Optical Ring Resonator Based Notch Filter Using Lithium Niobate on Insulator (LNOI)

H. Kumar[1], V. Janyani[1], B. Oleh[2], U. Serhij[2], S. Dmytro[2], G. Singh[1]

[1]Malaviya National Institute of Technology Jaipur, India,
[2]Inst. of Tele. Radioelectronics and Electronic Engg.,Lviv Polytechnic National University, Lviv (Ukraine)

Introduction: All optical microring resonator based notch filter using LNOI has been proposed as shown in figure 1. 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 travelling in the ring is out of phase and destructively interferes with the signal in the bus waveguide.
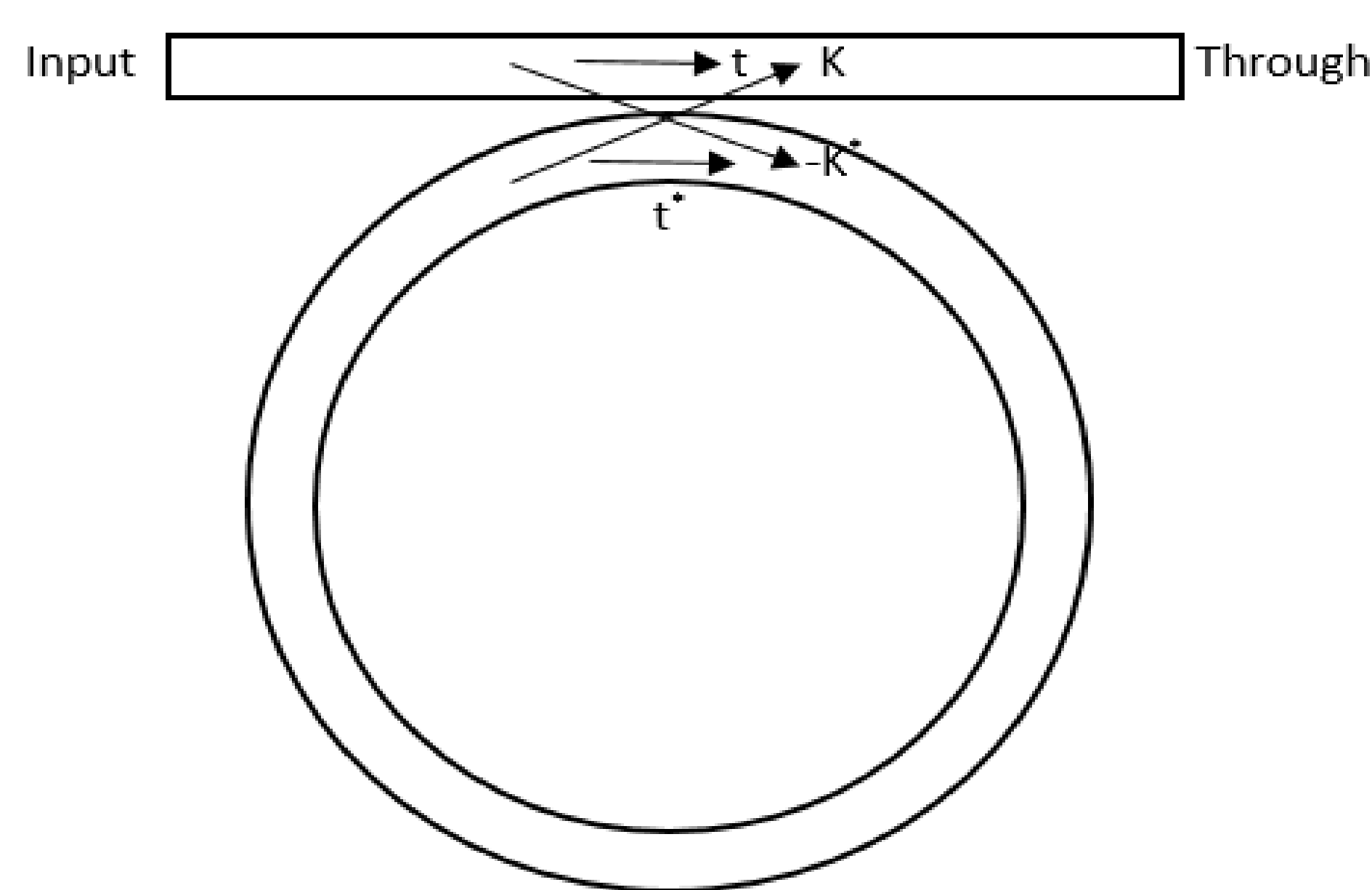

Figure 1. Schematic of an optical ring resonator

Computational Methods: The modelling of ring resonator is done by using the Electromagnetic Waves, Beam Envelopes physics interface which is utilized to handle the propagation over distances that are many wavelengths long. The electric field along the ring can be given as:

$$E = E_1 e^{-j\emptyset} \tag{1}$$

where E_1 is a slowly varying field envelope function and ϕ is an approximation of the propagation phase. At the resonating wavelength the optical power is almost zero at through port as shown in figure 2.(a), otherwise optical signal is passed through as shown in figure 2.(b).
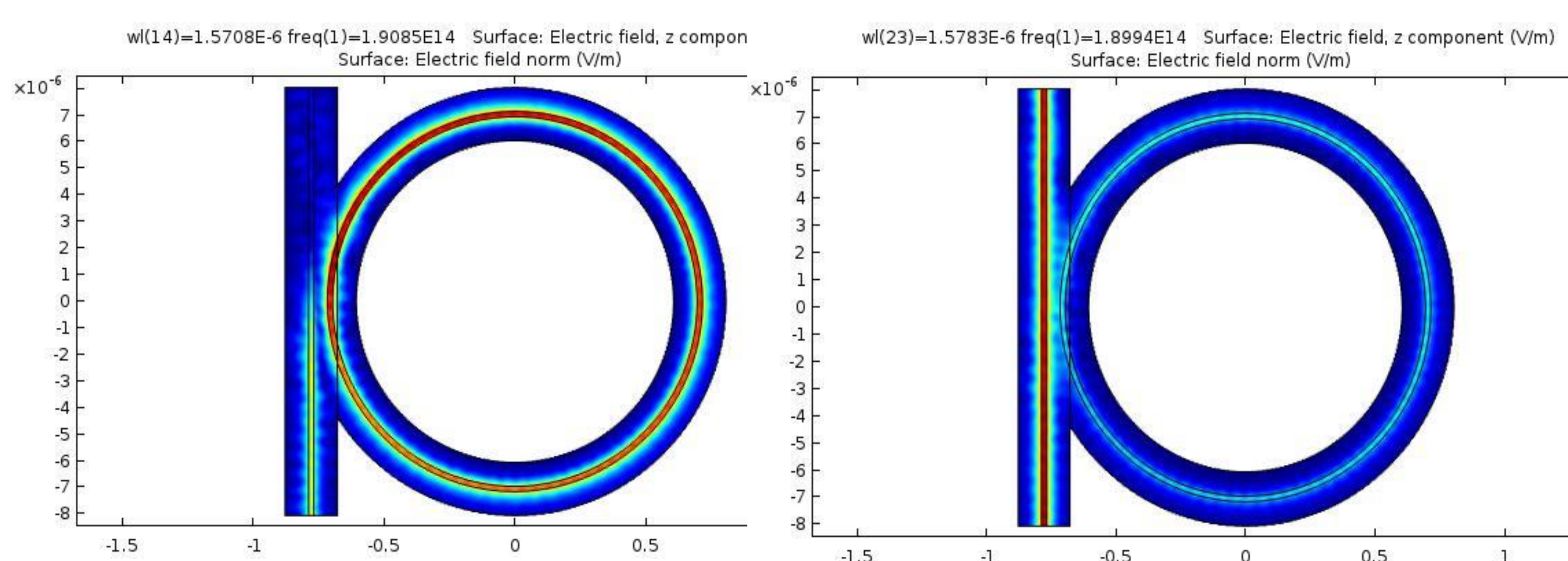

Figure 2. E-Field distribution in Optical Ring Resonator at
(a) resonating wavelength   (b) Non resonating wavelength

Results: 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. The transmittance curve of given modal in COMSOL library at same resonating wavelength is shown in figure 4 which has notch bandwidth of 1 nm. Q-factor is calculated as 415.
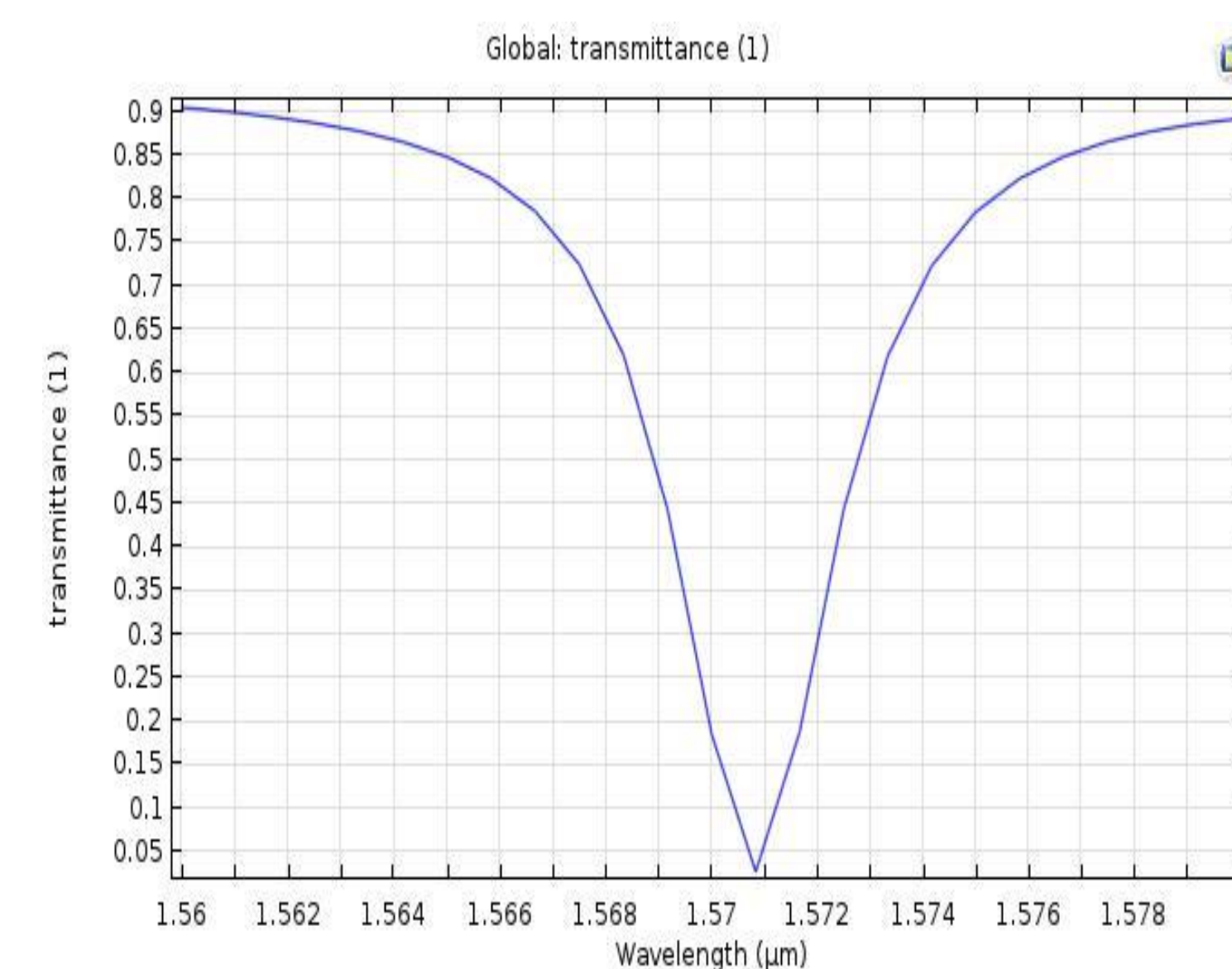

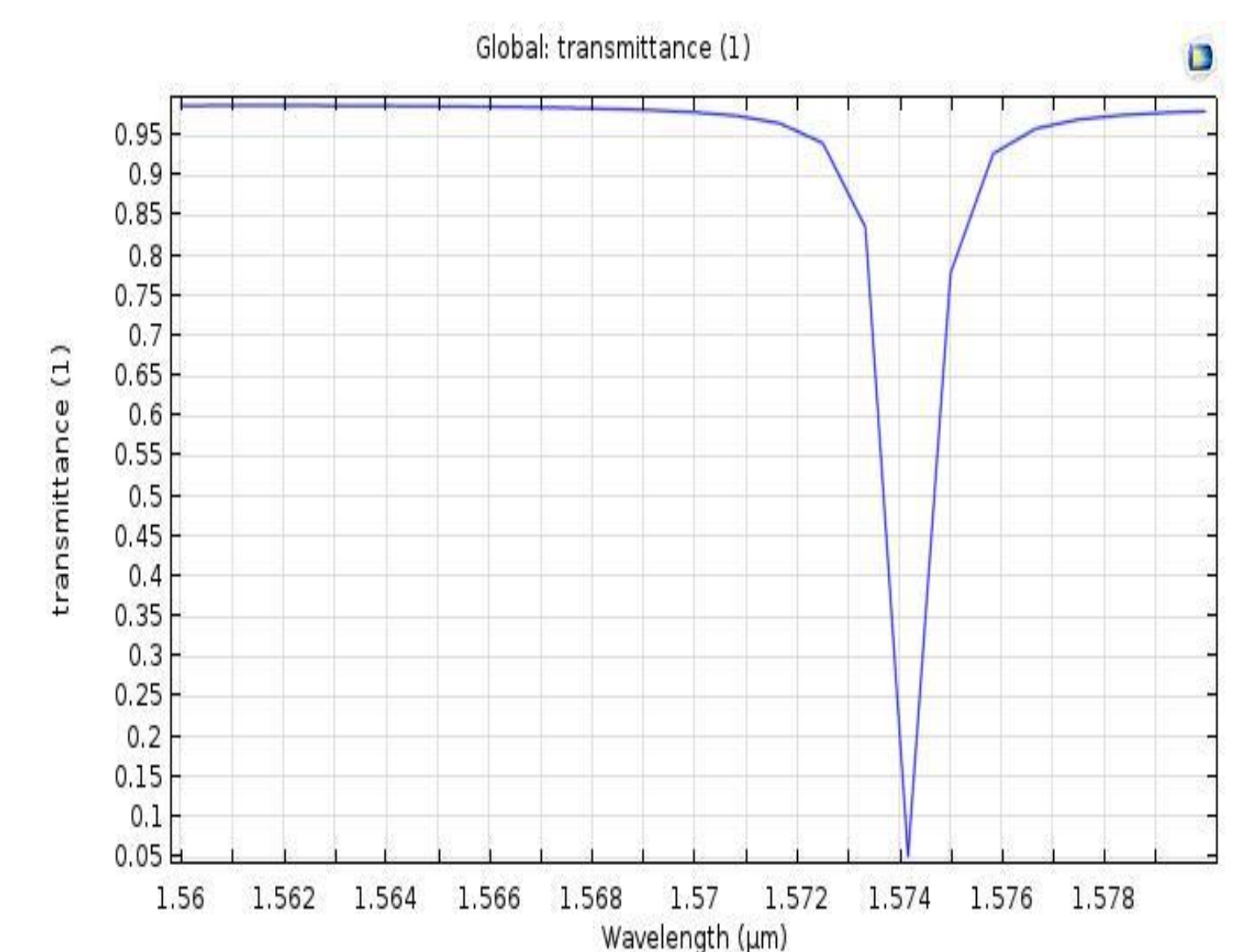**Figure 3**. Transmittance curve of notch filter based on LNOI.

Figure 4. Transmittance curve of the theoretical modal.

Conclusions: Optical notch filter will be used to filter out the specific wavelength and it is mainly used in optical signal processing and optical biosensors. The notch bandwidth of the optical ring resonator based notch filter is 3.8 nm and Q-factor is 415 which can be further improved.

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