



Nano Scale Disruptive Silicon-Plasmonic Platform for Chip-to-Chip Interconnection

First report on NAVOLCHI exploitation activities

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List of Partners concerned

Partner number	Partner name	Partner short name	Country	Date enter project	Date exit project
1	Karlsruher Institut für Technologie	KIT	Germany	M1	M36
2	INTERUNIVERSITAIR MICRO-ELECTRONICA CENTRUM VZW	IMEC	Belgium	M1	M36
3	TECHNISCHE UNIVERSITEIT EINDHOVEN	TU/e	Netherlands	M1	M36
4	RESEARCH AND EDUCATION LABORATORY IN INFORMATION TECHNOLOGIES	AIT	Greece	M1	M36
5	UNIVERSITAT DE VALENCIA	UVEG	Spain	M1	M36
6	STMICROELECTRONICS SRL	ST	Italy	M1	M36
7	UNIVERSITEIT GENT	UGent	Belgium	M1	M36

¹
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Executive Summary

This document presents the exploitation activities consortium partners have carried out from M01 – M18. Patents portfolio, theses and other activities are listed. Future plans to exploit the research outcomes of the NAVOLCHI project are also included.

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1. Introduction

Exploitation activities are activities that will introduce novel high-impact technologies and trigger further research in plasmonic technology. This report will present the activities that have been performed during the first 18 months of the project NAVOLCHI and the partners' exploitation plans.

Generally, the activities can be categorized in:

- Patents
- Industrial outreach
- Commercial activities
- BCA, Master and PhD theses
- Other uses of expertise in plasmonic technology

NAVOLCHI deals with the cutting-edge technology of plasmonics. Due to the early stage of this technology, it is difficult to prepare for commercial products within or shortly after the timeframe of the project. At the same time, the embryonic state of plasmonics means that project partners have the opportunity to lead the way in the technological advancement in their respective fields. For the time being, this is mainly expressed through patent opportunities and innovative research through theses at the Master's and PhD level of participating institutions.

In summary, 1 patent has been filed successfully (by consortium partner UVEG) this far. In addition, 4 master and 3 PhD theses are in progress with NAVOLCHI content.

Note that due to deep reorganization at STMicroelectronics, exploitation planning of the industrial partner is currently under review at the company.

2. Exploitation activities and plans

2.1 KIT

- Master thesis:
 - Calus Gaertner, "Plasmonic Modulators,"
- KIT is interested on patent opportunities related to the plasmonic modulator and will be looking into such possibilities and development progresses.

2.2 IMEC

- The QDOT based optical amplifier and the focusing grating couplers are still very much under development. Possibilities for patenting were evaluated but not considered appropriate.

- The optical filters are much more mature and ready for further exploitation in focused projects. Actions taken include dissemination through scientific journals and through internal contacts with industrial partners. They are also include in several new project proposals (local + EU) recently submitted or under preparation.
- IMEC has also co-advised (with UGent) 2 master theses related to this project. See UGent section (page 7).

2.3 TU/e

- The first results of our research on plasmonic lasers and metallo-dielectric nanolasers have been reported at ICTON 2012 [1], and the 17th IEEE Photonics Benelux Symposium [2], respectively.
- Additionally, we have recently received invitations to be presented our recent research results at ICTON 2013 [3] and OECC/PS 2013 [4].
- Metallo-dielectric lasers are not yet sufficiently mature for industrial applications. However, TU/e approach to couple them to membrane based waveguides offers a route to commercial application. TU/e recently started cooperation with an industrial CMOS manufacturer on integration of their IMOS (InP-membrane on Silicon) technology with his CMOS technology. Metallo-dielectric lasers can be integrated in this platform technology for offering fast low-power light sources.

2.4 AIT

- AIT is currently looking for a PhD student to work on the chip-to-chip interconnect system. Recruitment is expected in Fall 2013.
- AIT has been able to develop a number of numerical tools for the simulation of plasmonic waveguiding and amplification structures. In particular, tools involving Muller's method, a modified effective index method, and a Finite Difference Frequency Domain method have already been developed. AIT has thus significantly strengthened its expertise on the simulation, design and evaluation of photonic structures. The plan is to make use of, establish, and develop further this expertise in additional research projects of European or local horizons. It is worth noting that the aforementioned tools are of a quite general usefulness and can also be used outside the field of plasmonics (e.g. more conventional photonics, such as the design of dielectric waveguides).
- Patent opportunities on the plasmonic amplifier that is being designed are also of interest to AIT. Such opportunities will be constantly under review as development progresses.

2.5 UVEG

➤ Patents:

- “Method to obtain metallic structures of nano- and micro-metric size from lithographic resists based on nanocomposites,, (P201201282).
 (“Método de obtención de estructuras metálicas de tamaño nano y micrométrico a partir de resinas litográficas basadas en nanocomposites)

➤ PhD theses:

- Henry Gordillo Millán, PhD thesis on Fabrication and characterization of polymer doped with quantum dots for photonic applications.
- Mari Luz Martínez Marco, PhD thesis on conducting polymers containing metal nanoparticles and metal nano- and micro-structures using polymer-based patterns.

➤ Master thesis:

- Víctor Latorre Garrido, “Propiedades Eléctricas y Ópticas del PMMA 3T- Au”
 (“Optical and electrical properties of PMMA-3T-Au”)

2.6 ST

Because of deep company reorganization, no exploitation activities have been carried out in ST during the first 18 months of the project. The Interconnect Systems Group (ISG) has been moved from a product division to a central organization responsible for technology R&D and design services, and its current activities, including the NAVOLCHI project, will be presented to the new management soon. After this presentation the new management will clarify the future scenarios where ISG will operate, and the activities related to NAVOLCHI will be planned accurately. It appears evident that the new ISG collocation fits much better with the objectives of NAVOLCHI, since they represent novel approaches from both a system and technological point of view, so the possibility to be better followed, sponsored and encouraged is concrete.

2.7 UGent

UGent has one PhD and two Master theses related to NAVOLCHI:

➤ PhD thesis:

- Sukumar Rudra, “*Diffraction Micro-Electromechanical Structures in Si and SiGe*”, PhD Thesis UGent, submitted 2013

- Master theses (co-advised with IMEC):
- Floris Taillieu, “*Broadband colloidal quantum dot LED for active plasmonics*”, Master Thesis UGent, June 2012
 - Qi Lu, “*Colloidal Nanocrystal Light Sources on Silicon*”, Master Thesis UGent, June 2011

No other exploitation plans from UGent at the moment. Depending on the results of technology development, patent possibilities will be looked into in the future.

3. References

- [1] V. Dolores-Calzadilla, A. Fiore, M. K. Smit, “Towards plasmonic lasers for optical interconnects”, *IEEE Proceedings of the 14th International Conference on Optical Transparent Networks*, 2012.
- [2] V. Dolores-Calzadilla, D. Heiss, A. Fiore, M. K. Smit, “Metallo-dielectric nanolaser coupled to an InP-membrane waveguide”, Proceeding of the *Proceedings of the 17th Annual Symposium of the IEEE Photonics Society Benelux Chapter*, 2012.
- [3] V. Dolores-Calzadilla, D. Heiss, A. Fiore, M. K. Smit, “Waveguide-coupled nanolasers in III-V membranes on silicon”, *IEEE Proceedings of the 15th International Conference on Optical Transparent Networks*, 2013. To be presented.
- [4] V. Dolores-Calzadilla, D. Heiss, A. Fiore, M. K. Smit, “Nanometallic lasers for optical interconnects”, *The 18th OptoElectronics and Communications Conference/Photonics in Switching*, 2013. To be presented.