Design and Analysis of Integrated Plasmonic Modulators

Surface plasmon-polaritons have received much attention because of their ability to confine and guide light in a very small area, which can further decrease footprint of photonic integrated circuits down to the size of electronic circuits. Unlike dielectric waveguides which guide volume electromagnetic waves via total internal reflection, these surface plasmon-polariton waves are coupled to electron density oscillations along metal-dielectric interfaces. This effect increases the confinement of the mode but causes a higher losses compared to dielectric. Plasmonic waveguide structures can be combined with other materials like Graphene or transparent conducting thin films (e.g. ITO) to realize a plasmonic modulator.

In this thesis your task is to develop and simulate a plasmonic modulator that can be integrated with silicon photonics technology.

Supervisor: Giannino Dziallas

Institutions: TU Berlin

Nonlinear Effects in Graphene-integrated Silicon Waveguides

Optical signals have a lot of potential to increase the capacity and the speed of interconnection systems. One way for fast signal processing in such systems is by using nonlinear optical effects to switch or amplify optical signals. Therefore highly nonlinear materials that can be integrated with current photonic integrated circuits are necessary. A single layer of Graphene offers strong nonlinear effects and can be integrated on top of e.g. Silicon waveguides to increase the interaction length.

In this thesis your task is to simulate nonlinear effects in Graphene-integrated Silicon waveguides and develop a waveguide structure that possibly increases the Light-Graphene interaction.

Supervisor: Giannino Dziallas

Institutions: TU Berlin

Optical Properties of Chiral Nanostructures

Chiral nanostructures like metamaterials formed from gold nano-helices have notable optical properties with potential applications in sensing, photo-chemistry, filtering, etc. Goal of this project is to systematically investigate these properties by numerical simulations.

For this aim state-of-the-art finite-element methods will be used. The project will be associated at the Computational Nanooptics group at Zuse Institute Berlin, located on the campus of Freie Universität Berlin.

Please contact burger@zib.de for more informations.

Supervisor: Sven Burger

Institutions: Zuse Institute Berlin
TU-Berlin

Numerical Investigation of Nano-Lasers

Miniaturized lasers like vertical cavity surface emitting lasers (VCSEL) are used as light sources in fiberoptical communcation systems. Goal of this project is to analyze and optimize modal properties of nano-lasers.

For this aim state-of-the-art finite-element methods will be used. The project will be associated at the Computational Nanooptics group at Zuse Institute Berlin, located on the campus of Freie Universität Berlin.

Please contact burger@zib.de for more informations.

Supervisor: Sven Burger

Institutions: Zuse Institute Berlin
TU Berlin

Design and characterization of high-power germanium photodetectors

Photodiodes for high-power and high-frequency are key building blocks for photonic analog links. Integrated germanium photodiodes are an attractive alternative to existing III-V based solutions due to the potential of co-integration with signal processing electronics. The work will deal with the design and experimental evaluation of high-power germanium photodiode structures so as to develop optimum integration strategies and to study performance trade-offs for integrated devices.

Supervisor: Georg Winzer

Institutions: IHP Frankfurt (Oder)*
TU Berlin

Design of traveling wave EO modulator structures based on transition metal oxides

The integration of transition metal oxide materials in the silicon photonics platform enables promising electro-optical functionalities. A modulator based on this concept could offer the advantages of high speed, low power consumption and small footprint. This topic regards the theoretical optimization of such a novel-concept modulator and the comparison of its performance to state-of-the-art modulator technologies. After the design optimization, a test layout of the metals could be implemented in order to be fabricated using IHP technology.

Supervisors: Despoina Petousi

Institutions: IHP Frankfurt (Oder)*
TU Berlin

Experimental analysis of linearity and chirp of photonic BiCMOS Mach-Zehnder modulator structures

IHP photonic BiCMOS technology offers the advantage of combining high-speed electronics together with photonic components on the same chip. In this topic the MAPNET student will have the possibility to characterize Si modulators with monolithically integrated drivers. Such a high-performance IQ modulator can be used in optical coherent systems. The deterioration of the MZM output when used for higher order modulation formats due to phase shifter chirp can be analyzed. The experimental results should be then compared to co-simulation results by using CADENCE in order to describe the device limits.

Supervisor: Despoina Petousi

Institutions: IHP Frankfurt (Oder)*
TU Berlin

Investigation of Integrated Electrical Drive Circuits for Silicon Mach-Zehnder Modulators

Integration of silicon-based optical components in CMOS technologies promises to transfer the high bandwidth seen in classical fiber communication systems down to the chip scale, while simultaneously reducing cost and power. Mach-Zehnder modulators show good linearity and low chirp. However current modulation efficiency is rather limited for this kind of modulator. Part of this inefficiency can be accounted to the losses due to the passive connection of external drivers to the actual modulator. Integrating the driver electronics closely to the actual modulator may avoid these losses and improve overall efficiency. Your task will be to investigate different driver topologies and optimize design parameters for different goal functions mainly by simulation.

Supervisor: Gregor Ronniger

Institutions: TU Berlin

*Please note that the IHP is located around 100km away from Berlin. Get in contact with the supervisors, to make clear how to handle presence at IHP.