Semiconductor optical nanosources

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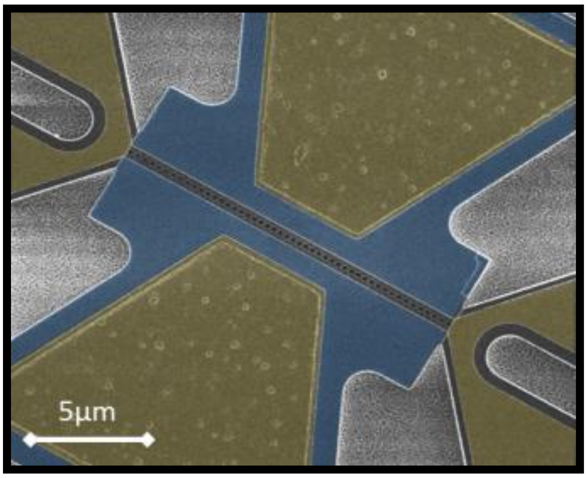
Nanophotonics has demonstrated over the years to be the solution to provide extremely large light matter interactions which are at the center of numerous applications in data communications and processing as well as quantum optics. Photonic crystals are certainly amongst the most emblematic nanophotonic structures. They enable the conception of the best photonic cavities with the highest measured Q factor over modal volume ratios which scale with intracavity electromagnetic field intensity. Our research activity is focused on the exploration of these interactions in III-V semiconductor/Silicon hybrid photonic crystal (PhC) structures and their exploitation for the achievement of smaller, smarter, faster energy-efficient optoelectronic components which will revolutionize our world, governed by information and communication technology.

Indeed, these hybrid structures combine the best of Silicon and III-V semiconductor photonics, merging the fantastic capacity of Silicon and especially Silicon on insulator (SOI) to provide an excellent way to achieve highly compact low loss passive optical circuitries, with the optical gain and nonlinearity of III-V semiconductor compounds. This is the key technology for achieving the convergence of microelectronics and photonics.

Amongst all the devices to be developed, sources are of utmost importance as they provide the necessary electro-optical conversion functionality. In this talk, I will describe our latest work on nanolaser diodes [1] as well as the first demonstration of a nanocavity based optical parametric oscillator [2]. I will also show that the latter can also be used as a heralded single photon source [3].



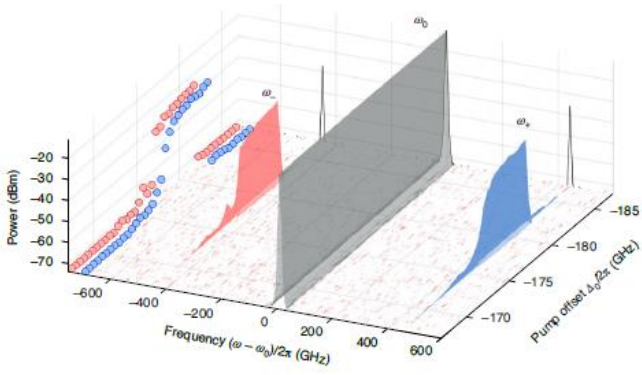


Figure Left: optical microscope image of hybrid InP on SOI nanolasers. Right: Emission from our nano optical parametric oscillator.

[1] G. Crosnier et al, Nature Phot, 11, 297–300 (2017).
[2] G. Marty et al, Nature Phot. 15, 53–58 (2021).
[3] A. Chopin et al, Communications Physics 6, 77 (2023).