ESYCOM Lab

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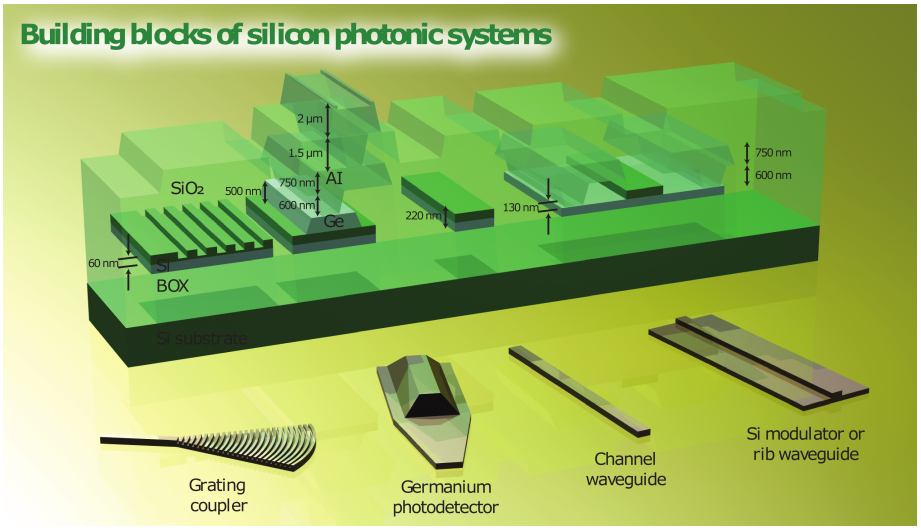
Graduate Program CODS at ESYCOM Lab.

Silicon Photonic Waveguides modeling for Radio over Fiber Applications

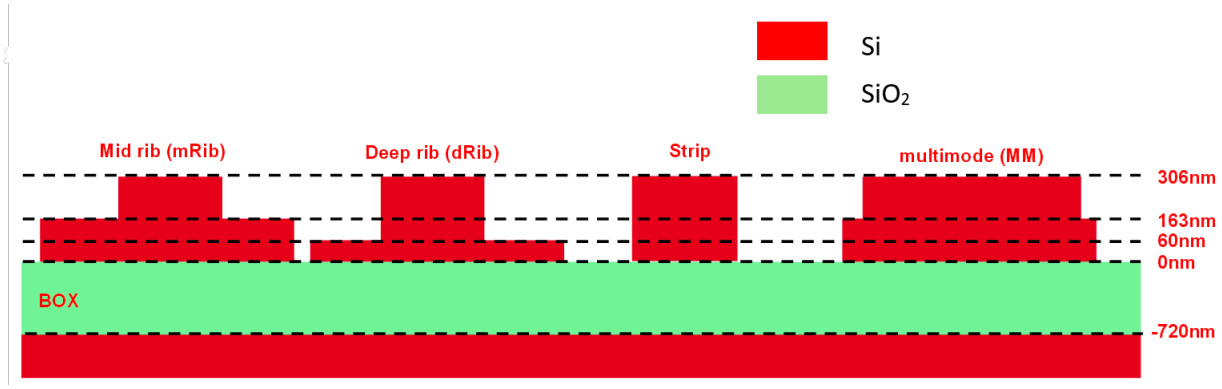
Topic:

Photonic Integrated Circuits (PICs) are fast-growing for very high data rate applications [Wat11]. Long distance optical communication and the emerging data centers are quite pioneering in the progress of these technologies and particularly on silicon platform. Systems such as Analog Radio-over-Fiber (A-RoF) benefit from technological progress in optical communications and could gain a great advantage from silicon PICs. The challenge of the communication is now to miniaturize the photonic system as it has been done earlier for the electronic system owing to the development of the microelectronic technology. Nowadays, this objective is based on the development of the PIC whose forecasts for the years 2021-2030 announce an average annual growth rate of 20.5%. The III-V photonic technology now accounts for 82% of the PIC market share while only 16% of the PIC market is carried by Silicon technology. However, silicon photonics technology is cheaper and offers small circuit sizes allowing strong integration [BC18]. The market for silicon PICs for telecommunication and for home area network applications is in progress and will be significant in near future.

Today, this mature PICs technology is optimized for digital communications and not optimized for analog-photonic communications (A-RoF). Thus, the building blocks of silicon photonic components for A-RoF systems concern optical waveguides, intensity and phase modulators, optical filters and hybrid III-V silicon laser sources and photodiodes (see the below figure). The future A-RoF system and more precisely, each of the building block, has to be redesigned and optimized to fit in the 5G fronthaul architectures or beyond for an enhanced mobility at a higher data rate. Optical wireless communication like LiFi could be also befit from these optimized PICs.



In this internship, we'll focus on the characterisation and modeling of silicon photonic waveguides. Some examples of such components are given in the following figure where Rib (Ribbon guide), Strip and Multmode waveguides are described.



Work objectives:
The internship can be divided in 3 work packages:

WP1: Optical waveguides theory
This part concerns the bibliography study where the student will take an interest on the optical waveguides and the principal parameters of silicon optical waveguides: attenuation, mode propagation, mode profil, etc.

WP2: Characterisation of silicon optical waveguides
Different silicon chips will be provided by CEA-LEti to be characterized in the Lab. An experimental setup will be developed considering grating coupling access for optical signal. Optical power losses for different optical waveguides will be estimated from these characterisations.

WP3: Silicon optical waveguides modeling
The student will develop models of these photonic waveguides in Matlab or Python. Interfacing with Pathwave ADS software (Keysigth Technologies) will be studied in order to design/simulate PICs with the developed models [Bil+15]. Two possibilities are offered with the software either by using Python interface or with a user-compiled model where C-script is required.

Contacts

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*References

[Bil+15] Anne-Laure Billabert et al. "Photonic components advanced modelling for RoF link design". In: *2015 17th International Conference on Transparent Optical Networks (ICTON)*. 2015, pp. 1–4. DOI: 10.1109/ICTON.2015.7193624.

[BC18] Wim Bogaerts and Lukas Chrostowski. "Silicon Photonics Circuit Design: Methods, Tools and Challenges". In: *Laser & Photonics Reviews* 12.4 (2018), p. 1700237. DOI: https://doi.org/10.1002/lpor.201700237. eprint: https://onlinelibrary.wiley.com/doi/pdf/10.1002/lpor.201700237. URL: https://onlinelibrary.wiley.com/doi/abs/10.1002/lpor.201700237.

[Wat11] Michael R. Watts. "Silicon photonic components and networks". In: *2011 Optical Fiber Communication Conference and Exposition and the National Fiber Optic Engineers Conference*. 2011, pp. 1–3.