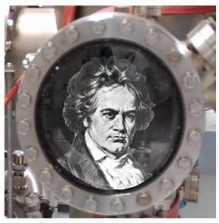

SINPHONIC

Post-doctoral fellowship proposal

"Heterogeneous Growth of III-V semiconductors nanostructures on silicon with a LPCVD-MBE connected experimental setup"

Context of the proposal:

The post-doctoral position described below is funded by the French National Research Agency (ANR) through the SINPHONIC project (SIlicoN PHOtonics with diluted NItride Coherent integration). The position is open on January 2012, and will last for one year. The candidate will be welcome in the FOTON laboratory (CNRS) of INSA (engineer school) in the city of Rennes (western part of France).

Scientific content:

Up to now, silicon is considered as the ruling material for the photovoltaic industry and the whole semiconductor chip industry including the dominating CMOS (Complementary Metal Oxide Semiconductor) processing technology. The rapid trend of dimension reduction and increasing density of metal interconnects leads the Si-based semiconductor technology to face fundamental problems, in particular in terms of data transfer speed. A possible solution is looked for in optoelectronics, by usage of optical interconnects on the chip level.

One of the hot topics developed in the recent years besides in the development of efficient laser on Silicon.[1] FOTON laboratory proposes to develop heterogeneous epitaxy of efficient III-V nanostructure-based optical emitters on silicon, by using the GaP, which is nearly lattice-matched to the silicon.[2,3,4,5] Such heterogeneous growth should ensure a single crystal coherent growth, which is very promising for the development of highly efficient devices. However this heterogeneous growth also implies problems related to the formation of planar defects: antiphase boundaries (APB) and stacking faults (SF) or microtwins (MT).[2] The first one (APB) forms mainly on the monosteps of the Si surface and is a fundamental problem of heteroepitaxy of III-V/IV while the others (SF and MT) occur as a result of inadequate nucleation conditions due to growth and/or silicon surface preparation. The post-doctoral position proposed here aims at developping the heterogeneous growth of III-V semiconductors on silicon, by using a new experimental setup (first attempt in Europe) composed of a LP-CVD growth chamber designed to make a high quality Si buffer layer, and connected under ultra-high vacuum to a solid-source MBE system for the III-V semiconductors growth.[6] The applicant will have to work on the silicon surface preparation, growth of the silicon buffer layer, RHEED characterisation of double stepped silicon surface,

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[1] D. Liang and J. E. Bowers, Nat. Photon. **4**, 511 (2010).
[2] K. Volz et al., J. Cryst. Growth **315**, 37 (2011).
[3] K. Yamane et al., J. Cryst. Growth **312**, 2179 (2010).
[4] T. J. Grasman et al., Appl. Phys. Lett. **94**, 232106 (2009).
[5] A. Létoublon et al. J. Cryst. Growth **323**, 409 (2011).
[6] Y. Furukawa et al., J. Cryst. Growth **300**, 172 (2007).

and finally heterogeneous growth of GaP on silicon studied in situ by RHEED observations. Growth of nanostructures-based active area (quantum wells or quantum dots) will finally be performed and tested optically to validate the growth process.[7]

Collaborations:

He/She will work in strong collaborations with other members of FOTON-INSA involved in the project, using results from Atomic Force Microscopy (AFM), high resolution X-ray diffraction and luminescence properties (PL, PLE @ 4-300 K). He/She will also benefits from collaboration at the national level in the frame of the SINPHONIC project (TEM, tr-PL), or at the international level especially with European partners (positron annihilation, cathodoluminescence). Finally, he/she will participate to the dissemination of the results in international conferences.

About FOTON Laboratory (INSA-Rennes):

FOTON laboratory is part of the CNRS (biggest French research institute). FOTON is recognized at the European level through participations to European Networks of Excellence on nanostructures properties and devices SANDIE and EPIXNET. FOTON has also been recognized as part of "Labex" (Laboratory of excellence) and is being selected for IRT (Technological Research Institute) at the national level.

The laboratory has a large experience in the growth,[8] structural,[9] optical[10] and electrical characterisation of III-V semiconductor nanostructures, and for the development of semiconductor-based devices such as Light emitting diodes[7], edge lasers[11], saturable absorbers[12] or Vertical Cavity Surface Emitting Lasers (VCSELs).[13] In order to use its know-how on the conventional and low-cost silicon substrate, FOTON-INSA has explored recently the coherent integration of III-V semiconductors on Silicon; The postdoctoral fellow will be able to leverage the very promising results obtained since 2009 for the success of the project.[14]

About the candidate:

The candidate should have convincing experience in the field of semiconductors growth, and structural properties. The knowledge of silicon growth (particularly by LPCVD techniques) would be a major advantage for starting this post-doc. He/She should show good capacities in oral and written english expression and be able to present research results verbally in international conferences. The candidate should show a real motivation to work in a group, and participate actively to the ANR regular meetings and reports. During the one year post-doctoral fellowship, the gross income is 28 k€/year.

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[7] C. Robert et al., Appl. Phys. Lett. **98**, 111922 (2011).
[8] C. Paranthoën et al., Appl. Phys. Lett. **78**, 1751 (2001).
[9] A. Létoublon et al., Phys. Rev. Lett. **92**, 186101 (2004).
[10] C. Cornet et al., Phys. Rev. B **74**, 035312 (2006).
[11] D. Zhou et al. Electron. Lett. **45**, 50 (2009).
[12] M. Gicquel-Guézo et al. Appl. Phys. Lett. **85**, 5926 (2004).
[13] O. Castany et al. Appl. Phys. Lett. **98**, 161105 (2011).
[14] C. Cornet et al., Proceedings of the IPRM 2011.