INFORMATION ON THE DOCTORAL THESIS

Thesis title: **Study on design of nanoplasmonic waveguide in wavelength division multiplexing.**

Speciality: **Electronic Engineering**

Code: **9.52.02.03**

Name of PhD Candidate: **Nguyen Van Tai**

Scientific supervisors:

1. Assoc. Prof, PhD **Dang Hoai Bac**
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Training institution: Posts and Telecommunications Institute of Technology

NEW FINDINGS OF THE THESIS

The nanometer-sized plamonic waveguide has the ability to transmit sub-wavelength light with wide bandwidth, high transmission efficiency, low loss and extremely compact size, which has been proven by scientific studies to be one of the good candidates for the design of integrated circuits in wavelength division multiplexing systems and in some high-speed computing systems.

Researching design methods based on FDTD technique, time-mode coupled theory combined with EME simulation method to optimize structural parameters of the structure and analyze and evaluate the structure's properties. proposed such as transmission, absorption characteristics, allowable manufacturing tolerances.

The thesis has presented the designs of plsamonic nano waveguides according to the MIM structure with the functions of rotating polarization, calculating logic, adding/reducing/dividing wavelengths in the telecommunications wavelength window to apply multiplexing techniques. wavelength division as well as signal processing functional components in all-optical communication networks.

The main results of the thesis are as follows:

1) Proposed design of HPW plasmonic hybrid waveguide with rotation polarization function and XOR, OR, NOT logic gates, reversible optical Feynman gate based on nanometer plasmonic waveguide according to MIM structure, including:

HPW waveguide has small absorption and reflection power (absorption below -7dB and reflection below -10dB), low transmission loss (less than -

1.5dB) in the 100nm bandwidth range at 1500nm to 1600nm. The size of the component is only 4.1µm long and 400nm wide, which is very small.

The proposed plasmonic logic gates can greatly reduce the size thereby reducing scattering, reduce the signal threshold for logic operations, and have a wide bandwidth of over 300 nm while being compact in size, the size of the OR, XOR gates , NOT is 340nm x 1.073µm; Feynman gate is 1.25µm x 963nm.

2) Proposal to design nanometer plasmonic waveguides according to MIM structure to create optical wavelength filters with large bandwidth, high transmission efficiency and allowing suitable fabrication tolerances, including:

Create a 1310nm and 1550nm dual-band plasmonic demultiplexer with the following characteristics: the overall size of the device is 1.7µm x 3.4µm; when the crosstalk is below -20dB, the bandwidth is 80 nm in the band window of 1310 nm (1290 nm to 1370 nm) and the bandwidth covers the entire C + L range (1525 nm to 1625 nm) in the 1550 nm band window; Absorption coefficient A is -1.8dB at 1310nm and absorption coefficient A is less than -3.7dB in the whole C+L range.

Generate 1310 nm, 1430 nm and 1550 nm tri-band optical wavelength filters and 3dB wavelength divider based on nanometer-sized MIM plasmonic waveguide structure that features: transmitted power at the output ports of the tri-band filter 1310nm, 1430nm, and 1550nm waves are -5.37dB, -6.19dB and -5.68dB respectively; 3dB bandwidth of the three bands 1310nm, 1430nm, and 1550nm is relatively wide, 90nm, 80nm, and 100nm respectively; with manufacturing tolerances, the transmitted power is not less than -7dB, the crosstalk power is less than -15dB, absorption is less than -1dB and reflection is less than -10dB.

The nanometer RGB plasmonic wavelength filter based on the MIM structure has the characteristics: the signal-to-noise difference in the 3dB band is always greater than -10dB, and the transmission loss is <-8dB in the 30nm bandwidth at three RGB color spectrum is 465nm, 520nm and 640nm; capture optical modes with a size of several tens of nanometers, the size of the whole circuit is 2.2µm x 3.2µm.

APPLICATIONS, PRACTICAL APPLICABILITY, AND MATTES NEED FURTHER STUDIES

The entire content and obtained results of the thesis indicate that the research direction of applying plasmonic nanowaveguides in wavelength division multiplexing is feasible and has high potential. The development direction in the coming time is to test the proposed methods on hardware circuits, thereby obtaining actual measurement results of working efficiency, absorption loss rate, crosstalk as well as the actual size of the circuit. Comparing the actual measurement results with the theoretical and numerical simulation results, we will have an accurate assessment of the proposed scientific content as well as the applicability of those devices to other devices. equipment or actual communication systems.

In addition, with the knowledge that the PhD student has gained during the implementation of this thesis, the PhD student will continue to research and cooperate with the research community to apply plasmonic effects in ultra-optical structures. compact to be able to propose more optimal design methods and put them into practice.

Confirmation of representative Scientific supervisor **PhD. Candidate**

Assoc. Prof, PhD Dang Hoai Bac **PhD. Truong Cao Dung** **Nguyen Van Tai**