PHOTONICS SEMINAR

Semiconductor lasers for next generation silicon photonics

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Tuesday 18 December 2018
10:30-12:30
ENSSAT, Lannion
137C

Abstract

Silicon photonics has the potential to radically change the landscape of photonics. Its compatibility with well-known and mature CMOS fabrication technology offers multiple advantages, such as low-cost, high-volume and reliable manufacturing with nanoscale precision [1,2]. Applications can typically be found in datacom optical systems, future optical interconnects, board-to-board and chip-to-chip integrated photonics, self-driving cars and others [1]. Multiple breakthroughs in silicon photonics have been achieved with high-speed silicon modulators, nanophotonic components (waveguides, ring resonators and filters), and photodetectors, which can operate at the telecommunication wavelengths. However, the indirect band gap nature of silicon makes the realization of light emitters on silicon highly inefficient with extremely poor radiative efficiency, which means that other techniques such as wafer bonding must be investigated if light emission is to be realized [2]. Such hybrid lasers made with several passive and active interfaces/transitions between the III-V material and the silicon strongly suffer from multiple internal reflections which become highly problematic for integration on a photonic chip [3]. In this work, I will discuss new semiconductor lasers relying on the direct epitaxial growth of GaAs layers onto silicon with InAs quantum dot (QD) [4]. Owing to the atom-like discrete energy states, InAs/GaAs QD lasers directly grown on silicon enable smaller devices, amplification, thermal stability, cost advantages with reduced need for optical isolator hence making them ideal candidates for silicon integration with excellent energy efficiency [5]. During the presentation, I will review the recent results obtained on InAs/GaAs QD lasers directly grown on silicon; in particular, I will show a room temperature operation with threshold current not exceeding a few milliamps and a zero-chirp parameter [6]. I will also discuss the impact on the laser performance of the QD size homogeneity, doping

level, the threading dislocation density, and the Shockley-Read-Hall (SRH) recombination. Finally, I will focus on the dynamical and noise properties of InAs/GaAs QD lasers directly grown on silicon and show their ability to operate at high-speed without optical isolator in future silicon photonic systems.

References
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Frédéric Grillot received an M.Sc. in Physics from the University of Dijon, a Ph.D. in Electrical Engineering from the University of Besançon, and the Research Habilitation designation in Physics from the University of Paris VII, France.
He is currently a Professor at Télécom Paristech, France and a Research Professor at the University of New-Mexico, United States. In April 2017, he joined the Electrical Engineering department at the University of California at Los Angeles (UCLA) as a Visiting Professor teaching laser dynamics and quantum mechanics. Dr. Grillot is the author or coauthor of 84 journal papers, one book, three book chapters, and more than 200 contributions in international conferences and workshops. His current research interests include advanced quantum confined devices using new materials such as quantum dots and dashes, light emitters based on intersubband transitions, nonlinear dynamics and optical chaos in semiconductor lasers systems as well as microwave and silicon photonics applications including photonic clocks and photonic analog to digital converters. He is an Associate Editor for Optics Express, Senior Member of the SPIE and of the IEEE Photonics Society, as well as a regular member of the OSA.