

Si photonic using direct band gap group IV elements

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The objective of the project is to explore the potential of merging direct band gap Ge-based material for developing new electro-optical application with group IV elements such as optical sources in the NIR and the MIR.

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. C2N research group 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. This has led to recent demonstration of laser effect in Ge at low temperature. 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 as well. 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 absorbtion signature. Applications for labs-on-chip spectroscopy for biosensing, gas 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 develop 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, vous exprimer précisément et pouvoir rédiger des documents et rapports techniques.

- *Germanium microlasers on metallic pedestals*

A. Elbaz, M. El Kurdi, A. Aassime, S. Sauvage, X. Checoury, I. Sagnes, C. Baudot, F. Boeuf, P. Boucaud, APL Photonics 3, 106102 (2018)

- *Direct band gap germanium microdisks obtained with silicon nitride stressor layers*

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

Nature Photonics 7, 162 (2013)

- *All-Around SiN Stressor for High and Homogeneous Tensile Strain in Germanium Microdisk Cavities*

A. Ghrib, M. El Kurdi, M. Prost, S. Sauvage, X. Checoury, G. Beaudoin, M. Chaigneau, R. Ossikovski, I. Sagnes, and P. Boucaud, Advanced Optical Materials 3, 353 (2015)