Width modulated cascaded photonic crystal nanocavity for Wavelength Division Multiplexing

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1. Introduction

The degree of photonic integration is still very inadequate compared to the electronics-integration because of their large foot-print and high power consumption. Therefore, large number of researchers has now focused to reduce the energy consumption by introducing optical communiaction on a chip. However, for on-chip photonic functionalities, the requirements of components like, wave division multiplexer (WDM), De-multiplexer, switching network, optical interconnects are still a challenge. With this motivation, the work presents a cascaded nanocavity for on-chip wavelength division multiplexing.

2. Device Architecture

A two dimensional view of the proposed cascaded-nanocavity, which is designed based on the principles as described in [1] and [2], is shown in the fig. 1. These nanocavities are designed using a silicon-based slotted photonic crystal (PhC) slab waveguide of thickness 301 nm. The PhC slab is permeated of air holes of radius 129 nm those are arranged in a triangular lattice of lattice constant 430 nm. Width of these nanocavities is modulated by shifting some of the associated air holes upward and downward by either by 30 nm or 60 nm, as shown in the figure. The air slot in this slotted-PhC is considered to be placed at the centre of the cavities and its width is modulated as 129 nm, 107 nm , 86 nm, and 64 nm at the different nanocavity sections.

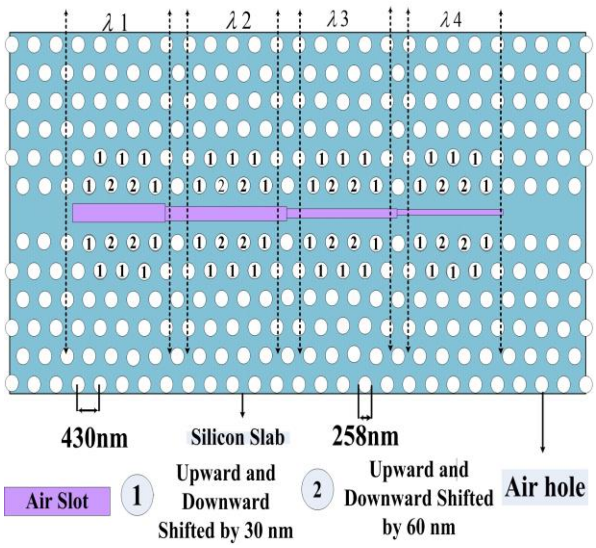

Fig 1: Device architecture of the WDM cavity

2. Result and Discussion

A 3D FDTD method is used to evaluate the performances of different sections (i.e. of different slot widths) of the nanocavities. The corresponding frequency responses are shown in the fig. 2.

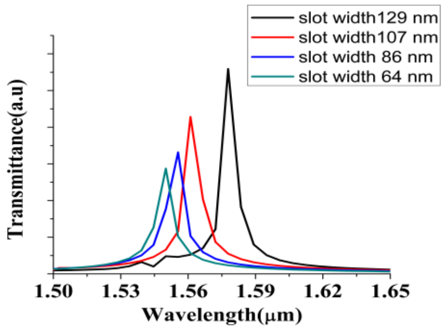

Fig 2: Frequncy response for various slot width of the cascaded nano avity

It is observed that both the modulated width of the waveguide and the air slot play important roles in cavity formation. The dispersion diagrams at different positions of the waveguide changes and the propagation band gradually shifts toward lower frequencies as the width of the slot (and, hence, of the cavity) decrease. The group velocity reduces to zero as the wavelength approaches to the cut-off value and, thus, the light is unable to escape from cavity. So, different wavelengths can be trapped at different positions of the cavity by varying the slot. It is seen from the figure that resonant wavelengths λ1 (=1550 nm), λ2 (=1555 nm), λ3 (=1560 nm), λ4 (=1575 nm) are trapped at different cavity positions due to the variations in the corresponding slot widths.

3. Conclusions

Design of a width-modulated air slot based cascaded photonic crystal nanocavity is presented in this work for applications in on-chip WDM network. Transmittance of the cavity is calculated using a 3D FDTD method. Four different frequency components are trapped at different positions by varying slot width. The design can be enhanced to accommodate more wavelengths by varying slot width further.

References

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[2] Li et al., "Slot Photonic Crystal Microcavity for Refractive Index Gas Sensing," *IEEE Photonics Journal,6(2014)1-9*