

Jacopo Frigerio
CURRICULUM VITAE

July the 24th 2019

ADDRESS

Via Mario Bianco 13,
20131 Milano, Italy
Tel: +39 338 1735321
Professional E-mail: jacopo.frigerio@polimi.it
Personal E-mail: jacopo.frigerio84@gmail.com

PERSONAL DATA

Born: Lecco, 04/03/1984
C.F.: FRGJCP84C04E507P

LANGUAGES

Italian: Mother Tongue

English:

Reading: Excellent
Writing: Excellent
Verbal: Excellent

TOEIC English test passed (25/03/2008) with the score of 895/990.

SUMMARY

I graduated in Physical Engineering (master degree) at the Politecnico di Milano, Italy in 2010 and I hold a Ph.D. in Physics from the same institution. Between 2010 and 2019 I worked on the deposition and characterization of silicon-germanium heterostructures at the L-NESS laboratory-Politecnico di Milano-Polo di Como. My current interests and expertise include: Electro-absorption and electro-refraction in Ge/SiGe multiple quantum wells for silicon photonics applications, infrared light detection in Ge/Si heterostructures, infrared light detection in GaAs nanostructures, integration of III-V semiconductors on Ge/Si, heavily doped germanium for mid-infrared plasmonics. I am co-author of more than 60 publications on international peer reviewed journals (h-index=16 Scopus).

EDUCATION

MASTER DEGREE

2008-2010: Master degree in Physical Engineering (20/12/2010) Politecnico di Milano, passing grade of 103/110. Dissertation (original in Italian): "SiGe heterostructures for optoelectronic applications", supervisor Prof. G. Isella
Concentrations: Solid state physics and photonics.
My master thesis work was focused on the fabrication and characterization of Ge-on-Si vertically illuminated photodiodes. In this period I have acquired the following research skills: UV lithography, dry etching, e-beam deposition of metals and oxides, atomic force microscopy, photocurrent spectroscopy.

PH. D.

2011-2014: Ph. D. in Physics, Physics Department, Politecnico di Milano.
Dissertation: "Silicon-germanium heterostructures for silicon photonics" supervisor: Prof. G. Isella
Concentrations: Deposition and characterization of SiGe heterostructures for silicon photonics applications.

My activity during the PhD was focused on the following research topics:

- **Ge/SiGe quantum wells for silicon photonics:** This work regards the possibility to exploit the Quantum Confined Stark Effect in Ge/SiGe multiple quantum well to realize intensity and phase optical modulators for silicon photonics technology. In the framework of a collaboration with the group of Prof. Delphine Marris-Morini, I spent a month (March 2012) in the laboratory of the Institute of Fundamental Electronics – University Paris South – Orsay-France working on optical measurements (transmission and photocurrent) on integrated optical devices.
My personal contributions are listed below:
 - Deposition of the MQW structure by LEPECVD.
 - Design of the MQW structures by using the NextNano software package.
 - Characterization of the deposited material by atomic force microscopy and high resolution X-ray diffraction.
 - Analysis of the optical transmission measurements data in order to extract the effective refractive index variation as a function of the electric field applied to the MQW devices.
- **SiGe heterostructure for thermo-electric applications:** This work regards the possibility to exploit quantum confinement of carriers and phonon dispersion engineering to control the thermoelectric properties of SiGe heterostructures.
My personal contributions are listed below:
 - Deposition of SiGe heterostructures by LEPECVD.
 - Characterization of the deposited material by atomic force microscopy.
- **Highly strained germanium:** This work regards the realization of free-standing micro-bridge structures on pre-strained germanium epilayers in order to induce a strong uniaxial strain, which can be exploited to induce a direct bandgap in germanium.
My personal contributions are listed below:
 - Deposition of pre-strained Ge epilayers by LEPECVD.
 - Characterization of the deposited material by atomic force microscopy, defect etching and high resolution X-ray diffraction and Hall effect measurements.

- Development of rapid thermal annealing procedures to enhance the pre-strain.
- Investigation of germanium-on-insulator substrates as a way to reduce the defect density in the germanium epilayer in order to improve the mechanical stability of micro-bridge structures.

- **Study of the strain distribution of SiGe epilayers grown on Ge and on Si substrates:** This work regards the study of the strain in SiGe epilayers as a function of thickness, composition, growth temperature and of the material used as a substrate.
My personal contribution was:
 - Deposition of SiGe epilayers by LEPECVD.

- **Infrared photodetectors based on GaAs quantum dots (QDs):** This work regards the exploitation of inter-subband transitions in QDs to achieve optical detection in the mid-infrared spectral region.
My personal contributions are listed below:
 - Development of a fabrication process (by UV lithography, wet etching and e-beam metal deposition) for the infrared photodetector.
 - Electrical measurements on the fabricated devices (Temperature dependent I-V curves and transmission line measurements).

ACADEMIC EMPLOYMENT

JUNIOR RESEARCHER (RTD-A)

07-2018-present: My research activity is focused on the following topics:

- **Ge/SiGe asymmetric coupled quantum wells (ACQW) for non-linear mid-infrared photonics:** This activity regards the investigation of ACQW as a way to achieve even order non-linear effects in the mid-infrared with group IV semiconductors.
My personal contributions are listed below:
 - Design of the ACQW structure by using the Nextnano software package.
 - Deposition of the CQW structure by LEPECVD.
 - Contribution in the experimental measurement of second harmonic generation

- **Ge/SiGe coupled quantum wells (CQW) for silicon photonics:** This work regards the investigation of quantum well coupling to enhance the electro-refraction in the Ge/SiGe material system.
My personal contributions are listed below:
 - Design of the CQW structure by using the Nextnano software package.
 - Deposition of the CQW structure by LEPECVD.
 - Analysis of the optical transmission measurements data in order to extract the effective refractive index variation as a function of the electric field applied to the CQW structure

- **SiGe based mid-infrared integrated photonics:** This work regards the development of an integrated photonic platform operating in the mid-infrared based on SiGe heterostructures. In particular this project aims to develop low-loss waveguides and other passive photonics components (Mach-Zehnder interferometers, ring resonators, ecc.) exploiting the control of the refractive index achievable with SiGe linearly graded layers and the transparency of Ge-rich SiGe in the mid-infrared spectral range.
My personal contribution was:
 - Deposition of the SiGe graded buffers by LEPECVD.

- **SiGe dual band image sensor:** This work regards the realization of photodetector capable to detect light in the visible and near-infrared range. The device spectral response can be switched between visible/near-infrared by changing the polarity of the applied bias voltage.
My personal contribution are listed below:
 - Deposition of the SiGe heterostructures.
 - Characterization of the deposited materials by SEM and AFM
 - Fabrication (by UV lithography, dry etching, e-beam evaporation and wafer thinning) of the designed photodiodes.
 - Design of the lithographic mask used to process the photodiodes
- **Ge/GaAs dual band image sensor:** This work regards the realization of photodetector capable to detect light in the visible and near-infrared range. The device spectral response can be switched between visible/near-infrared by changing the polarity of the applied bias voltage.
My personal contribution are listed below:
 - Deposition of the Ge layer.
 - Characterization of the deposited materials by SEM and AFM and XRD
 - Fabrication (by UV lithography, dry and wet etching, e-beam evaporation and wafer thinning) of the designed photodiodes.
 - Design of the lithographic mask used to process the photodiodes
- **Photonic applications of Ge micro-crystals:** This work regards the deposition of Si and Ge micro-pillars deposited on patterned Si substrates and the investigation of their structural and optical properties.
My personal contributions are listed below:
 - Deposition of Si and Ge micro-crystals on patterned Si substrates by LEPECVD.
 - Characterization of the deposited materials by SEM.
 - Development of a preliminary fabrication process suitable for the realization of photodiodes on non-planar structures.
 - Design of the lithographic mask used to process the photodiodes.

POST-DOCTORAL RESEARCH

2014 – present: My post-doctoral activity was focused on the following research topics:

- **Ge/SiGe coupled quantum wells (CQW) for silicon photonics:** This work regards the investigation of quantum well coupling to enhance the electro-refraction in the Ge/SiGe material system.
My personal contributions are listed below:
 - Design of the CQW structure by using the Nextnano software package.
 - Deposition of the CQW structure by LEPECVD.
 - Analysis of the optical transmission measurements data in order to extract the effective refractive index variation as a function of the electric field applied to the CQW structure
- **Heavily doped germanium for mid infrared plasmonics:** This work regards the exploitation of plasmon-resonances in nanoantennas made by n-doped germanium for molecular sensing in the mid-infrared.
My personal contributions are listed below:
 - deposition of heavily n-type germanium on silicon by LEPECVD.
 - development of a rapid thermal annealing procedure in order to enhance the activation of dopants in the germanium epilayer.
 - Fabrication (by UV lithography, dry etching and e-beam metal deposition) of six-terminals Hallbar structures.
 - Temperature dependent Hall-effect and resistivity measurements in order to determine the electron concentration and the mobility in the n-type germanium epilayers.

- **Infrared photodetectors based on GaAs quantum dots (QDs):** This work regards the exploitation of inter-subband transitions in QDs to achieve optical detection in the mid-infrared spectral region.
My personal contribution was:
 - Deposition of Ge-on-Si to be used as a virtual substrate for the integration of III-V materials.
- **SiGe based mid-infrared integrated photonics:** This work regards the development of an integrated photonic platform operating in the mid-infrared based on SiGe heterostructures. In particular this project aims to develop low-loss waveguides and other passive photonics components (Mach-Zehnder interferometers, ring resonators, ecc.) exploiting the control of the refractive index achievable with SiGe linearly graded layers and the transparency of Ge-rich SiGe in the mid-infrared spectral range.
My personal contribution was:
 - Deposition of the SiGe graded buffers by LEPECVD.
- **SiGe dual band image sensor:** This work regards the realization of photodetector capable to detect light in the visible and near-infrared range. The device spectral response can be switched between visible/near-infrared by changing the polarity of the applied bias voltage.
My personal contribution are listed below:
 - Deposition of the SiGe heterostructures.
 - Characterization of the deposited materials by SEM and AFM
 - Fabrication (by UV lithography, dry etching, e-beam evaporation and wafer thinning) of the designed photodiodes.
 - Design of the lithographic mask used to process the photodiodes
- **Photonic applications of Ge micro-crystals:** This work regards the deposition of Si and Ge micro-pillars deposited on patterned Si substrates and the investigation of their structural and optical properties.
My personal contributions are listed below:
 - Deposition of Si and Ge micro-crystals on patterned Si substrates by LEPECVD.
 - Characterization of the deposited materials by SEM.
 - Development of a preliminary fabrication process suitable for the realization of photodiodes on non-planar structures.
 - Design of the lithographic mask used to process the photodiodes.

REVIEWER

2016-2017: Reviewer activity for the following scientific journals: Optics Express, Applied Physics Letters, Journal of Applied Physics, Journal of Selected Topics in Quantum Electronics, Optics Communications, Elsevier Optics & Laser Technology, Photonics.

TEACHING EXPERIENCE

2010/2011

- **Laboratory Tutor** at the Politecnico di Milano (Mechanics 1 e 2 for Prof. Zani, Electrostatics for prof. Valentini, Magnetostatics for prof. Contini).

2011/2012

- **Laboratory Tutor** at the Politecnico di Milano (Mechanics 1 e 2 for Prof. Bassi).
- **Tutor** for the **Bachelor** thesis work (Physical Engineering) of two students: Vittorio Sala e Giulio Vincini (Politecnico di Milano).

2012/2013

- **Assistant** for the undergraduate course “Fisica A” (Environmental Engineering, 32 hours, 8 CFU, ≈ 220 students) for prof. Cantoni (Politecnico Milano).
- **Tutor** for the **Master** thesis work (Physical Engineering) of Ing. Marcello Ferretto (Politecnico di Milano).

2013/2014

- **Tutor** for the **Master** thesis work (Physical Engineering) of Ing. Emanuele Ghisetti (Politecnico di Milano).
- **Tutor** for the **Bachelor** thesis work (Physical Engineering) for two students: Giovanni Pirro e Alberto Riva (Politecnico di Milano).
- **Seminar** on the “Quantum Confined Stark Effect and Silicon Photonics Technology” for the graduate course “Semiconductor nanostructures” (Prof. G. Isella, Politecnico di Milano).

2014/2015:

- **Assistant** for the undergraduate course “Fondamenti di Fisica Sperimentale” (Mechanical, Aerospace, Energy Engineering, 48 hours, 12 CFU, ≈ 100 students) for prof. Bussetti (Politecnico di Milano).
- **Tutor** for the **Master** thesis work (Physical Engineering) for Ing. Tommaso Maggi (Politecnico di Milano).
- **Seminar** on the “Quantum Confined Stark Effect and Silicon Photonics Technology” for the graduate course “Semiconductor nanostructures” (Prof. G. Isella, Politecnico di Milano).

2015/2016:

- **Assistant** for the undergraduate course “Fondamenti di Fisica Sperimentale” (Mechanical, Aerospace, Energy Engineering, 48 hours, 12 CFU, ≈ 100 students) for prof. Isella (Politecnico di Milano).
- **Tutor** for the **Master** thesis work (Physical Engineering) for Ing. Stefano Sem (Politecnico di Milano).
- **Seminar** on the “Quantum Confined Stark Effect and Silicon Photonics Technology” for the graduate course “Semiconductor nanostructures” (Prof. G. Isella, Politecnico di Milano).

2016/2017:

- **Assistant** for the undergraduate course “Fondamenti di Fisica Sperimentale” (Mechanical, Aerospace, Energy Engineering, 48 hours, 12 CFU, ≈ 100 students) for prof. Isella (Politecnico di Milano).
- **Tutor** for the Master thesis work (Physical Engineering) for Ing. Enrico Talamas Simola (Politecnico di Milano).

2017/2018:

- **Tutor** of the PhD student Ing. Enrico Talamas Simola (Politecnico di Milano).

2018/2019:

- **Assistant** for the undergraduate course “Fisica Sperimentale A+B” (Materials and Chemical Engineering, 40 hours, 10 CFU, ≈ 100 students) for prof. Brambilla (Politecnico di Milano).
- **Tutor** of the PhD student Ing. Enrico Talamas Simola (Politecnico di Milano).
- **Seminar** on the “Quantum Confined Stark Effect and Silicon Photonics Technology” for the graduate course “Semiconductor nanostructures” (Prof. G. Isella, Politecnico di Milano)
- **Lecturer** for the undergraduate course “Fondamenti di Fisica Sperimentale B” (Mechanical, Aerospace, Energy Engineering, 30 hours, 5 CFU, ≈ 220 students)

TECHNOLOGY TRANSFER

2012:

- I have developed a lithographic process for a very thick resist suitable for the electro-deposition of micrometer-size needles in a project funded by Technoprobe, a company producing micro-needles for wafer testing, and involving the Chemistry Department of the Politecnico di Milano.

2013:

- I have developed a lithographic process for a negative resist suitable for the deposition and lift-off process of solar cell devices for RSE.

2016-2018:

- I'm currently working in a technology transfer collaboration with Rockley Photonics for the development and commercialization of optical modulators based on Ge/SiGe multiple quantum wells.

My personal contribution is focused on:

- the optimization of the deposition process.
 - the characterization of the deposited material by XRD, AFM and optical spectroscopy.
 - Numerical modeling of the Quantum-Confined Stark-effect and of the expected device performances.
- An **international patent application** has been deposited within this collaboration, where I am listed as a co-inventor: "Quantum confined Stark Effect electroabsorption modulator on a SOI platform" Ref: WO2018007824A1

RESEARCH PROJECTS

- 11/2017 – in progress: **VISIR** (H2020 ATTRACT Project). The project regards the development of an high speed detector based on Ge/GaAs heterostructures covering the full VIS-NIR range.
Personal Role: Head of the POLIMI unit (Growth and characterization of Ge layers, design and fabrication of optoelectronic devices).
Partners: Politecnico di Milano, Università Roma Tre, IMASENIC srl.
- 11/2017 – in progress: **MICROSPIRE** (FET-OPEN grant number 766955). The project regards the development of a SPAD device based on Ge/Si microcrystals deposited on patterned substrates.
Personal Role: Participant (Growth and characterization of SiGe alloys, design and fabrication of optoelectronic devices).
Partners: Politecnico di Milano, Università Milano Bicocca, University of Marburg, TU Dresden, University of Glasgow, Micro-Photon devices srl.
- 05/2017 – in progress: **TEINVEIN** (Accordi per la Ricerca, lo Sviluppo e l’Innovazione POS FESR 2014-2020). The project regards the development of innovative technologies for smart vehicles.
Personal Role: Participant (Growth and characterization of SiGe alloys, design and fabrication of optoelectronic devices).
Partners: ST Microelectronics, Politecnico di Milano, Università Milano Bicocca, OPTEC SpA - Optical & Optoelectronic Systems, Cover Sistemi S.r.l., C.S. Milano S.r.l., Ro Technology S.r.l., Adecco Professional Solutions S.r.l.,
- 01/2019 – in progress: **SiGe-DBIS Second Phase:** SiGe Dual Band Image Sensor. The aim of this project is to extend the results obtained in the first phase by the realization of an array of photodiodes and by the integration with CMOS electronics.
Personal Role: Participant (Growth and characterization of SiGe alloys, design and fabrication of optoelectronic devices, electrical and optical measurements of the fabricated devices).
Partners: Università Roma Tre, Politecnico di Milano, University of Pisa
- 01/2017 – 06/2018: **SiGe-DBIS:** SiGe Dual Band Image Sensor This project aims at the realization of a photodetector capable to detect light in the visible and near-infrared range. The device spectral response can be switched between visible/near-infrared by changing the polarity of the applied bias voltage.
Personal Role: Participant (Growth and characterization of SiGe alloys, design and fabrication of optoelectronic devices, electrical and optical measurements of the fabricated devices).
Partners: Università Roma Tre, Politecnico di Milano.
- 06/2015 – in progress: **INSPIRE** (ERC grant N°639107). The INsPIRE project aims at investigating the non linear optical properties of Ge/SiGe multiple quantum wells in the mid-infrared spectral region. The project is coordinated by Prof. Delphine Marris-Morini.
Personal Role: Participant (Growth and characterization of SiGe alloys, design of epitaxial stack suitable for waveguiding in the mid-infrared, design of quantum wells suitable for intensity and phase modulation).
Partners: Université Paris Sud, Politecnico di Milano
- 02/2014 – 02/2017: **GEMINI** (FP7-ICT-2013-X FET X-TRACK: n°613055)
The GEMINI project aims at investigating the application of n-type Ge as a “plasmonic” material suitable for the fabrication of mid-infrared plasmon-enhanced sensors. The project was coordinated by Prof. P. Biagioni.
Personal Role: Participant (Growth of heavily n-doped Ge thin films, thermal processes on the deposited materials to promote dopant activation, Hall effect measurements)

at room and cryogenic temperatures).

Partners: Politecnico di Milano, Sapienza Università di Roma, University of Glasgow, University of Konstanz,

- 02/2014-01/2016: **COSMOS** (Regional Project financed by Fondazione Cariplo).
Development of multispectral sensors for the near and mid-infrared based on III-V quantum dots grown on Ge-on-Si substrates. Coordinator: Prof. S. Sanguinetti.
Personal Role: Participant (Growth of Ge-on-Si substrates, development of the fabrication process for the detector).
Partners: Politecnico di Milano, Università di Milano Bicocca, Osservatorio Astronomico di Brera, ANTARES.
- 08/2010-06/2013: **GREEN Silicon** (FP7-ICT-2009-5 FET-PROACTIVE n°257750).
The project aimed at exploiting quantum confinement and phonon engineering in SiGe heterostructures to improve their thermoelectric properties. Coordinator: Prof. D.J. Paul.
Personal Role: Participant (Growth and characterization of SiGe alloys)
Partners: University of Glasgow, University of Linz, University of Marburg, ETH Zurich, Politecnico di Milano.
- 01/2011-01/2014: **DEFCON IV** (Regional Project financed by Fondazione Cariplo).
The project aims at investigating the strain distribution in SiGe blanket and patterned epilayers in order to induce a large amount of tensile strain in the substrate. Coordinator: Prof. E. Bonera.
Personal Role: Participant (Growth of SiGe alloys)
Partners: Università di Milano Bicocca, Politecnico di Milano, CNR

INVITED TALKS

1. **22th Meeting of the Electrochemical Society**, Cancun, Mexico, Oct 2014
“Ge/SiGe optical interconnect”.
2. **Semicon Nano 2017**, Como, Italy, Sep 2017,
“Ge/SiGe quantum wells for near and mid-IR photonics
3. **PIERS (Progress in Electromagnetic Research) 2019**, Rome, June 2019
“Mid-infrared non-linear optical properties of Ge-rich SiGe waveguides”

CONFERENCES AND PHD SCHOOLS

1. **6th optoelectronics and photonics winter school** “Physics and applications of T-rays”
Trento, Italy, February 2011
2. **Silicon Photonics Summer School**, St. Andrews, U.K. July 2011
3. **18th International Winter school on New Developments in Solid State Physics**
Mauterndorf, Austria, February 2012
4. **Spring Meeting of the European Material Research Society**, Strasbourg, France, May 2012
Contribution: Oral Presentation “Quantum dot infrared photodetectors integrated on silicon”

5. **SPIE Microtechnologies**, Grenoble, France, April 2013
Contribution: Oral Presentation “Electro-refractive effect in Ge/SiGe Multiple Quantum wells”
6. **Spring Meeting of the European Material Research Society**, Strasbourg, France, May 2013
Contribution: Oral Presentation “Phase-shift in Ge/SiGe multiple quantum wells”
7. **IEEE 11th International Conference on Group IV Photonics**, Paris, France, August 2014
Contributions: Oral Presentation “Germanium mid-infrared plasmonics”
Poster: “Infrared photodetectors fabricated on 3D epitaxial Ge-on-Si”
8. **IEEE 12th International Conference on Group IV Photonics**, Vancouver, Canada, August 2015
Contribution: Oral Presentation “Strong electro-refractive effect in Ge/SiGe coupled quantum wells”
9. **Spring Meeting of the European Material Research Society**, Lille, France, May 2016.
Contributions: Oral Presentation “Electro-absorption and electro-refraction in standard and coupled QWs”
Oral Presentation “Mid-infrared plasmonic germanium antennas on silicon”.
Oral Presentation “Local uniaxial tensile strained germanium by nanopatterning of epitaxial SiGe stressors”.
10. **Fall Meeting of the European Material Research Society**, Warsaw, Poland, Sept. 2016.
Contributions: Oral presentation: “Heavily n doped germanium epitaxially grown on silicon for mid-infrared Plasmonics”
11. **The 10th International Conference on Silicon Epitaxy and Heterostructures (ICSI-10)**, Warwick, U.K., May 2017.
Contributions: Oral presentation: “n-type Ge-on-Si epilayers for mid-infrared plasmonics with activated doping above 10^{20} cm^{-3} ”
Poster presentation: “Low-loss silicon-germanium waveguides for mid-infrared photonics”
12. **IEEE 14th International Conference on Group IV Photonics**, Berlin, Germany, 23-25 August 2017
Contribution: Oral Presentation “Heavily doped Germanium on Silicon with activated doping exceeding 10^{20} cm^{-3} as an alternative to gold for mid-infrared plasmonics”
13. **1ST joint ISTDM/ICSI conference**, Potsdam, Germany 27-31 May 2018
Contribution: Oral Presentation “Non-linear optical properties of Ge rich SiGe waveguides in the near and mid infrared”.
14. **Fall Meeting of the European Material Research Society**, Warsaw, Poland, Sept. 2018.
Contributions: Oral presentation: “Mid-infrared non-linear optics with Ge-rich SiGe heterostructures”
15. **CLEO Europe 2019**, Munich, Germany, June 2019
Contributions: Poster presentation: “ Ge/SiGe Asymmetric Quantum Wells for second harmonic generation in the mid-infrared”

PUBLICATIONS

PEER-REVIEWED PAPERS

1. A. Ballabio, J. Frigerio, S. Firoozabadi, D. Chrastina, A. Beyer, K. Volz and G. Isella: *Ge/SiGe parabolic quantum wells*, J. Phys. D, Accepted for publication
2. A. De Iacovo, A. Ballabio, **J. Frigerio**, L. Colace and G. Isella: *Design and Simulation of Ge-on-Si Photodetectors with Electrically Tunable Spectral Response*, J. Light. Tech 37 3517-3525 (2019)
3. V. Vakarín, W. N. Ye, J.M. Ramírez, Q. Liu, **J. Frigerio**, A. Ballabio, G. Isella, L. Vivien, C. Alonso-Ramos, P. Cheben, D. Marris-Morini: *Ultra-wideband Ge-rich silicon germanium mid-infrared polarization rotator with mode hybridization flattening*, Opt. Expr. 27, 9838-9847 (2019)
4. E. Talamas Simola, A. De Iacovo, **J. Frigerio**, A. Ballabio, A. Fabbri, G. Isella and L. Colace: *Voltage-tunable dual-band Ge/Si photodetector operating in VIS and NIR spectral range*, Opt. Expr. 27, 8529-8539 (2019)
5. P. Chaisakul, V. Vakarín, **J. Frigerio**, D. Chrastina, G. Isella, L. Vivien and D. Marris-Morini: *Recent Progress on Ge/SiGe Quantum Well Optical Modulators, Detectors, and Emitters for Optical Interconnects*, Photonics 6, 24 (2019).
6. S. Qiang Li, A. Solanki, **J. Frigerio**, D. Chrastina, G. Isella, C. Zheng, A. Ahnood, K. Ganesan, K. B. Crozier: *Vertical Ge-Si Nanowires with Suspended Graphene Top Contacts as Dynamically-tunable Multispectral Photodetectors*, ACS Photonics 6, 735-742 (2019).
7. J-M. Ramirez, Q. Liu, V. Vakarín, X. Le Roux, **J. Frigerio**, A. Ballabio, C. Alonso-Ramos, E. Talamas Simola, L. Vivien, G. Isella, D. Marris-Morini *Broadband integrated racetrack ring resonators for long-wave infrared photonics*, Opt. lett. 44, 407-410 (2019)
8. Q. Liu, J-M. Ramirez, V. Vakarín, X. Le Roux, **J. Frigerio**, A. Ballabio, E. Talamas Simola, C. Alonso-Ramos, D. Benedikovic, D. Bouville, L. Vivien, G. Isella, D. Marris-Morini: *On-chip Bragg grating waveguides and Fabry-Perot resonators for long-wave infrared operation up to 8.4 μm* , Opt. Expr. 26, 34366-34372 (2018).
9. M. P. Fischer, A. Riede, K. Gallacher, **J. Frigerio**, G. Pellegrini, M. Ortolani, D. J. Paul, G. Isella, A. Leitenstorfer, P. Biagioni, D. Brida: *Plasmonic mid-infrared third harmonic generation in germanium nanoantennas*, Light: Science & Applications 7, 106 (2018).
10. **J. Frigerio**, A. Ballabio, M. Ortolani, M. Virgilio: *Modeling of second harmonic generation in hole-doped silicon-germanium quantum wells for mid-infrared sensing*: Opt. Expr. 26, 31861-31872 (2018).
11. T Guillet, Alain Marty, C Beigné, C Vergnaud, M-T Dau, P Noël, **J. Frigerio**, G Isella, M Jamet: *Magnetotransport in Bi_2Se_3 thin films epitaxially grown on Ge(111)*: AIP Adv. 8, 115125 (2018).
12. Q. Liu, J-M. Ramirez, V. Vakarín, X. Le Roux, C. Alonso-Ramos, **J. Frigerio**, A. Ballabio, E. Talamas Simola, D. Bouville, L. Vivien, G. Isella, D. Marris-Morini: *Integrated broadband dual-polarization Ge-rich SiGe mid-infrared Fourier-transform spectrometer*, Opt. Lett. 43, 5021-5024 (2018).
13. D. Marris-Morini, V. Vakarín, J-M. Ramirez, Q. Liu, A. Ballabio, **J. Frigerio**, M. Montesinos, C. Alonso-Ramos, X. Le Roux, S. Serna, D. Benedikovic, D. Chrastina, L. Vivien, G. Isella: *Germanium-based integrated photonics from near-to mid-infrared applications*, Nanophotonics 7, 1781-1793 (2018).

14. G. Pellegrini, L. Baldassare, V. Giliberti, **J. Frigerio**, K. Gallacher, D. J. Paul, G. Isella, M. Ortolani, P. Biagioni: *Benchmarking the Use of Heavily Doped Ge for Plasmonics and Sensing in the Mid-Infrared*, ACS Photonics 9, 3601-3607 (2018).
15. V. Vakarín, J.-M. Ramírez, **J. Frigerio**, Q. Liu, A. Ballabio, X. Le Roux, C. Alonso-Ramos, G. Isella, P. Cheben, W. N. Ye, L. Vivien, D. Marris-Morini: *Wideband Ge-rich SiGe polarization-insensitive waveguides for mid-infrared free-space communications*, Appl. Sci. 8, 1154 (2018).
16. Q. Liu, J.-M. Ramirez, V. Vakarín, X. Le Roux, A. Ballabio, **J. Frigerio**, D. Chrastina, G. Isella, D. Bouville, L. Vivien, C. Alonso Ramos, D. Marris-Morini: *Mid-infrared sensing between 5.2 and 6.6 μm wavelengths using Ge-rich SiGe waveguides*, Opt. Mater. Expr. 8, 1305-1312 (2018).
17. J.M. Ramirez, Q. Liu, V. Vakarín, **J. Frigerio**, A. Ballabio, X. Le Roux, D. Bouville, L. Vivien, G. Isella and D. Marris-Morini: *Graded SiGe waveguides with broadband low-loss propagation in the mid infrared*, Optics Express 26 (2), 870 (2018).
18. A. Bashir, K. Gallacher, R.W. Millar, D.J. Paul, A. Ballabio, **J. Frigerio**, G. Isella, D. Kriegner, M. Ortolani, J. Barthel and I. MacLaren: *Interfacial sharpness and intermixing in a Ge-SiGe multiple quantum well structure*, J. Appl. Phys. 123 (3), 035703 (2018).
19. S. Serna, V. Vakarín, J. M. Ramirez, **J. Frigerio**, A. Ballabio, X. Le Roux, L. Vivien, G. Isella, E. Cassan, N. Dubreuil and D. Marris-Morini: *Nonlinear Properties of Ge-rich $\text{Si}_{1-x}\text{Ge}_x$ Materials with Different Ge Concentrations*, Scientific Reports 7(1), 14692 (2017).
20. **J. Frigerio**, A. Ballabio, K. Gallacher, V. Giliberti, L. Baldassarre, R. Millar, R. Milazzo, L. Maiolo, A. Minotti, F. Bottegoni, P. Biagioni, D. Paul, M. Ortolani, A. Pecora, E. Napolitani and G. Isella: *Optical properties of highly n-doped germanium obtained by in situ doping and laser annealing*, J. Phys. D 50 (46), 465103 (2017).
21. S. Prucnal, **J. Frigerio**, E. Napolitani, A. Ballabio, Y. Berencén, L. Rebohle, M. Wang, R. Böttger, M. Voelskow, G. Isella, R. Hübner, M. Helm, S. Zhou and W. Skorupa: *In situ ohmic contact formation for n-type Ge via non-equilibrium processing*, Semicon. Sci. Tech. 32 (11), 115006 (2017).
22. V. Vakarín, J. M. Ramírez, **J. Frigerio**, A. Ballabio, X. Le Roux, Q. Liu, D. Bouville, L. Vivien, G. Isella and D. Marris-Morini: *Ultra-wideband Ge-rich silicon germanium integrated Mach-Zehnder interferometer for mid-infrared spectroscopy*, Optics Letters 42 (17), 3482 (2017).
23. **J. Frigerio**, V. Vakarín, P. Chaisakul, A. Ballabio, D. Chrastina, M. Leone, X. Le Roux, L. Vivien, G. Isella, and D. Marris-Morini: *Electro-Refraction in Standard and Symmetrically Coupled Ge/SiGe Quantum Wells*, Nanosci. Nanotech. Lett. 9, 1123 (2017).
24. M. Lodari, D. Chrastina, V. Mondiali, M. R. Barget, **J. Frigerio**, E. Bonera, and M. Bollani: *Strain in Si or Ge from the Edge Forces of Epitaxial Nanostructures*, Nanosci. Nanotech. Lett. 9, 1128 (2017).
25. F. Bottegoni, C. Zucchetti, S. Dal Conte, **J. Frigerio**, E. Carpena, C. Vergnani, M. Jamet, G. Isella, F. Cicacci, G. Cerullo and M. Finazzi: *Spin-Hall voltage over a large length scale in bulk germanium*, Phys. Rev. Lett. 118, 167402 (2017).
26. J.M. Ramirez, V. Vakarín, **J. Frigerio**, P. Chaisakul, D. Chrastina, X. Le Roux, A. Ballabio, L. Vivien, G. Isella and D. Marris Morini: *Ge-rich graded index $\text{Si}_{1-x}\text{Ge}_x$ waveguides with broadband tight mode confinement and flat anomalous dispersion for nonlinear mid-infrared photonics*, Opt. Expr. 25, 6561-6567 (2017).
27. T. Etzelstorfer, A. Wyss, M. Suess, F. F. Schlich, R. Geiger, **J. Frigerio** and J. Stangl: *Determining the directional strain shift coefficients for tensile Ge: a combined x-ray diffraction and Raman spectroscopy study*, Meas. Sci. & Tech. 28, 025501 (2017).

28. V. Gilberti, E. Sakat, M. Bollani, M. Altoe, M. Melli, A.W. Bargioni, L. Baldassarre, M. Celebrano, **J. Frigerio**, G. Isella, S. Cabrini and M. Ortolani: *Functionalization of scanning probe tips with epitaxial semiconductor layers*, Small Methods 1, 1600033 (2017).
29. J. M. Ramirez, V. Vakarin, C. Gilles, **J. Frigerio**, A. Ballabio, P. Chaisakul, X. Le Roux, C. Alonso-Ramos, G. Maisons, L. Vivien, M. Carras, G. Isella and D. Marris-Morini: *Low-loss Ge-rich Si_{0.2}Ge_{0.8} waveguides for mid infrared photonics*, Optics Letters 42, 105-108 (2017).
30. M. Finazzi, F. Bottegoni, C. Zucchetti, M. Bollani, A. Ballabio, **J. Frigerio**, F. Rortaris, C. Vergnaud, A. Marty, M. Jamet, G. Isella and F. Ciccacci: *Optical orientation and inverse spin Hall effect as effective tools to investigate spin-dependent diffusion*, Electronics 5, 80 (2016).
31. **J. Frigerio**, A. Ballabio, G. Isella, E. Sakat, G. Pellegrini, P. Biagioni, M. Bollani, E. Napolitani, C. Manganelli, M. Virgilio, A. Grupp, M. Fischer, D. Brida, K. Gallacher, D. J. Paul, L. Baldassarre, P. Calvani, V. Gilberti, A. nucare and M. Ortolani: *Tunability of the dielectric function of heavily doped germanium thin films for mid infrared plasmonics*, Phys. Rev. B 94, 085202 (2016)
32. M. Fischer, C. Schmidt, E. Sakat, J. Stock, A. Samarelli, **J. Frigerio**, M. Ortolani, D.J. Paul, G. Isella, A. Leitenstorfer, P. Biagioni and D. Brida: *Optical activation of germanium plasmonic antennas in the mid-infrared*, Phys. Rev. Lett. 117, 047401 (2016).
33. M. Bollani, V. Gilberti, E. Sakat, L. Baldassarre, M. Celebrano, **J. Frigerio**, G. Isella, M. Finazzi, M. Melli, A. Weber-Bargioni, S. Cabrini, P. Biagioni and M. Ortolani: *Photoluminescence emission from a nanofabricated scanning probe tip made of epitaxial germanium*, Microelectronic Engineering 159, 164-168 (2016).
34. R.W. Millar, K. Gallacher, **J. Frigerio**, A. Ballabio, A. Bashir, I. Mac Laren, G. Isella and D.J. Paul: *Analysis of Ge micro-cavities with in plane tensile strains above 2%*, Optic Express 24, 4365-4374 (2016)
35. A. Samarelli, **J. Frigerio**, L. Baldassarre, K. Gallacher, M. Finazzi, G. Isella, M. Ortolani, P. Biagioni and D.J. Paul: *Fabrication of mid-infrared plasmonic antennas based on heavily doped germanium thin films*, Thin Solid Films 602, 52-55 (2016).
36. R.W. Millar, K. Gallacher, A. Samarelli, **J. Frigerio**, D. Chrastina, T. Dieing, G. Isella and D.J. Paul: *Expanding the Ge emission wavelength to 2.25 μm with Si_xN_y strain engineering*, Thin Solid Films 602, 60-63 (2016).
37. K. Gallacher, A. Ballabio, R.W. Millar, **J. Frigerio**, A. Bashir, I. Mac Laren, G. Isella, M. Ortolani and D.J. Paul: *Mid-infrared intersubband absorption from p-Ge quantum wells grown on Si*, Applied Physics Letters 108, 091114 (2016)
38. K. Gallacher, L. Baldassarre, A. Samarelli, R.W. Millar, A. Ballabio, **J. Frigerio**, G. Isella, A. Bashir, I. Mac Laren, V. Gilberti, G. Pellegrini, P. Biagioni, M. Ortolani and D.J. Paul: *Ge-on-Si photonics for mid-infrared sensing applications*, MRS Advances 1-11 (2016)
39. V. Vakarin, P. Chaisakul, **J. Frigerio**, A. Ballabio, X. Le Roux, J-R. Coudeville, D. Bouville, D. Perez-Galacho, L. Vivien, G. Isella and D. Marris-Morini: *Sharp bends and Mach-Zehnder interferometers based on Ge-rich SiGe waveguides on SiGe graded buffer*, Optics Express 23, 30821-30826 (2015).
40. E. Vitiello, M. Virgilio, A. Giorgioni, **J. Frigerio**, E. Gatti, S. De Cesari, E. Bonera, E. Grilli, G. Isella and F. Pezzoli: *Spin-dependent direct gap emission in tensile-strained Ge films on Si substrates*, Phys. Rev. B. 92, 201203 (2015).
41. **J. Frigerio**, V. Vakarin, P. Chaisakul, M. Ferretto, D. Chrastina, X. Le Roux, L. Vivien, G. Isella, and D. Marris-Morini: *Giant electro-optic effect in Ge/SiGe coupled quantum wells*, Sci. Reports 5, 15398 (2015).

42. L. Baldassarre, E. Sakat, **J. Frigerio**, A. Samarelli, K. Gallacher, E. Calandrini, G. Isella, D. Paul, M. Ortolani, and P. Biagioni: *Mid-infrared plasmon-enhanced spectroscopy with germanium antennas on silicon substrates*, Nano Lett. 15, 7225-7231 (2015).
43. M. Bollani, D. Chrastina, L. Gagliano, L. Rossetto, D. Scopece, M. Barget, V. Mondiali, **J. Frigerio**, M. Lodari, F. Pezzoli, F. Montalenti, and E. Bonera: *Local uniaxial tensile strain in germanium up to 4% by epitaxial nanostructures*, Appl. Phys. Lett. 107, 083101 (2015).
44. V. Giliberti, E. Sakat, L. Baldassarre, A. Di Gaspare, A. Notargiacomo, E. Giovine, **J. Frigerio**, G. Isella, M. Melli, A. Weber-Bargioni, S. Aloni, S. Sassolini, S. Cabrini, P. Biagioni, M. Ortolani, and M. Bollani: *Three-dimensional fabrication of free-standing epitaxial semiconductor nanostructures obtained by focused ion beam*, Microelectron. Eng. 141, 168 (2015).
45. R. W. Millar, K. Gallacher, A. Samarelli, **J. Frigerio**, D. Chrastina, G. Isella, T. Dieing, and D. J. Paul: *Extending the emission wavelength of Ge nanopillars to 2.25 μm using silicon nitride stressors*, Opt. Express 23, 18193 (2015).
46. P. Biagioni, **J. Frigerio**, A. Samarelli, K. Gallacher, L. Baldassarre, E. Sakat, E. Calandrini, R.W. Millar, V. Giliberti, G. Isella, D. J Paul, M. Ortolani: *Group IV mid-infrared plasmonics*, Journal of Nanophotonics, 9, 093789-093789 (2015)
47. M. Celebrano, M. Baselli, M. Bollani, **J. Frigerio**, A. B. Shehata, A. Della Frera, A. Tosi, A. Farina, F. Pezzoli, J. Osmond, X. Wu, B. Hecht, R. Sordan, D. Chrastina, G. Isella, L. Duò, M. Finazzi, and P. Biagioni: *Emission engineering in germanium nanostructures*, ACS Photonics 2, 53 (2014).
48. P. Chaisakul, **J. Frigerio**, D. Marris-Morini, V. Vakarin, D. Chrastina, G. Isella, L. Vivien: *O-band quantum-confined Stark effect optical modulator from Ge/Si_{0.15}Ge_{0.85} quantum wells by well thickness tuning*, Journal of Appl. Phys. 116, 193103 (2014)
49. **J. Frigerio**, M. Lodari, D. Chrastina, V. Mondiali, G. Isella, and M. Bollani: *Metastability and relaxation in tensile SiGe on Ge (001) virtual substrates*, J. Appl. Phys. 116, 113507 (2014).
50. A. Samarelli, L. Ferre Llin, S. Cecchi, **J. Frigerio**, D. Chrastina, G. Isella, E. Müller Gubler, T. Etzelstorfer, J. Stangl, Y. Zhang, J.M.R. Weaver, P.S. Dobson, D.J. Paul: *Prospects for SiGe thermoelectric generators*, Solid-State Electronics 98, 70-74 (2014)
51. M.-S. Rouifed, D. Marris-Morini, P. Chaisakul, **J. Frigerio**, G. Isella, D. Chrastina, S. Edmond, X. Le Roux, J.-R. Coudeville, D. Bouville, and L. Vivien: *Advances toward Ge/SiGe quantum-well waveguide modulators at 1.3 μm* , IEEE J. Sel. Top. Quant. 20, 3400207 (2014).
52. P. Chaisakul, D. Marris-Morini, **J. Frigerio**, D. Chrastina, M.-S. Rouifed, S. Cecchi, P. Crozat, G. Isella, and L. Vivien: *Integrated germanium optical interconnects on silicon substrates*, Nature Photonics 8, 482 (2014).
53. S. Cecchi, E. Gatti, D. Chrastina, **J. Frigerio**, E. Müller Gubler, D. J. Paul, M. Guzzi, and G. Isella: *Thin SiGe virtual substrates for Ge heterostructure integration on silicon*, J. Appl. Phys. 115, 093502 (2014).
54. R. Geiger, **J. Frigerio**, M. J. Süess, D. Chrastina, G. Isella, R. Spolenak, J. Faist, and H. Sigg: *Excess carrier lifetimes in Ge layers on Si*, Appl. Phys. Lett. 104, 062106 (2014).
55. P. Chaisakul, D. Marris-Morini, M.-S. Rouifed, **J. Frigerio**, D. Chrastina, J.-R. Coudeville, X. Le Roux, S. Edmond, G. Isella, and L. Vivien: *Recent progress in GeSi electro-absorption modulators*, Sci. Technol. Adv. Mat. 15, 014601 (2014).
56. D. Marris-Morini, P. Chaisakul, M.-S. Rouifed, **J. Frigerio**, D. Chrastina, G. Isella, S. Edmond, X. Le Roux, J.-R. Coudeville, and L. Vivien: *Towards low energy consumption integrated photonic circuits based on Ge/SiGe quantum wells*, Nanophotonics 2, 279 (2013).

57. D. Chrastina, S. Cecchi, J. P. Hague, **J. Frigerio**, A. Samarelli, L. Ferre-Llin, D. J. Paul, E. Müller, T. Etzelstorfer, J. Stangl, and G. Isella: *Ge/SiGe superlattices for nanostructured thermoelectric modules*, Thin Solid Films 543, 153 (2013).
58. A. Samarelli, L. Ferre Llin, S. Cecchi, **J. Frigerio**, T. Etzelstorfer, E. Müller, Y. Zhang, J. R. Watling, D. Chrastina, G. Isella, J. Stangl, J. P. Hague, J. M. R. Weaver, P. Dobson, and D. J. Paul: *The thermoelectric properties of Ge/SiGe modulation doped superlattices*, J. Appl. Phys. 113, 233704 (2013).
59. M. J. Süess, R. Geiger, R. A. Minamisawa, G. Schiefler, **J. Frigerio**, D. Chrastina, G. Isella, R. Spolenak, J. Faist, and H. Sigg: *Analysis of enhanced light emission from highly strained germanium micro bridges*, Nature Photonics 7, 466 (2013).
60. P. Chaisakul, D. Marris-Morini, G. Isella, D. Chrastina, M.-S. Rouified, **J. Frigerio**, and L. Vivien: *Ge quantum well optoelectronic devices for light modulation, detection, and emission*, Solid State Electron. 83, 92 (2013).
61. P. Chaisakul, D. Marris-Morini, M.-S. Rouified, **J. Frigerio**, G. Isella, D. Chrastina, J.-R. Coudevylle, X. Le Roux, S. Edmond, D. Bouville, and L. Vivien: *Strong quantum-confined Stark effect from light hole related direct-gap transitions in Ge quantum wells*, Appl. Phys. Lett. 102, 191107 (2013).
62. **J. Frigerio**, P. Chaisakul, D. Marris-Morini, S. Cecchi, M. S. Rouified, G. Isella, and L. Vivien: *Electro-refractive effect in Ge/SiGe multiple quantum wells*, Appl. Phys. Lett. 102, 061102 (2013).
63. K. Gallacher, P. Velha, D. J. Paul, S. Cecchi, **J. Frigerio**, D. Chrastina, and G. Isella: *1.55 μm direct bandgap electroluminescence from strained n-Ge quantum wells grown on Si substrates*, Appl. Phys. Lett. 101, 211101 (2012).
64. M. Bollani, D. Chrastina, M. Fiocco, V. Mondiali, **J. Frigerio**, L. Gagliano, and E. Bonera: *Lithographically-defined low dimensional SiGe nanostripes as silicon stressors*, J. Appl. Phys. 112, 094318 (2012).
65. M.-S. Rouified, P. Chaisakul, D. Marris-Morini, **J. Frigerio**, G. Isella, D. Chrastina, S. Edmond, X. Le Roux, J.-R. Coudevylle, and L. Vivien: *Quantum-confined Stark effect at 1.3 μm in Ge/Si_{0.35}Ge_{0.65} quantum-well structure*, Optics Lett. 37, 3960 (2012).
66. P. Chaisakul, D. Marris-Morini, M.-S. Rouified, G. Isella, D. Chrastina, **J. Frigerio**, X. Le Roux, S. Edmond, J.-R. Coudevylle, and L. Vivien: *23 GHz Ge/SiGe multiple quantum well electro-absorption modulator*, Opt. Express 20, 3219 (2012).

CONFERENCE PROCEEDINGS

1. M. P. Fischer, K. Gallacher, **J. Frigerio**, G. Pellegrini, G. Isella, A. Leitenstorfer, D. J. Paul, P. Biagioni, D. Brida, *Field-Resolved Detection of the Temporal Response of a Mid-Infrared Plasmonic Antenna*, CLEO 2019, FTh3C. 6 (2019).
2. Q. Liu, J. M. Ramirez, V. Vakarin, X. Le Roux, C. Alonso-Ramos, **J. Frigerio**, A. Ballabio, E. Talamas Simola, D. Bouville, L. Vivien, G. Isella, D. Marris-Morini, *Mid-infrared integrated wideband dual-polarization Fourier-transform spectrometer*, SPIE OPTO, 10921, 109210Z (2019).
3. V. Vakarin, JM Ramírez, **J. Frigerio**, Q. Liu, A. Ballabio, X. Le Roux, C. Alonso-Ramos, G. Isella, L. Vivien, P. Cheben, N. Ye Winnie, D. Marris-Morini, *Ge-rich SiGe-based wideband polarization insensitive photonic platform for mid-infrared free-space communications*, SPIE OPTO 10923, 109230Y (2019).
4. JM Ramírez, V Vakarin, Q Liu, **J Frigerio**, A Ballabio, X Le Roux, G Isella, C Alonso-Ramos, M Montesinos, L Vivien, D Marris-Morini, *Ge-rich graded-index Si_{1-x}Ge_x racetrack resonators for long-wave infrared photonics*, Quantum Sensing and Nano Electronics and Photonics XVI 10960, 10960U (2019)

5. Q. Liu, J. M. Ramírez, V. Vakarín, X. Le Roux, C. Alonso-Ramos, **J. Frigerio**, A. Ballabio, E. Talamas Simola, D. Bouville, L. Vivien, G. Isella, D. Marris-Morini, *Integrated broadband mid-infrared polarization insensitive Fourier-Transform spectrometer*, 2018 Asia Communications and Photonics Conference (ACP) (2018).
6. K. Gallacher, R. W. Millar, U. Griškevičiūtė, M. P. Fischer, A. Riede, **J. Frigerio**, L. Baldassarre, G. Pellegrini, A. Leitenstorfer, D. Brida, G. Isella, M. Ortolani, P. Biagioni, D. J. Paul, *Components for Integrated Ge on Si for Mid-Infrared Photonic Sensors*, 2018 IEEE Photonics Society Summer Topical Meeting Series (SUM), 177-178 (2018)
7. JM Ramirez, Q Liu, V Vakarín, **J. Frigerio**, A Ballabio, D Chrastina, X Le Roux, C Alonso-Ramos, G Isella, L Vivien, D Marris-Morini, *Ge-Rich Graded-Index SiGe Alloys: Exploring a Versatile Platform for mid-IR Photonics*, IEEE ICTON 2018, 1-4 (2018)
8. JM Ramírez, S Serna, V Vakarín, Q Liu, **J. Frigerio**, A. Ballabio, X Le Roux, L Vivien, E Cassan, G Isella, N Dubreuil, D Marris-Morini, *Ge-rich SiGe waveguides for supercontinuum generation in the mid-IR*, Silicon Photonics: From Fundamental Research to Manufacturing 16860, 16860P (2018)
9. J. M. Ramirez, V. Vakarín, P. Chaisakul, S. Serna, Q. Liu, **J. Frigerio**, A. Ballabio, X. Le Roux, L. Vivien, G. Isella, E. Cassan, N. Dubreuil, D. Marris-Morini, *Silicon Photonics Based on Ge/SiGe Quantum Well (QW) Structures and Ge-Rich Materials for Near-IR and Mid-IR*, ECS Meeting 16, 1173 (2018)
10. J. M. Ramírez, Q. Liu, V. Vakarín, **J. Frigerio**, A. Ballabio, X. Le Roux, L. Vivien, G. Isella, D. Marris-Morini, *A compact Ge-rich graded-index SiGe platform with broadband low-loss propagation in the mid infrared*, Mid infrared coherent sources 2018, MM3C 3 (2018)
11. Q. Liu, J. M. Ramírez, V. Vakarín, **J. Frigerio**, A. Ballabio, L. Vivien, C. Alonso-Ramos, G. Isella, D. Marris-Morini: *Mid-IR integrated cavity based on Ge-rich graded SiGe waveguides with lateral Bragg grating*, Mid infrared coherent sources 2018, MM3C 4 (2018)
12. J.M. Ramirez, V. Vakarín, Q. Liu, **J. Frigerio**, A. Ballabio, X. Le Roux, D. Benedikovic, C. Alonso-Ramos, G. Isella, L. Vivien, D. Marris-Morini: *Ge-rich graded-index Si1-xGex devices for Mid-IR integrated photonics*, SPIE OPTO 2018 10537 (2018)
13. D. Marris-Morini, V. Vakarín, Q. Liu, J.M. Ramirez, A. Ballabio, **J. Frigerio**, X. Le Roux, S. Serna, E. Cassan, D. Benedikovic, C. Alonso-Ramos, G. Isella, L. Vivien: *Ge-rich SiGe photonic-integrated circuits for mid-IR spectroscopy*, SPIE OPTO 2018 10540, (2018).
14. **J. Frigerio**, J. M. Ramírez, A. Ballabio, V. Vakarín, P. Chaisakul, C. Gilles, Q. Liu, G. Maisons, X. Le Roux, L. Vivien, M. Carras, G. Isella and D. Marris-Morini: *Mid-infrared integrated photonics with Ge-rich SiGe waveguides*, Semicon Nano 2017.
15. P. Chaisakul, V. Vakarín, **J. Frigerio**, G. Isella, L. Vivien and D. Marris-Morini: *Silicon nitride waveguide-integrated Ge/SiGe quantum wells optical modulator*, Journal of Physics: Conference Series **901** (1), 012152 (2017).
16. K. Gallacher, A. Sorigi, V. Giliberti, **J. Frigerio**, G. Isella, P. Biagioni, D. J. Paul, M. Ortolani and L. Baldassarre: *Integrated germanium-on-silicon waveguides for mid-infrared photonic sensing chips*, Infrared, Millimeter, and Terahertz Waves (IRMMW-THz) (2017).
17. K. Gallacher, R. W. Millar, V. Giliberti, E. Calandrini, L. Baldassarre, **J. Frigerio**, A. Ballabio, E. Sakat, G. Pellegrini, G. Isella, M. Ortolani, P. Biagioni and D. J. Paul: *Mid-infrared n-Ge on Si plasmonic based microbolometer sensors*, IEEE Group IV Photonics, 3-4 (2017).

18. **J. Frigerio**, A. Ballabio, G. Pellegrini, K. Gallacher, V. Giliberti, L. Baldassarre, R. Milazzo, K. Huet, F. Mazzamuto, P. Biagioni, D. J. Paul, M. Ortolani, E. Napolitani and G. Isella: *Heavily-doped germanium on silicon with activated doping exceeding 10^{20} cm^{-3} as an alternative to gold for mid-infrared plasmonics*, IEEE Group IV Photonics, 9-10 (2017).
19. V. Vakarin, J. M. Ramirez, Q. Liu, X. Le Roux, **J. Frigerio**, A. Ballabio, L. Vivien, G. Isella and D. Marris-Morini: *Broadband mid infrared photonic integrated components using a Ge-rich SiGe platform*, IEEE Group IV Photonics, 5-6 (2017).
20. K. Gallacher, L. Baldassarre, R.W. Millar, A. Sorgi, V. Giliberti, **J. Frigerio**, G. Isella, I. Figliolia, P. Biagioni, M. Ortolani and D. J. Paul: *Germanium-on-silicon waveguides for mid-infrared photonic sensing chips*, IEEE Group IV Photonics, 64-64 (2017).
21. S. Serna, V. Vakarin, J. M. Ramirez, X. Le Roux, **J. Frigerio**, A. Ballabio, L. Vivien, G. Isella, E. Cassan, N. Dubreuil and D. Marris-Morini: *Third order nonlinear optical properties of Ge-Rich SiGe waveguides*, IEEE Group IV Photonics, 111-112 (2017).
22. S. Serna, V. Vakarin, J. M. Ramirez, **J. Frigerio**, A. Ballabio, L. Vivien, G. Isella, E. Cassan, N. Dubreuil and D. Marris-Morini: *Non-linear properties of Ge-rich SiGe waveguides*, CLEO Pacific Rim Conference, (2017).
23. D. J. Paul, K. Gallacher, R. W. Millar, V. Giliberti, E. Calandrini, L. Baldassarre, M. P. Fischer, **J. Frigerio**, A. Ballabio, E. Sakat, G. Pellegrini, D. Brida, G. Isella, M. Ortolani and P. Biagioni: *n-Ge on Si for mid-infrared plasmonic sensors*, IEEE Photonics Society Summer Topical Meeting Series (SUM), 125-126 (2017).
24. M. P Fischer, A. Riede, A. Grupp, K. Gallacher, **J. Frigerio**, G. Pellegrini, M. Ortolani, D. J. Paul, G. Isella, A. Leitenstorfer, P. Biagioni and D. Brida: *Germanium nanoantennas for plasmon-enhanced third harmonic generation in the mid infrared*, European Quantum Electronic Conference, EH_9_2 (2017).
25. Q. Liu, J. M. Ramirez, V. Vakarin, D. Perez-Galacho, C. Alonso-Ramos, L. Vivien, D. Marris-Morini, **J. Frigerio**, A. Ballabio and G. Isella: *Design of mid-IR integrated cavity based on Ge-rich graded SiGe waveguides*, Photonics North, 2017.
26. M. Fischer, A. Riede, A. Grupp, K. Gallacher, **J. Frigerio**, G. Pellegrini, M. Ortolani, D.J. Paul, G. Isella, A. Leitenstorfer, P. Biagioni and D. Brida: *Mid-infrared Third-Harmonic emission from heavily doped germanium plasmonic nanoantennas*, CLEO:QWLS_Fundamental Science, FF1G.2 (2017).
27. V. Vakarin, P. Chaisakul, **J. Frigerio**, A. Ballabio, J.M. Ramirez, X. Le Roux, J.R. Coudeville, L. Vivien, G. Isella and D. Marris-Morini: *Polarization insensitive Ge-rich silicon germanium waveguides for optical interconnects on silicon*, SPIE Optics + Optoelectronics, 102420T – 102420T-8 (2017).
28. J.M. Ramirez, V. Vakarin, P. Chaisakul, **J. Frigerio**, A. Ballabio, C. Gilles, D. Chrastina, Q. Liu, G. Maisons, X. Le Roux, L. Vivien, M. Carras, G. Isella and D. Marris-Morini: *Ge-rich SiGe waveguides for mid-infrared photonics*, Proc of SPIE 10108, 1010812-1(2017).
29. G. Pellegrini, L. Baldassarre, V. Giliberti, **J. Frigerio**, K. Gallacher, D.J. Paul, G. Isella, M. Ortolani and P. Biagioni: *Benchmarking the use of heavily doped Ge against noble metals for plasmonics and sensing in the mid-infrared*, Infrared, Millimeter, and Terahertz waves (IRMMW-THz), 2016 41th International Conference on, (2016)

30. K. Gallacher, R.W. Millar, A. Ballabio, **J. Frigerio**, A. Bashir, I. Mac Laren, G. Isella, M. Ortolani and D.J. Paul: *Mid- Infrared intersubband absorption from p-Ge quantum wells on Si*, Infrared, Millimeter, and Terahertz waves (IRMMW-THz), 2016 41th International Conference on, (2016)
31. L. Baldassarre, E. Sakat, M. Bollani, A. Samarelli, K. Gallacher, **J. Frigerio**, G. Pellegrini, V. Gilberti, A. Ballabio, M. Fischer, D. Brida, G. Isella, D.J. Paul, M. Ortolani and P. Biagioni: *Mid-infrared plasmonic platform based on n-doped Ge-on-Si: molecular sensing with germanium nano-antennas on Si*, Infrared, Millimeter, and Terahertz waves (IRMMW-THz), 2016 41th International Conference on, (2016)
32. M. Fischer, A. Riede, A. Grupp, K. Gallacher, **J. Frigerio**, M.Ortolani, D. J. Paul, G. Isella, A. Leitenstrofer, P. Biagioni and D. Brida: *Germanium plasmonic nanoantennas for third-harmonic generation in the mid infrared*, Infrared, Millimeter, and Terahertz waves (IRMMW-THz), 2016 41th International Conference on, (2016)
33. K. Gallacher, A. Ballabio, R.W. Millar, **J. Frigerio**, A. Bashir, I. Mac Laren, G. Isella, M. Ortolani and D. J. Paul: *Intersubband absorption in p-Ge QWs on Si*, Group IV Photonics (GFP) 2016 IEEE 13th International Conference on, 30-31 (2016).
34. R.W. Millar, K. Gallacher, **J. Frigerio**, A. Ballabio, A. Bashir, I. Mac Laren, G. Isella and D.J. Paul: *Engineering large in-plane tensile strains in Ge microdisks, microrings and racetrack optical cavities*, ECS Transactions 75, 633-640 (2016)
35. L. Baldassarre, E. Sakat, **J. Frigerio**, A. Samarelli, V. Gilberti, G. Pellegrini, K. Gallacher, M. Fischer, D. Brida, G. Isella, P. Biagioni, D.J. Paul and M. Ortolani: *Mid-infrared sensing using heavily doped germanium plasmonics on silicon*, ECS Transactions 75, 247-251 (2016)
36. D. Marris-Morini, V. Vakarini, P. Chaisakul, **J. Frigerio**, M. Rahman, J.M. Ramirez, M-S. Rouified, D. Chrastina, X. Le Roux, G. Isella and L. Vivien: *Silicon photonics based on Ge/SiGe quantum well structures*, Transparent Optical Networks (ICTON) 2016 18th Conference on (2016).
37. S. Li, **J. Frigerio**, D. Chrastina, G. Isella, A. Solanki, W. Song, C. Zheng and K. B.Crozier: *Vertical germanium nanowire photodetectors with suspended graphene on top contact*, Lasers and Electro-Optics (CLEO) 2016 Conference on (2016)
38. J.M. Ramirez, V. Vakarini, M. Rahman, P. Chaisakul, X. Le Roux, L. Vivien, D. Marris-Morini, D. Chrastina, **J. Frigerio**, A. Ballabio and G. Isella: *Broadband single mode SiGe graded waveguides with tight mode confinement for mid-infrared photonics*, Photonics North (PN) (2016)
39. G. Isella, A. Ballabio and **J. Frigerio**: *Ge/SiGe quantum well for photonic applications: modelling of the quantum confined Stark effect*, SPIE Photonics Europe, 98910G-98910G-8(2016).
40. V. Vakarini, P. Chaisakul, **J. Frigerio**, A. Ballabio, X. Le Roux, J.R. Coudevylle, L. Vivien, G. Isella and D. Marris-Morini: *Ge-rich silicon germanium on graded buffer as a new material platform for optical interconnects on silicon*, SPIE Photonics Europe, 98910M-98910M-8 (2016).
41. **J. Frigerio**, V. Vakarini, P. Chaisakul, A. Ballabio, D. Chrastina, X. Le Roux, L. Vivien, G. Isella and D. Marris-Morini: *Electro-absorption and electro-refraction in Ge/SiGe coupled quantum wells*, SPIE Photonics Europe 989113-989113-8 (2016).

42. V. Vakarín, P. Chaisakul, **J. Frigerio**, A. Ballabio, X. Le Roux, J.R. Coudevylle, L. Vivien, G. Isella and D. Marris-Morini: *Silicon germanium graded buffer as a new material platform for optical interconnects on silicon*, SPIE OPTO 975309-975309-8 (2016).
43. R.W. Millar, K. Gallacher, **J. Frigerio**, D. Chrastina, G. Isella, D.J. Paul: *Highly strained Ge on Si micro-disks with silicon nitride stressors*, Group IV Photonics (GFP), 2015 IEEE 12th International Conference on Group IV Photonics, 65-66 (2015).
44. K. Gallacher, A. Ballabio, R.W. Millar, A. Samarelli, **J. Frigerio**, D. Chrastina, G. Isella, L. Baldassarre, M. Ortolani, E. Sakat, P. Biagioni, D.J. Paul: *Mid-infrared intersubband absorption in p-Ge/SiGe quantum wells grown on Si*, Group IV Photonics (GFP), 2015 IEEE 12th International Conference on Group IV Photonics, 15-16 (2015).
45. **J. Frigerio**, L. Baldassarre, E. Sakat, A. Samarelli, K. Gallacher, M. Fischer, D. Brida, D.J. Paul, G. Isella, P. Biagioni, M. Ortolani: *Heavily phosphorous-doped Germanium thin films for mid-infrared plasmonics*, Group IV Photonics (GFP), 2015 IEEE 12th International Conference on Group IV Photonics, 94-95(2015).
46. D. Marris-Morini, P. Chaisakul, **J. Frigerio**, M-S. Rouifed, V. Vakarín, D. Chrastina, X. Le Roux, G. Isella, L. Vivien: *Silicon photonics based on Ge/SiGe quantum well structures*, Group IV Photonics (GFP), 2015 IEEE 12th International Conference on Group IV Photonics, 11-12(2015).
47. M. P. Fischer, C. Schmidt, J. Stock, E. Sakat, A. Samarelli, **J. Frigerio**, P. Biagioni, D.J. Paul, G. Isella, A. Leitenstorfer, D. Brida: *Optical Activation of Plasmonic Germanium Nanoantennas Resonant in the Mid-Infrared*, European Quantum Electronics Conference, EH_5_5 (2015).
48. M. Ortolani, L. Baldassarre, M. Virgilio, **J. Frigerio**, V. Giliberti, E. Sakat, M. Bollani, E. Napolitani, D. De Salvador, P. Biagioni, G. Isella: *Resolving the plasmon decay mechanisms in heavily doped semiconductors*, Plasmonica 2015 (2015).
49. P. Chaisakul, V. Vakarín, D. Marris-Morini, **J. Frigerio**, K. Wada, G. Isella, L. Vivien: *Ge/SiGe multiple quantum wells for photonic integrated circuits on silicon*, Photonics North 2015, 1 (2015).
50. D. Marris-Morini, P. Chaisakul, **J. Frigerio**, D. Chrastina, V. Vakarín, S. Cecchi, G. Isella, L. Vivien: *Optical Interconnects based on Ge/SiGe Multiple Quantum Well Structures*, CLEO: Science and Innovations, SM3G. 1 (2015).
51. MP Fischer, C Schmidt, J Stock, E Sakat, A Samarelli, **J. Frigerio**, P. Biagioni, D.J. Paul, G. Isella, A. Leitenstorfer, D.Brida: *Optical Switching of Mid-Infrared Plasmonic Nanoantennas Based on Germanium*, CLEO: QELS_Fundamental Science, FW3E. 2 (2015).
52. P Biagioni, E Sakat, L Baldassarre, E Calandrini, A Samarelli, K Gallacher, **J Frigerio**, G.Isella, DJ Paul, M Ortolani: *Mid-infrared plasmonic resonances exploiting heavily-doped Ge on Si*, SPIE OPTO, 93570G-93570G-6 (2015).
53. P. Chaisakul, V. Vakarín, D. Marris-Morini, **J. Frigerio**, K. Wada, G. Isella, L. Vivien: *GeSi photonics for telecommunication applications*, SPIE/COS Photonics Asia, 92770E-92770E-7 (2014).
54. **J. Frigerio**, P. Chaisakul, D. Marris-Morini, M. S. Rouifed, S. Cecchi, D. Chrastina, G. Isella and L. Vivien: *Photonic Interconnection Made by a Ge/SiGe MQW Modulator Connected to a Ge/SiGe MQW Photodetector through a SiGe Waveguide*, ECS Transactions 64, 761-773 (2014).

55. A. Samarelli, L. Ferre Llin, S. Cecchi, **J. Frigerio**, T. Etzelstorfer, E. Müller Gubler, J. Stangl, D. Chrastina, G. Isella, and D. Paul: *The thermoelectric properties of Ge/SiGe based superlattices: from materials to energy harvesting modules*, ECS Transactions 64, 929 (2014).
56. L. Baldassarre, E. Calandrini, A. Samarelli, K. Gallacher, D.J. Paul, **J. Frigerio**, G. Isella, E. Sakat, M. Finazzi, P. Biagioni, M. Ortolani: *Mid-infrared plasmonic platform based on heavily doped epitaxial Ge-on-Si: Retrieving the optical constants of thin Ge epilayers*, Infrared, Millimeter, and Terahertz waves (IRMMW-THz), 2014 39th International Conference on, 1-3 (2014).
57. R. W. Millar, K. Gallacher, A. Samarelli, D. C. S. Dumas, **J. Frigerio**, D. Chrastina, G. Isella, and D. J. Paul: *Process induced tensile strain of Ge on Si nanopillars by ICP-PECVD SiN stressor layers* IEEE 11th Int. Conf. Group IV Photonics, 235-236 (2014).
58. R. Geiger, M. J. Süess, C. Bonzon, **J. Frigerio**, D. Chrastina, G. Isella, R. Spolenak, J. Faist, and H. Sigg: *Carrier lifetimes in uniaxially strained Ge micro bridges* IEEE 11th Int. Conf. Group IV Photonics, 227-228 (2014).
59. P. Chaisakul, D. Marris-Morini, **J. Frigerio**, D. Chrastina, M. S. Rouifed, S. Cecchi, G. Isella, and L. Vivien: *High quality SiGe waveguide platform for Ge photonics on bulk silicon substrates*, IEEE 11th Int. Conf. Group IV Photonics, 108--109 (2014).
60. M. S. Rouifed, D. Marris-Morini, X. Le Roux, P. Chaisakul, **J. Frigerio**, D. Chrastina, G. Isella, and L. Vivien: *Advances towards the demonstration of a Ge/SiGe modulator integrated on SOI*, IEEE 11th Int. Conf. Group IV Photonics, 75-76 (2014).
61. **J. Frigerio**, F. Isa, E. Ghisetti, G. Isella, and L. Miglio: *Infrared photodetectors fabricated on 3D epitaxial Ge-on-Si*, IEEE 11th Int. Conf. Group IV Photonics, 61-62 (2014).
62. **J. Frigerio**, M. Ortolani, L. Baldassarre, E. Calandrini, A. Samarelli, K. Gallacher, E. Sakat, M. Finazzi, D. J. Paul, P. Biagioni, and G. Isella: *Mid-infrared plasmonic germanium antennas on silicon*, IEEE 11th Int. Conf. Group IV Photonics, 27-28 (2014).
63. M-S. Rouifed, D. Marris-Morini, P. Chaisakul, **J. Frigerio**, G. Isella, D. Chrastina, S. Edmond, X. Le Roux, J-R. Coudeville, D. Bouville, L. Vivien: *Ge quantum-well waveguide modulator at 1.3 μm* , SPIE Photonics Europe, 91330Q-91330Q-6 (2014).
64. P. Chaisakul, D. Marris-Morini, N. Abadía, **J. Frigerio**, G. Isella, D. Chrastina, S. Olivier, R. Espiau de Lamaestre, T. Bernardin, J-C. Weeber, L. Vivien: *Ge quantum well plasmon-enhanced quantum confined Stark effect modulator*, MRS Proceedings, mrsf 13,1627 I09-60 (2014).
65. M-S. Rouifed, P. Chaisakul, D. Marris-Morini, **J. Frigerio**, G. Isella, D. Chrastina, L. Vivien: *Design of electroabsorption modulator based on Ge/SiGe multiple quantum wells, integrated on SOI waveguides*, Photonics Conference (IPC), 2013 IEEE, 40-41 (2013).
66. R. Geiger, **J. Frigerio**, M. J. Süess, R. A. Minamisawa, D. Chrastina, G. Isella, R. Spolenak, J. Faist, and H. Sigg: *Excess carrier lifetimes in Ge layers on Si*, In IEEE 10th Int. Conf. Group IV Photonics, 103-104 (2013).
67. R. Geiger, M. J. Süess, R. A. Minamisawa, C. Bonzon, G. Schiefler, **J. Frigerio**, D. Chrastina, G. Isella, R. Spolenak, J. Faist, and H. Sigg: *Enhanced light emission from Ge micro bridges uniaxially strained beyond 3%*, In IEEE 10th Int. Conf. Group IV Photonics, 93-94 (2013).
68. P. Chaisakul, D. Marris-Morini, M.-S. Rouifed, **J. Frigerio**, G. Isella, D. Chrastina, and L. Vivien: *Strong quantum-confined Stark effect from light hole excitonic transition in Ge quantum wells for ultra-compact optical modulator*, In IEEE 10th Int. Conf. Group IV Photonics, 63-64 (2013).

69. **J. Frigerio**, P. Chaisakul, D. Marris-Morini, S. Cecchi, M.-S. Rouifed, G. Isella, and L. Vivien: *Refractive index change induced by quantum confined stark effect in Ge quantum wells*, In IEEE 10th Int. Conf. Group IV Photonics, 67-68 (2013).
70. **J. Frigerio**, P. Chaisakul, D. Marris-Morini, S. Cecchi, M.-S. Rouifed, G. Isella, L. Vivien: *Phase-shift in waveguide integrated Ge quantum wells*, SPIE Microtechnologies, 87670B-87670B-9 (2013).
71. G. Isella, P. Chaisakul, D. Marris-Morini, M. S. Rouifed, D. Chrastina, **J. Frigerio**, X. L. Roux, S. Edmond, J.-R. Coudevylle, and L. Vivien: *High extinction ratio, low energy Ge quantum well electro-absorption modulator with 23 GHz bandwidth*, ECS Transactions 50, 387 (2013).
72. P. Chaisakul, M.-S. Rouifed, D. Marris-Morini, G. Isella, D. Chrastina, **J. Frigerio**, X. Le Roux, S. Edmond, J.-R. Coudevylle, and L. Vivien: *High speed electro-absorption modulator based on quantum-confined Stark effect from Ge/SiGe multiple quantum wells*, In IEEE 9th Int. Conf. Group IV Photonics, 60--62 (2012).
73. P. Chaisakul, D. Marris-Morini, M.-S. Rouifed, G. Isella, D. Chrastina, **J. Frigerio**, X. Le Roux, S. Edmond, J.-R. Coudevylle, and L. Vivien: *Ge/SiGe multiple quantum well optoelectronic devices for silicon photonics*, In SiGe Technology and Device Meeting, 2012. ISTDM 2012. (2012).
74. D. J. Paul, A. Samarelli, L. Ferre-Llin, J. R. Watling, Y. Zhang, J. M. R. Weaver, P. S. Dobson, S. Cecchi, **J. Frigerio**, F. Isa, D. Chrastina, G. Isella, T. Etzelstorfer, J. Stangl, and E. Müller Gubler: *Si/SiGe nanoscale engineered thermoelectric materials for energy harvesting*, Proceedings of the 12th IEEE International Conference on Nanotechnology (IEEE-NANO), 1-5 (2012).

Milano, 24/07/2019

Jacopo Frigerio