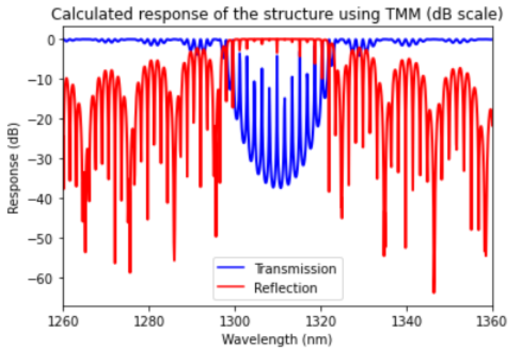

Fig. 4: Base Model Reflection and Transmission Spectrum

TABLE I: Parameters used in fundamental model

Parameter	Δw [nm]
Width (nm)	350
n_{eff}	2.38
Period (nm)	275.17
dW (nm)	50
kappa	151930
Number of periods	60
Cavity length (μm)	100

These values represent a low-risk and well-performing waveguide. Improvements can be made by sweeping over the number of periods and cavity length. These sweeps may present higher risk models, but if successful, will lead to larger Q factor values. Table 2 shows all currently constructed models with ranging parameters. In the coming days, I hope to sweep further and experiment will further values.

TABLE II: Parameter Variations

Number of Periods	Cavity Length (μm)
60	100
80	100
100	100
60	80
60	60

IV. Fabrication

V. Experiment Data

VI. Analysis

VII. Conclusion

Currently, parameters have been chosen that seem likely to lead to a successful laser. The largest hole in this report is the lack of a quantifiable Q factor which I have struggled to determine. That will be the first priority in the coming days.

Following that, more designs with ranging values for the number of periods and cavity length will be made to try and develop the highest Q factor possible.

VIII. References