



Monolithic In-Plane Tunable Optical Filter

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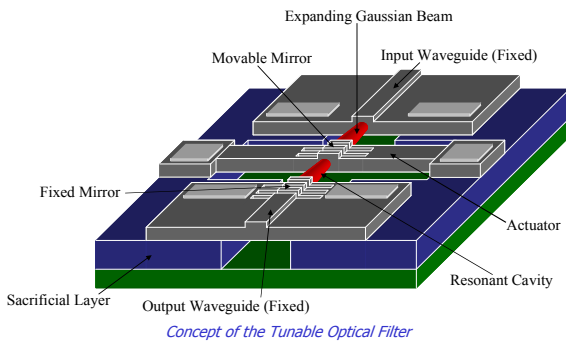
INTRODUCTION

OBJECTIVE: To create a tunable, in-plane optical filter suitable for use in a densely-integrated wavelength division multiplexing system

- Tunable filters are pivotal for Wavelength Division Multiplexing applications for lower inventory costs.
- Tunability loosens manufacturing tolerances, allowing manufacturing error to be compensated by the tuning mechanism
- In-plane devices facilitate monolithic with other photonic devices and systems.

CONCEPT AND DESIGN

A ridged waveguide interrupted by two Distributed Bragg Reflectors (DBR) provides a resonant cavity. By allowing one DBR to be displaced produces a cavity with a tunable resonant wavelength.

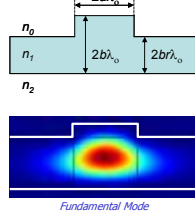


- Applying a voltage between the actuator and either waveguide will deflect the beam towards that waveguide, widening or narrowing the resonant cavity.

RIDGED WAVEGUIDES

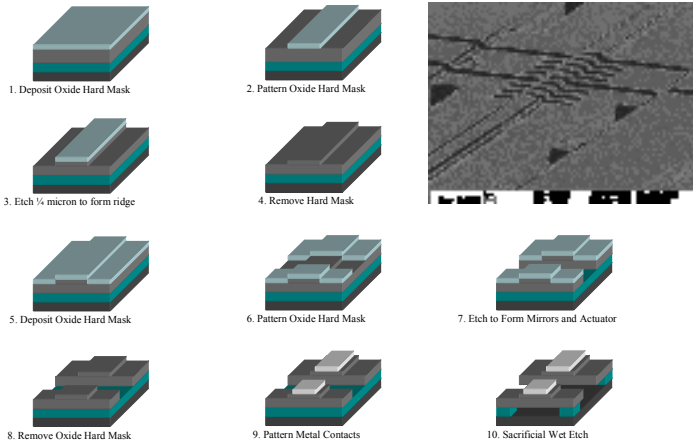
Light diverges upon leaving a guided medium, losing energy and reducing the efficiency of the filter.

- Divergent losses are inversely proportional to the cross-section of the waveguide.
- Large waveguides, while less susceptible to divergence, have multiple modes, making them undesirable for active devices.
- A ridged waveguide is a waveguide geometry where only one guided mode has significant energy in the core
- Ridged Waveguides provide large mode sizes, limiting divergence, while still maintaining single mode behavior



FABRICATION

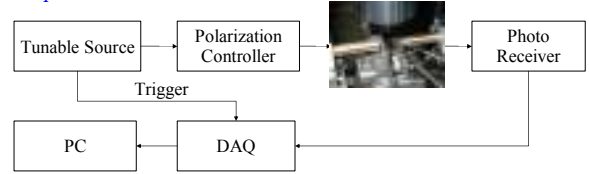
The devices were fabricated on an Indium Phosphide wafer with a 2µm Indium Phosphide device layer grown on top of a 2µm Indium Gallium Arsenide sacrificial layer.



CHARACTERIZATION

The filter's transfer function was measured by sweeping a tunable laser source and measuring the transmitted power as a function of the input wavelength.

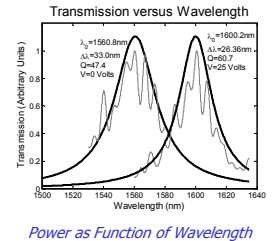
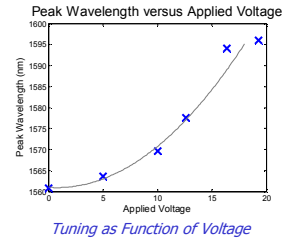
a) Test Setup



- Light generated in a continuous wave laser, continuously tunable from 1520 to 1630 nm with maximum output power of 8 mW
- Polarization at the output waveguide is controlled by a polarization controller
- Lensed fibers are focused onto waveguide facets of device under test with an electrostrictive actuated stage
- Transmitted power is measured with either an optical power meter or a high-speed photoreceiver when performing wavelength scans

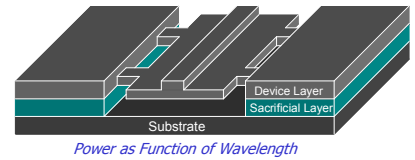
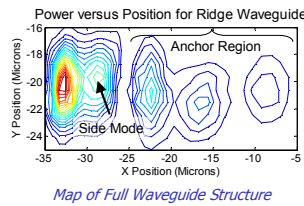
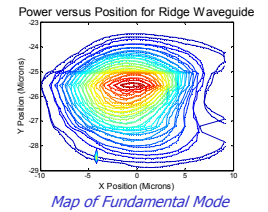
b) Filter Characterization

- Transmitted power is measured versus wavelength.
- High-frequency oscillations are filtered out and Lorentzians are fitted to peaks
- Fit parameters are used to determine tuned wavelength and filter quality factor
- Voltages are applied between actuator and waveguides to tune the filter



c) Waveguide Characterization

- With the input wavelength fixed, the fiber on the output facet is rastered, producing an image
- Image is the magnitude squared of the fiber's mode convoluted with the waveguide's mode
- Fiber is radially symmetric, so image approximates basic shape of waveguide modes
- Presence of higher order modes can be detected by presence of multiple peaks



CONCLUSION

- The wavelength-dependant properties of an in-plane tunable filter were presented
- An optical quality factor of 60.7 and a tunability range of 35nm was demonstrated
- The spatial properties of a suspended ridge waveguide were presented
- **Future Work:** Improve the tunability and quality of the filter

ACKNOWLEDGEMENTS

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