



DEMONSTRATION OF ALL OPTICAL NAND LOGIC GATE USING PHOTONIC INTEGRATED CIRCUITS

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Introduction

A novel dual wavelength operated all optical logic operations are demonstrated. The method makes use of bi-directional coupler with unequal lengths of waveguide. The truth table corresponding to the simulated results establishes a NAND logic operation. Since the logic operations are performed with all optical circuits, ultrafast operations of the order of few hundreds of THz could be a possible with the present method.

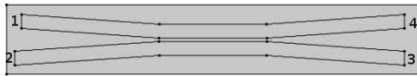
Basic Idea

Geometry of 4-port bi-directional coupler was simulated, power is launched from both of its input ports.



4-port Directional coupler

While simulating this model using COMSOL Multiphysics, we have used two physical modules i.e. we have studied the effects of two physical environments simultaneously.



Simulated Geometry

Principle

When we are giving two signal of same wavelengths, they make interference. We are using two waveguide of different path length, which is giving different phases for different wavelengths. Here we are using two wavelengths, for them phase differences are different. First is for constructive interference and second one is for destructive interference. So we are getting two different logics Logic 0 and logic 1.

Directional coupler

Power at both the output ports is the function of interaction length z , which is a function of optical path length that depends on wavelength.

$$P_1 = P_0 \cos^2 kz$$
$$P_2 = P_0 \sin^2 kz$$

If input wavelength is varying then optical path length will vary and interaction length will also vary. Because power transfer is depending upon wave vector and wave vector is depending upon the wavelength.

Results

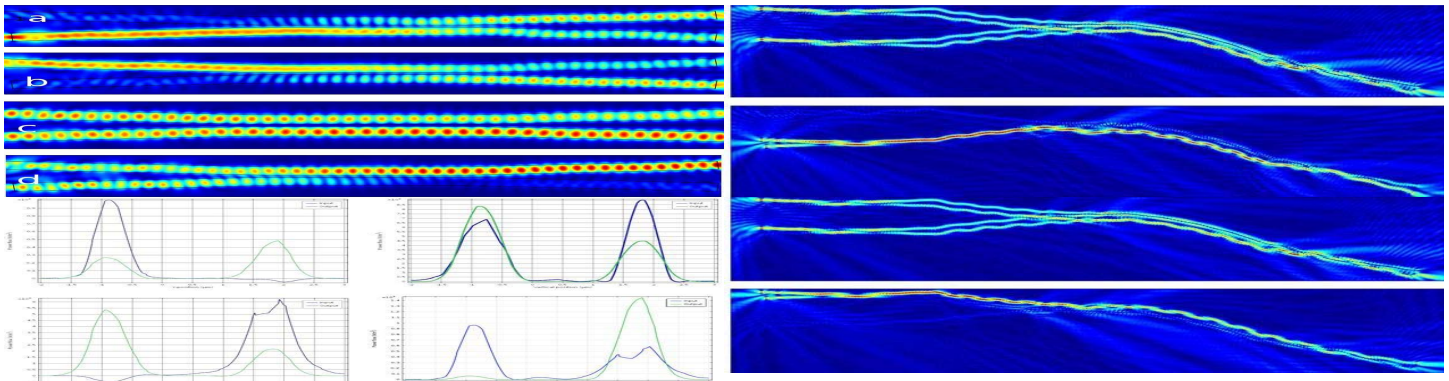


Fig Simulation result of optical NAND gate at left and Optical AND gate at right

Conclusion

In conclusion we proposed a novel method for all optical logic operation using simple bi-directional coupler with unequal length of waveguide. The simulated results show that the logic operation is possible. The truth table established shows the NAND logic operation. Since the logic operations are performed with all optical circuits without the help of any electronic system, ultrafast operations of the order of hundreds of THz could be possible.

References

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