Direct band gap Ge-based laser sources for IR silicon photonics

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The objective of the thesis project is to develop direct band gap group IV laser sources operating at room temperature by using GeSn material and strain engineering to meet the future challenges of Si-photonics.

Research context:

One of the major challenges of photonics is to meet a full-CMOS compatible technology. The main missing element that would allow to fully exploit the technology of silicon photonics is the laser source. Unfortunately silicon and germanium, which are the main group-IV elements used in the microelectronics industry, are penalized for the emission of light because of the indirect nature of their electronic band structure. Currently the semiconductor laser sources are mainly made from III-V elements whose integration on silicon turns out to be complex, for reasons of chemical incompatibilities between III-V and IV-IV, and also of manufacturing cost. In recent years several research groups have succeed to turn the band structure of germanium into direct band gap through the application of tensile mechanical stress or by alloying Ge with tin. It is also possible to combine both strain and alloying to obtain direct band gap materials. It has been recently shown a laser emission regime in the GeSn operating at low temperature. It turns out that the alloy of Ge with tin and the application of tensile stress reduces the band gap of the materials and the operating wavelengths can extend from 2 µm to 5 µm in depending on the tin composition and the stress applied. At these wavelength CO_2 and CH_4 exhibit a high absorption signature. Applications for labs-on-chip spectroscopy for biosensing, gas and liquid detection and air monitoring are envisioned with the opportunity to integrate the full group IV photonic circuits in interconnected objects.

Profile and skills required:

Knowledge in semiconductor physics and light-matter interaction, Physical electrical and lightwave engineers are appreciated as well.
The candidate will specifically developp electro-optical experimental analysis of the devices. He will also be strongly invested into the devices nano-Fabrication using clean room facilities of the C2N research center.

Niveau de français requis: Élémentaire: Vous pouvez comprendre la langue dans des situations quotidiennes élémentaires si votre interlocuteur parle doucement et clairement. Vous comprenez et utilisez des expressions simples.

Niveau d'anglais requis: Intermédiaire supérieur: Vous pouvez utiliser la langue de manière efficace et vous exprimer précisément.

- *Germanium microlasers on metallic pedestals*
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M. El Kurdi, M. Prost, A. Ghrib, S. Sauvage, X. Checoury, G. Beaudoin, I. Sagnes, G. Picardi, R. Ossikovski, and P. Boucaud, ACS photonics 3, 443 (2016)
-*Light emission from strained germanium*
P. Boucaud, M. El Kurdi, S. Sauvage, M. de Kersauson, A. Ghrib and X. Checoury
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