Microdisk lasers under electrical injection and lasers with 2D materials on III-nitride-on silicon nanophotonic platform

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- *http://www.researcherid.com/rid/F-1667-2011*
- Shared PhD between Institut d'Electronique Fondamentale (CNRS-Univ. Paris-Sud – Orsay - http://www.ief.u-psud.fr/) and CEA-Inac (http://inac.cea.fr/ Grenoble) –
- Partners associated with this work: CRHEA (http://www.crhea.cnrs.fr/) – LPN (http://www.lpn.cnrs.fr) – L2C (http://www.coulomb.univ-montp2.fr/) – Univ. Hong Kong (http://www.eee.hku.hk/people/hwchoi/) – Univ. Vienna (https://sites.google.com/site/tuviennagraphene/)

- Starting date**: October 2016 for three years**
- **PhD funded by the French network of excellence on nitride GANEX (http://www.ganex.fr/)**

The objective of this PhD is to investigate and to demonstrate microlasers based on a III-nitride nanophotonic platform on silicon. The nanophotonic platform associates microdisks and free-standing waveguides. We will focus on two main objectives:

- The demonstration of III-nitride microdisks lasers under electrical injection. The laser emission ranging from the UV to blue range depending on material will be coupled to waveguides in order to collect and distribute light emission on a photonic chip.
- The use of III-nitride microdisks as transparent nanoresonators with high quality factors in the visible spectral range on top of which an active layer of 2D material (WSe_2, $MoSe_2$) will be deposited. We will demonstrate lasers with an active layer constituted by only a single layer of material and study the physics of these lasers. Electrical modulation of these lasers can be allowed by the nitride properties. The final objective will be an integrated photonic chip with 2D materials

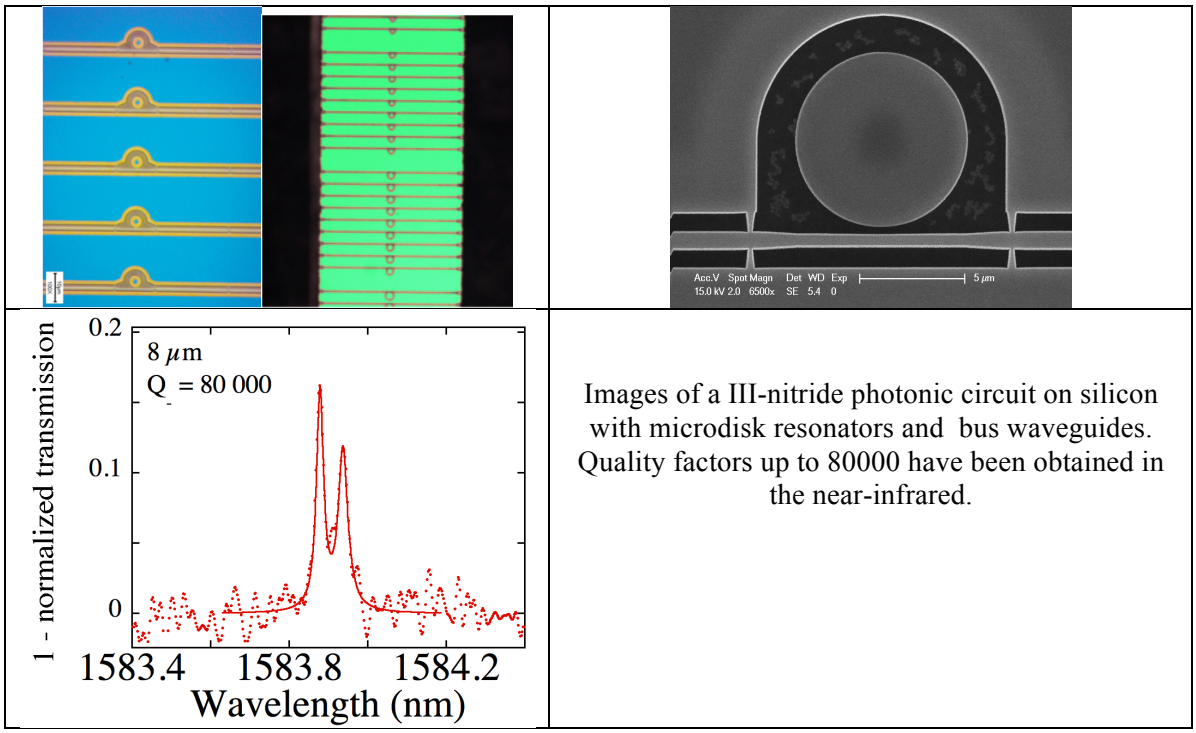
The partners of this project have already demonstrated III-nitride microdisk lasers operating at room temperature under optical injection from 275 nm to 470 nm, see for example [1] for deep-UV emission. This PhD will allow us to make a breakthrough with III-nitride photonic circuits by tackling the electrical injection issue and by fabricating photonic circuits that allow to efficiently collect the light emitted by microlasers. This represents key steps for the development of on-chip photonic circuits with wavelength-scale microresonators. The spectral range of emission will cover the UV and visible depending on materials (AlGaN, InGaN). Applications of microdisks under electrical injection for solid state lighting will be considered.

In parallel, we will further develop the III-nitride photonic platform, taking advantage of its wide transparency, to associate nitride microresonators and 2D single layer materials. The development of photonics with 2D materials is very strong and the III-nitride materials offer exceptional opportunities to bring added values to this field. Our consortium has already demonstrated state-of-the art quality factors up to 80000 for near-infrared microresonators with epitaxial nitride [2]. These resonators are ideal candidates to demonstrate lasing with 2D materials and study their properties. First tests have already been done in collaboration with the group of T. Mueller at University of Vienna by exfoliating 2D materials on the nitride. In this PhD, we will use 2D materials grown by chemical vapor deposition at LPN, a partner laboratory that will merge with Institut d'Electronique Fondamentale in 2016.

The PhD will combine design/modeling/nanofabrication and electro-optical spectroscopy. The PhD will be shared between two labs one in the Paris area, and another in Grenoble area. This will imply that the candidate makes short to medium stays in Grenoble (specific financial support will be allocated). The candidate will have the opportunity to cover many different fields associated with the

nitride materials and he will take advantage of specific assets in each laboratory, design and nanofabrication at IEF, advanced optical spectroscopy at CEA-Inac. Strong partnerships with French and international players will also benefit to the PhD: CRHEA for nitride material growth, L2C for complementary spectroscopy, LPN for processing and 2D materials, Univ. of Hong Kong for microdisk lasers and Univ. of Vienna for 2D materials.

Examples of structures fabricated at IEF with III-nitride materials grown at CRHEA.



Images of a III-nitride photonic circuit on silicon with microdisk resonators and bus waveguides. Quality factors up to 80000 have been obtained in the near-infrared.

References

[1] "Deep-UV nitride-on-silicon microdisk lasers"
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See also
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