

# Simulation of Optical Ring Resonator Based on Lithium Niobate on Insulator

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## Abstract

Abstract: - With this work, we have reviewed structuring of an all optical notch filter using the micro ring resonator based on Lithium Niobate on Insulator (LNOI) platform. The Electromagnetic Waves, Beam Envelopes (ewbe) physics interface is utilized to handle the propagation over distances that are many wavelengths long with scattering boundary conditions. The proposed notch filter shows almost zero transmittance at resonance and the notch bandwidth is calculated as 3.8 nm. The proposed structure is suitable for ultra fast optical communication networks.

## Introduction:

All optical ring resonator based notch filter is designed using Lithium Niobate on Insulator (LNOI) [1] and further development is proposed. Optical notch filter is important in all optical communication networks for optical signal processing. As time is progressing, the world is quickly moving towards replacing electronics communication system by optical communication system, thus needs of all optical signal processing devices e.g. notch filter, optical add drop multiplexer (OADM) [2], optical switches, etc. has arisen. Several attempts have been made in the past to develop micro ring resonator based on SOI [3], Lithium Niobate [4, 5], etc. In this paper all optical micro ring resonator based on Lithium Niobate on Insulator (LNOI) has been proposed as shown in Figure 1. LNOI has high refractive index contrast and also show better electro-optic & acousto-optic effects. The optical ring resonator resonates when the optical path-length of the ring is equal to the integral multiple of the wavelength. The optical signal at resonant wavelength traveling in the ring is out of phase and destructively interferes with the signal in the bus waveguide. Hence almost zero optical power is obtained at the output port of the ring resonator as shown in Figure 2.

The Wave Optics Module of COMSOL Multiphysics® software is used for analysis. The Electromagnetic Waves, Beam Envelopes physics interface is utilized to handle the propagation over distances that are many wavelengths long. The scattering boundary condition is used for outer boundaries. The notch filter shows almost zero transmittance at resonance and the notch bandwidth is calculated as 3.8 nm as shown in transmittance curve in Figure 3. In future we can make this notch filter tunable with the use of the electro-optic effect of Lithium Niobate by applying electrodes across the ring waveguide and another straight waveguide can also be coupled to make it like OADM.

## Reference

- [1] Poberaj, Gorazd, et al. "Lithium niobate on insulator (LNOI) for micro-photonic devices." *Laser & Photonics Reviews* 6.4, 488-503 (2012).
- [2] Christopher J. Kaalund, "Critically coupled ring resonators for add-drop filtering", *Optics Communications* 237, 357–362 (2004).
- [3] Bogaerts, Wim, et al. "Silicon microring resonators." *Laser & Photonics Reviews* 6.1, 47-73 (2012).
- [4] Wang, Tzyy-Jiann, Chia-Hong Chu, and Che-Yung Lin. "Electro-optically tunable microring resonators on lithium niobate." *Optics letters* 32.19, 2777-2779 (2007).
- [5] Hu, Zhefeng, et al. "Investigation of All-Optical Tunable Notch Filter Based on Sum-Frequency Generation in a PPLN Waveguide." *Photonics Journal, IEEE* 7.6, 1-7 (2015).

## Figures used in the abstract

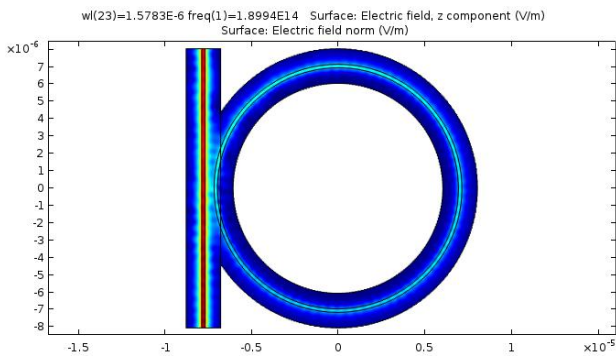


Figure 1: E-Field distribution in Optical Ring Resonator at non-resonating wavelength.

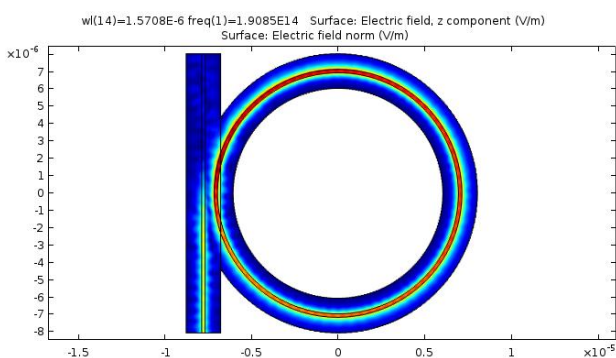
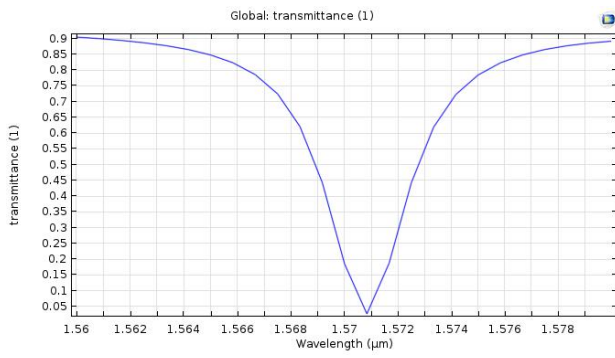
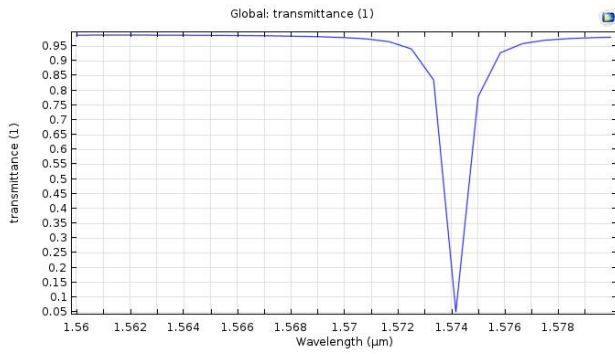


Figure 2: E-Field distribution in Optical Ring Resonator at resonating wavelength.



**Figure 3:** Transmittance curve of notch filter based on LNOI.



**Figure 4:** Transmittance curve of the modal "Optical Ring Resonator Notch Filter".