Gallium Nitride interconnects for quantum integrated photonic chips

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Directional Couplers and Y-branch splitters are one of the most essential components for photonic integrated circuits (PICs) [1]. Combined with the optical transparency and particularly good waveguiding properties of Gallium Nitride on Sapphire substrate in the telecommunication window around 1550 nm, makes it a viable material [2].

In this project, a GaN on Sapphire directional coupler and Y branch splitter have been designed which are compatible with the CMOS SOI(Silicon-on-Insulator) fabrication technologies. The passive structures are integrated and coupled with the SOI devices to make a PIC which can effectively accept the change in material properties for effective light coupling at the wavelength of around 1550nm through adiabatic tapers. The mode coupling in the directional coupler and the mode splitting into symmetrical and antisymmetrical modes has been proved numerically through two-photon interference in degenerate photon pairs and has been measured with the Hong-Ou-Mandel in terms of photon distinguishability with a 45 :55 coupling ratio in the DC. It has been further explained through the Y branch splitter, using the splitter as a model for the beam splitter and using the DC as a substitute to the beam interferometer to explain the coincidence probability. Beam Propagation method and FDTD models were utilized to calculate the length of the coupling region/splitting region. Matlab computation was used to import the files from the FDTD simulation to construct the Hong-Ou-Mandel probability model and using the optimized parameters from the earlier simulations, a dip with 95% visibility was computed and measured.

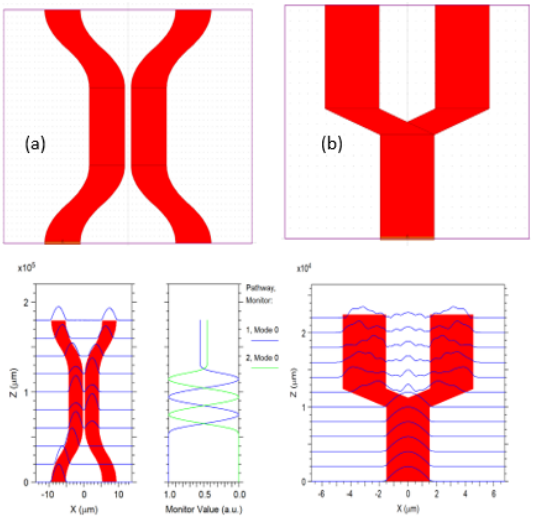

Figure 1: BPM simulation and results for the (a) Directional coupler and (b) Y branch splitter

Keywords: DISTINGUISHABLE PHOTONS, SPECTRAL DEGREE OF FREEDOM, COUPLING EFFICIENCY

References

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[2] Jialei Yuan *et al* 2017 *Semicond. Sci. Technol.* **32** 045001