Research Topic for the ParisTech/CSC PhD Program

Field: Information and Communication Sciences and Technologies

Subfield: Optoelectronics, physics of solid-state lasers

Title: **High-speed quantum dot lasers on germanium/silicon for short communication links**

ParisTech School: Telecom ParisTech

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Short description of possible research topics for a PhD

Silicon photonics has been a very active area of research for more than 2 decades, targeting at integrating both active and passive photonic and optoelectronic devices on a single silicon chip (laser sources, modulators, photodetectors, waveguides, filters, and optical switches). The greatest challenge is to integrate monolithically III-V semiconductor lasers on germanium or silicon (Ge/Si), due to epitaxial defects originating from the crystal lattice mismatch. Luckily, InAs/GaAs quantum dot (Qdot) lasers are weakly sensitive to such defects, and CW lasing of Qdot lasers grown on Ge/Si at 300K have been demonstrated. Qdot lasers exhibit superior characteristics such as low threshold current and large temperature stability, which is very useful for low energy consumption photonic integrated circuits. Recent work showed that Ge-based Qdot lasers could also exhibit a reduced noise in comparison with GaAs-based Qdot lasers, but a comprehensive understanding is still missing. This project will focus on physical modeling and experiments on InAs/GaAs Qdot lasers on Ge/Si. Phase noise modeling will be implemented both semi-analytically and numerically. Various characterizations will be performed, including spectral linewidth and power spectral density of flicker & white noise. The work will also address methods to reduce phase noise, such as photonic / optoelectronic perturbations (e.g. external optical feedback).

The thesis will be conducted in close collaboration with Dr. Cheng Wang at ShanghaiTech University (http://shanghaitech-sist-chengwang.myfreesites.net/).

Required background of the student:

Solid background in lasers/semiconductor optoelectronics ; communication and reporting skills.

2-3 representative publications of the group

[1] M. T. Crowley, N. A. Naderi, H. Su, F. Grillot and L. F. Lester, "GaAs based Quantum Dot Lasers", Semiconductors and Semimetals: Advances in Semiconductor Lasers, Vol. 86, (2012).

[2] Y. G. Zhou, C. Zhou, C. F. Cao, J. B. Du, Q. Gong, and C. Wang, "Relative intensity noise of InAs quantum dot lasers epitaxially grown on Ge," submitted Opt. Express, (2017).

[3] K. Schires, S. Gomez, A. Gallet, G. H. Duan, and F. Grillot, Passive chaos bandwidth enhancement under dual optical feedback with hybrid III-V/Si DFB lasers, IEEE Journal of Selected Topics in Quantum Electronics, vol. 23, pp. 1801309, (2017).