Cosimo Lacava

University of Pavia
27100 Pavia - Italy

+39 0382 985221
cosimo.lacava@unipv.it

Education

2010-2014 PhD in Electronics, Computer Science and Electrical Engineering - University of Pavia
Dissertation title: Nonlinear Silicon Photonic Devices

2008-2010 MSc (Laurea Specialistica) in Electronics Engineering - University of Pavia
Final Grade: 110/110 cum laude (First Class Hons).

2005-2008 BSc (Laurea Triennale) in Electronics Engineering and Computer Science - Polytechnic of Bari
Final Grade: 110/110 cum laude (First Class Hons).

Academic Certified Qualifications

2024-2034 "Abilitazione Scientifica Nazionale - Prima Fascia"
Settore Scientifico 02/B1 - "Fisica Sperimentale della Materia"

2021-2030 "Abilitazione Scientifica Nazionale - Seconda Fascia"
Settore Scientifico 02/B1 - "Fisica Sperimentale della Materia"

Other Academic Experiences

Jun 2013 - May 2014 Visiting PhD student at the University of Glasgow
Development of silicon photonic nonlinear switching components

Nov 2012 - Jan 2013 Visiting PhD student at the University of Valencia
Development of silicon photonic nonlinear waveguides

Employment History

Oct 2019 Current University of Pavia, Pavia, 27100, Italy
Tenure Track Assistant Professor

Nov 2017 - Sept 2019 Optoelectronics Research Centre, University of Southampton, Southampton, SO17 1BJ, UK
Senior Research Fellow

Nov 2014 - Nov 2017 Optoelectronics Research Centre, University of Southampton, Southampton, SO17 1BJ, UK
Research Fellow

Jan 2014 - Oct 2014 University of Pavia, Integrated Photonics Lab, Pavia, 27100 Italy
Research Associate

Profile Summary

CL holds a PhD in Electronics and Computer Science Engineering from the University of Pavia. During his PhD he studied nonlinear optical phenomenon observed on silicon photonic-based devices. In 2014, he worked as Postdoctoral Fellow at the University of Pavia within the frame of a European Project named "FABULOuS" (Project #318704, FP7/ICT), which aimed at the realization of silicon photonic optical devices and components for passive optical networks. Afterwards, CL was appointed as Research Fellow at the Optoelectronics Research Centre (ORC), University of Southampton, tasked with the realization of high-speed silicon photonic systems for telecom and data-com applications. CL worked as senior investigator of a 6M program grant, founded by the EPSRC Council, named "Silicon Photonics For Future Systems" which was set to tackle fundamental challenges that were still present in the silicon photonics technology. CL was responsible of the Work Package 3 that was devoted to the design, fabrication and realization of highly integrated optical devices and optical processors for operations at speeds exceeding 1 Tb/s. In 2018 CL was promoted at the ORC and appointed as Senior Research Fellow. In 2019 he moved to the University of Pavia, appointed as Assistant Professor.
CL has gained a significant experience and knowledge in the field on integrated optics, silicon photonics and optical linear and nonlinear processing, and his research agenda covers a wide range of topics. His current research interests include:

- Study of novel materials for high-efficiency nonlinear interactions in integrated photonic structures.
- All optical signal processing devices based on integrated photonic components.
- Novel optical transmission systems based on silicon photonic-based optical processors.
- Silicon photonics active and passive components, for telecom and sensing applications.

CL has established himself as a central figure in the field of the nonlinear photonics and is regularly asked to attend major conferences as invited speaker.

Publication record and metrics (scientific career started in 2011)

- Full and updated details:
  - https://www.scopus.com/authid/detail.uri?authorId=50461685300
  - https://scholar.google.co.uk/citations?user=Uz6-BR0AAAAJ

- H-index: **20**, Total citations count: >1500 (scopus)

- Author of **35** research journal publications (JCR-indexed)
  - First author count: 9
  - Corresponding author count: 18
  - **Invited paper count**: 6
  - The paper [J13] has been included in the *TOP 100 Physics* collection of Scientific Reports (ranked 15th). CL was corresponding Author of this journal publication.
  - The paper [J-I33] is constantly listed as one of the top 5 downloaded paper of the journal, scoring an average of 700 download requests per month on average.
- Author of **59** conference proceeding publications (international only)
  - **Invited conference contribution count: 11 (6 time presenter and first author)**.
  - The paper [C57] was the top scored paper at ECOC 2018 (committee n.5).
  - The paper [C64] was the top scored paper at OFC 2019 (committee n.5).

Other responsibilities and activities

International Invited Seminars (Selected List)[1]

- Title: **Coupling Devices for Silicon Photonics Components**, 12th ACHIP Collaboration Meeting, Germany, Sept 2021
- Title: **Intermodal Nonlinear Optics**, OSA Student Chapter Selected Talks, Jaipur India, Held Virtually, 24/09/2021
- Title: **All optical signal processing in silicon-based devices**, The Rank Prize Fund 2018 Edition, Lake District UK
- Title: **Silicon photonic transmitters and components**, OCLARO UK, Northampton, 10/10/2018
- Title: "**Optical components for future communication and computation techniques**, National Physical Laboratory, Teddington (UK), 03/09/2018
- Title: **Nonlinear Optical Devices in Silicon Rich Silicon Nitride**, Peking University, 01/11/2017
- Title: **Silicon Photonic Transmitters and Components** , Scuola Superiore Sant'Anna Pisa, 20/10/2017
- Title: **Silicon Photonics technologies for future optical systems**, Wuhan National Laboratory for Optoelectronics, 11/01/2017
- Title: **Silicon Photonics technologies for future optical systems**, Unveirsity of Pavia - 22/07/2016
- Title: **Advanced Nonlinear Optics at Southampton**, CNR , Tito, Italy - 25/05/2015

Scientific responsibilities and activities

- CL serves as Editorial board Member of MDPI Optics (ISSN 4444-9999).
- CL was Technical Program Committee Member of CLEO-PR 2020.
- CL serves as regular reviewer for OSA/IEEE/Nature publications.

[1] Excluding conferences that are listed in Scientific Publications

- CL was Technical Program Committee Member of ICMAP 2018.
- CL is Guest Editor for the *Roadmap on all-optical signal processing*, published on Journal of Optics - IOP Science.
- CL is Guest Editor for the *Roadmap on Multimode Photonics*, to be soon published on Journal of Optics - IOP Science.

Institutional responsibilities and activities

- CL is currently member of "Commissione Paritetica" - Faculty of Engineering at the University of Pavia (from 2020)
- CL was a member (2 years) of the "Equality and Diversity" Committee of the The Faculty of Science and Engineering (FPSE) at the University of Southampton

External and outreach responsibilities and activities

- CL was a board member of the "Italian Association of Scientists in the UK (AISUK)" that provides support to italian scientists in the UK and does dissemination activities across the whole country.
- CL is the founder and President of the italian organization named "Il Sellino Spiritato",

Research Activity Summary

CL has started his scientific career in 2011. He was awarded of a PhD scholarship to work on silicon photonic third- order nonlinear components for all optical signal processing applications. Since then, CL has mainly worked in the field of integrated optics and all-optical signal processing, using either linear and nonlinear optical techniques. A detailed review of his research interests is reported below.

Optical nonlinearities in integrated photonic components for all-optical processing

The ability to directly process an optical signal in the optical domain, without the use of any electrical wave, would unlock many unprecedented opportunities and applications. The use of optical nonlinearities has been identified as one of the possible options to realize all-optical processing functionalities. Indeed, nonlinear optical materials could show a nonlinear polarization response to an applied electrical field, thus facilitating the manipulation of optical signals (in phase or amplitude) in the optical domain. For this reason, it is of great importance to acquire a deep knowledge of the nonlinear optical properties of different materials, as well as developing the capability to design suitable waveguiding structures that enhance the desired effects. In this context, integrated photonic structures grant the possibility to fine-tune both the material properties (e.g. by suitable doping or by mechanical stress) and the waveguide properties (e.g. creating high/low confinement waveguides or even slot waveguides), hence representing a fundamental tool for the development of all-optical nonlinear components. Silicon photonic waveguides are typically composed of a silicon core (n=3.4) embedded in a silica (n=1.44) cladding. This creates waveguides with very high refractive index contrast (>2), thus allowing for very thigh optical mode confinement which in turn implies the potentiality to obtain strong optical intensities, even with relatively low power levels. Silicon also exhibits a very high $\chi^{(3)}$ coefficient, making silicon photonic waveguides very attractive for the realization of compact and low power integrated nonlinear devices.

Although this field has seen meaningful advancements in the last 10 years, significant limitations are still present. These are mainly related to presence of two-photon absorption (TPA) and free-carrier absorption (FCA) effects, that may occur in silicon structure when relatively high-intensity waves are sent into the waveguiding structure, even when beams with a photon energy lower than the band-gap (i.e. beams with an optical wavelength in the transparency region of the material) are considered. As the presence of large TPA and FCA in silicon waveguides represents a barrier for the (efficient) generation of nonlinear optical effects, during his research activity CL has tackled these issues, proposing both the use of novel materials (e.g. silicon-rich silicon nitride) or new device configurations, which allowed to achieve a high beam confinement in a material with high nonlinear response, exhibiting at the same time low linear and nonlinear losses.

During his PhD he mainly worked on the development of two main applications, which can be realized by making use of nonlinear devices, that were a) all-optical wavelength conversion using four wave mixing and b) high speed all-optical switching.

Four Wave Mixing (FWM) is a third-order ($\chi(3)$) nonlinear effect that allows the generation and conversion of frequency components. In its basic configuration, when two waves (placed at ν_1, ν_2, ν_2>ν_1) are launched in a $\chi(3)$ nonlinear media, two new frequency components are generated at $\nu_4 = \nu_2 + (\nu_2 - \nu_1)$ and $\nu_3 = \nu_1 - (\nu_2 - \nu_1)$. In this process two pump photons are annihilated, leading to the generation (energy exchange between the pumps and the generated waves occurs) of a pair of photons placed at ν_3 and ν_4. Due to its nature and its properties, FWM is relevant for a number of applications such as wavelength conversion and exchange (telecom-oriented), generation of quantum-pair generation or heralded single-photon sources (quantum applications) and optical comb and super-continuum generation (with applications in physics, telecom, sensing and metrology). CL has extensively explored FWM-based devices for a variety of uses. For example, he worked towards the realization of all optical, integrated, wavelength converters, that can operate at low power, and high bandwidth demonstrating wavelength conversion with optical power levels of tens of mW, operating across a bandwidth of more than 40 nm. CL has also explored FWM effect in optical cavity systems. Indeed, the strength of the FWM effect can be greatly enhanced when operated in resonant devices, giving the rise to cascaded frequency generation at relatively low power levels. In this context, CL has shown frequency generation is silicon photonic ring resonators, demonstrating their capability to operate as low power wavelength converters as well as compact comb sources.

All-optical switching also represents a key functionality for various fields. For example, the ability to switch an optical signal using another optical signal, would allow for extremely high speed optical modulation operations, paving the way to complex and sophisticated functionalities. During his PhD, CL has demonstrated all optical switching at rates of 40 GHz [J4], by making use of the ultrafast Kerr effect, whose speed was only limited by the testing instrumentation. The demonstrated device constituted a fundamental, scalable, building block, which can serve for the realization of integrated all optical processors.

CL has recently proposed the use of a novel technological platform based on silicon-rich silicon nitride as light-guiding material. CL has focused his initial research efforts on the material design and synthesis, developing novel, reliable fabrication routines to obtain silicon nitride films containing different quantities of silicon. The deep knowledge of the synthesis process allowed to fine-tune the material properties, obtaining a flexible platform showing, at the same time, low linear and nonlinear losses (due to reduced absorption and scattering effects as well as a negligible $Im\{\chi^{(3)}\}$) and a large real part of the $\chi^{(3)}$ coefficient, which allowed for efficient nonlinear effects. This study has been published in Scientific Reports [J11] and presented, as an invited contribution, at CLEO-PR 2017 and CLEO-PR2018. The platform developed by CL is currently used by the silicon photonics group (led by Prof. Graham Reed) to routinely produce silicon nitride devices, constituting part of fabrication protocols of the Cornerstone project (sotonfab.co.uk). This study has been also used as basis of a submitted EPSRC[2] project (in collaboration with Dr. Fred Gardes) which will look to de-

[2] Engineering and Physical Sciences Research Council

velop advanced silicon-rich silicon nitride devices for applied physics and quantum applications.
In order to explore the potentials of the developed platform and its use in a wider range of applications, CL has recently set two scientific collaborations:i) with Glasgow University that will provide support in designing, fabricating and testing of silicon-rich silicon nitride waveguides for supercontinuum generation, covering wavelengths ranging from visible to the mid infrared and ii) with EPFL Lausanne (Prof. Camille Bres), that will provide support in studying the second-order nonlinear effects (recently observed in silicon nitride-based materials) that arise from the silicon-rich silicon nitride material waveguides.
As an alternative route, CL has recently proposed the use of Ta_2O_5 as possible nonlinear material, exhibiting low loss and high nonlinearities at telecom and mid-IR wavelengths. This project is currently being investigated in collaboration with Prof. James Wilkinson who is providing fabrication support. Preliminary results have been presented at the Optical Fibre Communication Conference and further material developments are currently being investigated. CL coordinates this work within the optical communication, the silicon photonic and the integrated optics groups and he is currently responsible of the device design (in terms of linear and nonlinear response) and characterization steps.
During the last two years, CL has started a new activity, focused on the development of multi-mode nonlinear photonic components. Nonlinear multimode optics allows for more sophisticated signal processing devices, enabling, for instance, the generation of frequencies in the mid-IR region, using the inter-modal four wave mixing effect. CL has demonstrated, for the first time, the generation of new wavelength components in the L-band, using a dual-pump Bragg scattering inter modal four wave mixing scheme. The results have been presented at GFP 2018 and ECOC 2018 conferences. **The ECOC paper was one of the top scored papers of the conference** and CL has been invited to write an extended version of the manuscript. Recently, the same four wave mixing scheme has been employed to demonstrate broadband and efficient inter-modal four wave mixing in silicon rich silicon nitride devices. This work has been presented as **top scored paper** at the OFC 2019 conference and its extended version has been published in OSA Photonics Research Journal.

High-speed optical components and processors

Currently, the development of silicon photonic high speed (>100 Gb/s) transceivers and optical processors represents a hot research topic, and significant efforts are being devoted to this, from both high-tech companies and academic bodies. In this context, CL has focused his research efforts to the development of high-speed and ultra-linear optical intensity modulators, based on electro-optic effects. High-speed silicon photonic phase shifters are typically composed of a p-n junction-waveguide (half of the waveguide, or part of it, is n-doped, while the remaining is p-doped). By applying a reverse-voltage across the junction, thanks to the carrier-depletion effect, a phase shift is induced to the traveling wave. Intensity modulators are then obtained by incorporating a phase (or more) shifter section into a Mach-Zehnder or a microring device. These devices show strong nonlinear transfer functions, thus inducing unwanted distortion to the output modulated wave. The main sources of nonlinearities are related to the overlap integral between the carrier-distribution change (induced by the carried depletion effect) and the optical field of the traveling beam and and to the nonlinear transfer functions that either the Mach-zehnder or the microring structure exhibit. CL has worked toward the realization of ultra-linear silicon photonic modulators taking care of both these source of nonlinearities. In particular, he proposed a novel and optimized p-n junction doping map that allowed to position the p-n junction depletion region across a uniform region of the optical field, thus drastically reducing the device nonlinearities. Additionally he also designed a novel Mach-Zehnder scheme that incorporated a microring resonator in one of its arm. By operating the device at wavelengths that are out of the microring resonance wavelengths, the Mach Zehnder nonlinearities (sub-linear behaviour) can be compensated by the microring nonlinearities (super-linear behavior), producing a linear response.
The obtained results have shown that the developed devices offered superior performance,thus al-

lowing the transmission and manipulation of high-complexity multi-level signals, requiring highly linear modulators, (such as OFDM[3] and PAM[4]), with speed exceeding 100 Gb/s. These results have attracted considerable attention from the research community, and CL has been asked to give an invited speech at the last OSA Photonics in Switching conference (New Orleans – 2017) to describe these achievements.

Development of efficient fibre to chip coupling solutions

Silicon photonic integrated components show very high index contrast (≈2), thus facilitating high confinement of the optical radiation and, consequently, the realization of high-density photonic integrated circuits (PIC). Unfortunately this also introduces significant design challenges when an efficient interface between PIC and standard optical fibre is required. This is because the optical mode area of standard fibre is three order of magnitude larger than the modal area of a standard silicon waveguide. For this reason, the design and the study of efficient coupling device is essential to the functionality of any silicon photonic PIC that need to be interfaced to external, fibre-based components.
Although many approaches have been proposed in the past, this topic remains one of the biggest challenges in the field, and achieving efficient and broadband interfaces is still an open issue. In the past four years CL worked towards the realization of novel devices that can show a coupling efficiency (between the silicon photonic circuit and a standard single mode optical fibre) of more than 80 % ,and which can be produced by only using CMOS compatible processes. In this context, a significant achievement demonstrated by CL has been the realization of a fiber-to-PIC interface, fabricated in the ORC clean-room, exclusively using CMOS-compatible processes, which showed a record experimental efficiency of $> 81\%$. Such a result has been achieved by noticing that common grating-coupler structures, based on a linear apodization of the fill-factor parameter, intrinsically imply that the Bragg-law is only satisfied in a single position of the coupling element and not along its whole length. As a consequence, CL and coworkers, developed a new grating-coupler design procedure, allowing to satisfy the Bragg condition along the whole apodized grating, thus obtaining a significant performance improvement. As this technique allows a significant advantage over conventional approaches, it attracted significant interest both from academic and industrial bodies working in the field across the world. A US-patent application has also been filed. CL now plans to use the developed expertise to design and demonstrate more advanced devices, which can operate with more than one polarization state, with more spatial modes, across multiple wavelength bands. **CL has been invited**, by the *OSA Photonics Research Journal* Editorial board, to write a review paper covering the topic that is currently one of the most downloaded paper of the journal overall.

Advanced polarization control and re-configurable silicon photonic circuits

From 2019 CL has started a new research theme focused on the design and characterization of re-configurable silicon photonic circuits, using semiconductor nanowires (SNW). SNW are thin semiconductor cylinders with radii of the order of 100 nm and lengths of tens of micron. SNW and nanowire heterostructures represent a unique opportunity for nanoscience and nanotechnology fields, enabling unprecedented device functionalities, that might find countless applications spanning from quantum computation-technologies and sensing to energy harvesting and machine learning. For example electronic confinement in InP-InAs nanowire quantum dots is typically exploited for thermoelectric conversion and to enable single electron transistors coupled to microwaves; as another examples, broken-gap InAs-GaSb core-shell nanowires allow to implement Esaki tunnel diodes and are set to open new perspectives for studying the physics of interacting electrons and holes at the nanoscale. The basic idea underlying this research theme is to use those nanowires,

[3] Optical Frequency Division Multiplexing
[4] Pulse Amplitude Modulation

and their optical properties, to fictionalise an existing silicon photonic circuit. For example, SNW 's can be properly placed on waveguides to change the state of polarization of the travelling light beam. This can be done, in principle, as a post fabrication step, thus enabling the realization of re-configurable optical circuits. This research theme has started in 2020 in collaboration with the INFN institute and has already received considerable attention from the scientific community and funding bodies. In particular, the proposition to use SNW as polarization control elements in a silicon photonic circuit, has been used as core for two proposals that have been recently funded by national and international bodies (for a total of over 1M€ of value). These devices are also a key elements for future integrated quantum circuits: indeed a fine control of the state of polarization is fundamental tool for the realization of complex quantum states on chip. Thanks to its previous experiences and expertise CL has established a close-link with the INFN Institute, thus significantly widening his research portfolio.

Funded Projects Record

2023-Current **GRACE6G**
Role: PI
Value: 220k

2023-Current **MAGIC**
Role: Co-PI
Value: 2320k

2020-2023 **Quantep Program**
Role: CO-PI - Workpackage Leader
Value: 500k

2020-2022 **Huawei Contract - "Nonlinear CDMA for shared optical components "**
Role: PI
Value: 150k

2019-Current **EPSRC Research Grant "Junipers" EP/T007303/1**
Role: "Researcher Co-Investigator"
Value: 1.1M

Journal Publications

[J1] Trita, A., **Lacava, C.**, Minzioni, P., Colonna, J., Gautier, P., Fedeli, J., Cristiani, I., “Ultra-high four wave mixing efficiency in slot waveguides with silicon nanocrystals”. In: *Applied Physics Letters* 99.19 (2011), p. 191105.

[J2] Matres, J., **Lacava, C.**, Ballesteros, G. C., Minzioni, P., Cristiani, I., Mart, J., Oton, C. J., “Low TPA and free-carrier effects in silicon nanocrystal-based horizontal slot waveguides”. In: *Optics Express* 20.21 (2012), pp. 13187–13193.

[J3] **Lacava, C.**, Minzioni, P., Baldini, E., Tartara, L., Fedeli, J. M., Cristiani, I., “Nonlinear characterization of hydrogenated amorphous silicon waveguides and analysis of carrier dynamics”. In: *Applied Physics Letters* 103.141103 (2013), p. 4.

[J4] **Lacava, C.**, Strain, M. J., Minzioni, P., Cristiani, I., Sorel, M., “Integrated nonlinear Mach Zehnder for 40 Gbit/s all-optical switching”. In: *Optics Express* 21.18 (2013), p. 21587.

[J5] **Lacava, C.**, Pusino, V., Minzioni, P., Sorel, M., Cristiani, I., “Nonlinear properties of AlGaAs waveguides in continuous wave operation regime”. In: *Optics Express* 22.5 (2014), pp. 5291–5298.

[J6] Strain, M. J., **Lacava, C.**, Meriggi, L., Cristiani, I., Sorel, M., “Tunable Q-factor silicon microring resonators for ultra-low power parametric processes.” In: *Optics Letters* 40.7 (2015), pp. 1274–7.

[J7] **Lacava, C.**, Ettabib, M., Cristiani, I., Fedeli, J., Richardson, D., Petropoulos, P., “Ultra-Compact Amorphous Silicon Waveguide for Wavelength Conversion”. In: *IEEE Photonics Technology Letters* 28.4 (2016), pp. 410–414.

[J8] Domínguez Bucio, T., Khokhar, A., **Lacava, C.**, Stankovic, S., Mashanovich, G., Petropoulos, P., Gardes, F., “Material and optical properties of low-temperature NH3-free PECVD SiNx layers for photonic applications”. In: *Journal of Physics D: Applied Physics* 50.2 (2017).

[J9] Ettabib, M. A., **Lacava, C.**, Liu, Z., Bogris, A., Kapsalis, A., Brun, M., Labeye, P., Nicoletti, S., Syvridis, D., Richardson, D. J., Petropoulos, P., “Wavelength conversion of complex modulation formats in a compact SiGe waveguide”. In: *Optics Express* 25.4 (2017), p. 3252.

[J10] **Lacava, C.**, Cardea, I., Demirtzioglou, I., Khoja, A., Ke, L., Thomson, D., Ruan, X., Zhang, F., Reed, G., Richardson, D., Richardson, D., Petropoulos, P., “49.6 Gb/s direct detection DMT transmission over 40 km single mode fibre using an electrically packaged silicon photonic modulator”. In: *Optics Express* 25.24 (2017), pp. 29798–29811.

[J11] **Lacava, C.**, Stankovic, S., Khokhar, A. Z., Bucio, T. D., Gardes, F., Reed, G. T., Richardson, D. J., Petropoulos, P., “Si-rich Silicon Nitride for Nonlinear Signal Processing Applications”. In: *Scientific Reports* 7.22 (2017).

[J12] Marchetti, R., Vitali, V., **Lacava, C.**, Cristiani, I., Charbonnier, B., Muffato, V., Fournier, M., Minzioni, P., “Group-velocity dispersion in SOI-based channel waveguides with reduced-height”. In: *Optics Express* 25.9 (2017), pp. 9761–9767.

[J13] Marchetti, R., **Lacava, C.**, Khokhar, A., Chen, X., Cristiani, I., Richardson, D. J., Reed, G. T., Petropoulos, P., Minzioni, P., “High-efficiency grating-couplers: Demonstration of a new design strategy”. In: *Scientific Reports* 7.1 (2017), pp. 1–8.

[J14] Marchetti, R., Vitali, V., **Lacava, C.**, Cristiani, I., Giuliani, G., Muffato, V., Fournier, M., Abrate, S., Gaudino, R., Temporiti, E., Carroll, L., Minzioni, P., “Low-loss micro-resonator filters fabricated in silicon by CMOS-compatible lithographic techniques: Design and characterization”. In: *Applied Sciences (Switzerland)* 7.2 (2017).

[J15] Ruan, X., Li, K., Thomson, D., **Lacava, C.**, Meng, F., Demirtzioglou, I., Petropoulos, P., Zhu, Y., Reed, G., Zhang, F., "Experimental comparison of direct detection Nyquist SSB transmission based on silicon dual-drive and IQ Mach-Zehnder modulators with electrical packaging". In: *Optics Express* 25.16 (2017), pp. 19332–19342.

[J16] Xomalis, A., Demirtzioglou, I., Plum, E., Jung, Y., Nalla, V., **Lacava, C.**, MacDonald, K. F., Petropoulos, P., Richardson, D. J., Zheludev, N. I., "Fibre-optic metadevice for all-optical signal modulation based on coherent absorption". In: *Nature Communications* 2018 (2017), pp. 1–7.

[J17] Demirtzioglou, I., **Lacava, C.**, Bottrill, K., Thomson, D. J., Reed, G., Richardson, D., Petropoulos, P., "Frequency comb generation in a silicon ring resonator modulator". In: *Optics Express* 26.2 (2018), pp. 3–5.

[J18] Xomalis, A., Demirtzioglou, I., Jung, Y., Plum, E., **Lacava, C.**, Petropoulos, P., Richardson, D., Zheludev, N., "Picosecond all-optical switching and dark pulse generation in a fibre-optic network using a plasmonic metamaterial absorber". In: *Applied Physics Letters* 113.5 (2018).

[J19] Bottrill, K., Ettabib, M., Demirtzioglou, I., Marchetti, R., **Lacava, C.**, Parmigiani, F., Richardson, D., Petropoulos, P., "Spectral Difference Interferometry for the Characterization of Optical Media". In: *Laser and Photonics Reviews* 13.10 (2019).

[J20] Demirtzioglou, I., **Lacava, C.**, Shakoor, A., Khokhar, A., Jung, Y., Thomson, D., Petropoulos, P., "Apodized silicon photonic grating couplers for mode-order conversion". In: *Photonics Research* 7.9 (2019), pp. 1036–1041.

[J21] Korai, U., Wang, Z., **Lacava, C.**, Chen, L., Glesk, I., Strain, M., "Technique for the measurement of picosecond optical pulses using a non-linear fiber loop mirror and an optical power meter". In: *Optics Express* 27.5 (2019), pp. 6377–6388.

[J22] **Lacava, C.**, Dominguez Bucio, T., Khokhar, A. Z., Horak, P., Jung, Y., Gardes, F. Y., Richardson, D. J., Petropoulos, P., Parmigiani, F., "Intermodal frequency generation in silicon-rich silicon nitride waveguides". In: *Photonics Research* 7.6 (2019), p. 615.

[J23] **Lacava, C.**, Ettabib, M., Bucio, T., Sharp, G., Khokhar, A., Jung, Y., Sorel, M., Gardes, F., Richardson, D., Petropoulos, P., Parmigiani, F., "Intermodal bragg-scattering four wave mixing in silicon waveguides". In: *Journal of Lightwave Technology* 37.7 (2019).

[J24] Lamy, M., Finot, C., Parriaux, A., **Lacava, C.**, Bucio, T. D., Gardes, F., Millot, G., Petropoulos, P., Hammani, K., "Si and Si-rich silicon-nitride waveguides for optical transmissions and nonlinear applications around 2 μm". In: *Applied Optics* 58.19 (2019).

[J25] Xomalis, A., Demirtzioglou, I., Jung, Y., Plum, E., **Lacava, C.**, Petropoulos, P., Richardson, D., Zheludev, N., "Cryptography in coherent optical information networks using dissipative metamaterial gates". In: *APL Photonics* 4.4 (2019).

[J26] Xomalis, A., Jung, Y., Demirtzioglou, I., **Lacava, C.**, Plum, E., Richardson, D., Petropoulos, P., Zheludev, N., "Nonlinear control of coherent absorption and its optical signal processing applications". In: *APL Photonics* 4.10 (2019).

[J27] **Lacava, C.**, Babar, Z., Zhang, X., Demirtzioglou, I., Petropoulos, P., Hanzo, L., "High-speed multi-layer coded adaptive LACO-OFDM and its experimental verification". In: *OSA Continuum* 3.9 (2020), p. 2614.

[J28] Li, K., Liu, S., Ruan, X., Thomson, D. J., Hong, Y., Yang, F., Zhang, L., **Lacava, C.**, Meng, F., Zhang, W., Petropoulos, P., Zhang, F., Reed, G. T., "Co-design of a differential transimpedance amplifier and balanced photodetector for a sub-pJ/bit silicon photonics receiver". In: *Optics Express* 28.9 (2020), p. 14038.

[J29] Woods, J., Daykin, J., Tong, A., **Lacava, C.**, Petropoulos, P., Tropper, A., Horak, P., Wilkinson, J., Apostolopoulos, V., "Supercontinuum generation in tantalum pentoxide waveguides for pump wavelengths in the 900 nm to 1500 nm spectral region". In: *Optics Express* 28.21 (2020).

[J30] Franz, Y., Haines, J., **Lacava, C.**, Guasoni, M., "Strategies for wideband light generation in nonlinear multimode integrated waveguides". In: *Physical Review A* 103.1 (2021).

[J31] Taengnoi, N., Bottrill, K. R., Hong, Y., Thipparapu, N. K., **Lacava, C.**, Sahu, J. K., Richardson, D. J., Petropoulos, P., "4-Level Alternate-Mark-Inversion for Reach Extension in the O-Band Spectral Region". In: *Journal of Lightwave Technology* 39.9 (2021), pp. 2847–2853. ISSN: 15582213. DOI: 10.1109/JLT.2021.3062446.

[J32] Wu, D., Shen, L., Ren, H., Huang, M., **Lacava, C.**, Sun, S., Campling, J., Hawkins, T., Gibson, U., Petropoulos, P., Ballato, J., Peacock, A. C., "Four-wave Mixing-based Wavelength Conversion and Parametric Amplification in Submicron Silicon Core Fibers". In: *IEEE Journal of Selected Topics in Quantum Electronics* 27.2 (2021), pp. 1–11.

Journal Publications - Invited Contributions

[J-I33] **Lacava, C.**, Ettabib, M., Petropoulos, P., "Nonlinear silicon photonic signal processing devices for future optical networks (Invited)". In: *Applied Sciences* 7.1 (2017).

[J-I34] Marchetti, R., **Lacava, C.**, Carroll, L., Gradkowski, K., Minzioni, P., "Coupling strategies for silicon photonics integrated chips [Invited]". In: *Photonics Research* 7.2 (2019), p. 201.

[J-I35] Minzioni, P., **Lacava, C.**, Tanabe, T., Dong, J., Willner, A., Almaiman, A., Torres-company, V., Schroder, J., Peacock, A. C., Strain, M. J., Parmigiani, F., Contestabile, G., Marpaung, D., Liu, Z., Bowers, J. E., Chang, L., Fabbri, S., Vazquez, M. R., Bharadwaj, B., Eaton, S. M., Lodahl, P., Zhang, X., Eggleton, B. J., Munro, W., Nemoto, K., Morin, O., Laurat, J., Nunn, J., "Roadmap on all-optical processing [Invited]". In: *Journal of Optics* 21.063001 (2019).

[J-I36] Bucio, T., **Lacava, C.**, Clementi, M., Faneca, J., Skandalos, I., Baldycheva, A., Galli, M., Debnath, K., Petropoulos, P., Gardes, F., "Silicon Nitride Photonics for the Near-Infrared [Invited]". In: *IEEE Journal of Selected Topics in Quantum Electronics* 26.2 (2020).

Conference Proceedings

[C37] Trita, A., **Lacava, C.**, Cristiani, I., Gautier, P., Colonna, J. P., Fedeli, J. M., "Four-wave-mixing efficiency and conversion bandwidth in silicon-nanocrystals slot waveguides fabricated by PECVD". In: *2011 Conference on Lasers and Electro-Optics Europe and 12th European Quantum Electronics Conference, CLEO EUROPE/EQEC 2011*. 2011.

[C38] **Lacava, C.**, Minzioni, P., Baldini, E., Fedeli, J., Cristiani, I., "Four Wave Mixing Efficiency in Hydrogenated Amorphous Silicon Waveguides". In: *2013 Conference on Lasers & Electro-Optics Europe & International Quantum Electronics Conference CLEO EUROPE/IQEC* (2013), pp. 1–1.

[C39] **Lacava, C.**, Strain, M. J., Cristiani, I., Sorel, M., "40 GHz nonlinear all optical switching in a Mach-Zehnder interferometer integrated device". In: *2013 Conference on Lasers and Electro-Optics Europe and International Quantum Electronics Conference, CLEO/Europe-IQEC 2013*. 2013.

[C40] Strain, M. J., **Lacava, C.**, Minzioni, P., Sorel, M., "Tailoring of dispersion in silicon vertical slot waveguides". In: *2013 Conference on Lasers and Electro-Optics Europe and International Quantum Electronics Conference, CLEO/Europe-IQEC 2013*. 2013.

[C41] Strain, M. J., Orlandi, P., **Lacava, C.**, Morichetti, F., Melloni, A., Bassi, P., Cristiani, I., Sorel, M., "Silicon micro-ring resonators with tunable Q-factor for ultra-low power parametric signal generation". In: *2013 Conference on Lasers and Electro-Optics Europe and International Quantum Electronics Conference, CLEO/Europe-IQEC 2013*. 2013.

[C42] **Lacava, C.**, Carroll, L., Gerace, D., Andreani, L. C., Fournier, M., Messaoudene, S., Pavarelli, N., Lee, J. S., O'Brien, P. A., Menezo, S., Cristiani, I., "Performance of 2D-Grating couplers designed through full 3D-FDTD numerical simulations". In: *IEEE International Conference on Group IV Photonics GFP*. 2014, pp. 203–204.

[C43] Strain, M. J., **Lacava, C.**, Cristiani, I., Sorel, M., "Ultra-low power Four Wave Mixing wavelength conversion in silicon micro-ring resonators with tunable Q-factor". In: *IEEE International Conference on Group IV Photonics GFP*. 2014, pp. 175–176.

[C44] **Lacava, C.**, Marchetti, R., Giuliani, G., Fournier, M., Menezo, S., S, M., Minzioni, P., "Impact of waveguide cross section on nonlinear impairments in integrated optical filters for WDM communication systems". In: *Conference on Lasers and Electro-Optics 2012*. Vol. 29. 2012. 2015, p. 27100.

[C45] **Lacava, C.**, Strain, M. J., Pusino, V., Marchetti, R., Minzioni, P., Sorel, M., Cristiani, I., "Highy Nonlinear AlGaAs Waveguides for Broadband Signal Generation". In: *Optics InfoBase Conference Papers*. Vol. 1084. 2004. 2015, p. 27100.

[C46] **Lacava, C.**, Aghajani, A., Hua, P., Richardson, D. J., Petropoulos, P., Wilkinson, J. S., "Nonlinear optical properties of ytterbium-doped tantalum pentoxide rib waveguides on silicon at telecom wavelengths". In: *Optical Fiber Communication Conference 2016 (OFC 2016)* 1 (2016), W4E.4.

[C47] **Lacava, C.**, Carrol, L., Bozzola, A., Marchetti, R., Minzioni, P., Cristiani, I., Fournier, M., Bernabe, S., Gerace, D., Andreani, L. C., "Design and characterization of low-loss 2D grating couplers for silicon photonics integrated circuits". In: *Proceedings of SPIE - The International Society for Optical Engineering*. Vol. 9752. 2016, p. 97520V.

[C48] **Lacava, C.**, Ettabib, M., Cristiani, I., Fedeli, J.-M., Richardson, D., Petropoulos, P., "Ultra-low-power silicon photonics wavelength converter for phase-encoded telecommunication signals". In: *Proceedings of SPIE - The International Society for Optical Engineering*. Vol. 9752. 2016.

[C49] **Lacava, C.**, Marchetti, R., Vitali, V., Cristiani, I., Giuliani, G., Fournier, M., Bernabe, S., Minzioni, P., "Reduced nonlinearities in 100-nm high SOI waveguides". In: *Proceedings of SPIE - The International Society for Optical Engineering*. Vol. 9753. 2016, p. 975313.

[C50] **Lacava, C.**, Stankovic, S., Khokhar, A. Z., Dominguez Bucio, T., Gardes, F. Y., Richardson, D. J., Reed, G. T., Petropoulos, P., "CMOS-compatible Silicon-Rich Nitride Waveguides for Ultrafast Nonlinear Signal Processing". In: *Conference on Lasers and Electro-Optics*. 2016, STu4Q.7.

[C51] Bottrill, K., Ettabib, M. A., Gates, J. C., **Lacava, C.**, Parmigiani, F., Richardson, D. J., Petropoulos, P., "Flexible Scheme for Measuring Chromatic Dispersion Based on Interference of Frequency Tones". In: *Optical Fiber Communication Conference*. 2017, Th4H.5.

[C52] **Lacava, C.**, Demirtzioglou, I., Cardea, I., Khoja, A. E., Li, K., Thomson, D. J., Ruan, X., Zhang, F., Reed, G., Richardson, D. J., Petropoulos, P., "Spectrally Efficient DMT Transmission over 40 km SMF Using an Electrically Packaged Silicon Photonic Intensity Modulator". In: *European Conference on Optical Communications (ECOC) 2017*. 2017.

[C53] Marchetti, R., **Lacava, C.**, Khokhar, A., Cristiani, I., Richardson, D. J., Petropoulos, P., Minzioni, P., "Reflector-less Grating-Coupler with a -0 . 9 dB Efficiency Realized in 260-nm Silicon-On-Insulator Platform". In: *OSA Advanced Photonics Congress*. Vol. Part F52-I. 2017, pp. 2–4.

[C54] Marchetti, R., Vitali, V., **Lacava, C.**, Cristiani, I., Giuliani, G., Adelmini, L., Fournier, M., Minzioni, P., "Low-Loss Integrated Ring-Resonator Filters Realized by CMOS Fabrication Process". In: *Conference on Lasers and Electro-Optics Europe 2017*. 2017.

[C55] Demirtzioglou, I., Xomalis, A., Plum, E., Jung, Y., **Lacava, C.**, MacDonald, K., Petropoulos, P., Richardson, D., Zheludev, N., "A fiberized metamaterial device for ultrafast control of coherent optical signals". In: *Optical Fiber Communication Conference 2018*. Vol. Part F84-O. 2018.

[C56] Dominguez Bucio, T., Scholl, S. L., Ilie, S. T., **Lacava, C.**, Debnath, K., Khokhar, A. Z., Banakar, M., Sotto, M., Grabska, K. M., Clementi, M., Bajoni, D., Galli, M., Saito, S., Petropoulos, P., Gardes, F. ., "Low-temperature NH3-free Silicon Nitride Platforms for Integrated Photonics". In: *Group IV Photonics (GFP), 2018 15th IEEE International Conference on*. 2018, pp. 119–120. ISBN: 9781538653616.

[C57] Gardes, F., Dominguez Bucio, T., Mastronardi, L., Banakar, M., Bazin, A., Khokhar, A., **Lacava, C.**, Petropoulos, P., Littlejohns, C., Debnath, K., "Group IV Compounds Modulators and Mid Index Waveguides for Enhanced CMOS Photonics". In: *31st Annual Conference of the IEEE Photonics Society, IPC 2018* (2018).

[C58] **Lacava, C.**, Ettabib, M. A., Bucio, T. D., Sharp, G., Khokhar, A. K., Jung, Y., "Inter-Modal Wavelength Conversion in Silicon Waveguide (Top scored paper)". In: *European Conference on Optical Communications (ECOC) 2018*. 2018.

[C59] **Lacava, C.**, Ettabib, M. ., Sharp, G., Jung, Y., Petropoulos, P., Richardson, D. J., "Silicon photonics wavelength converter based on inter-modal four wave mixing Bragg scattering". In: *2018 IEEE 15th International Conference on Group IV Photonics (GFP)*. IEEE, 2018, pp. 99–100.

[C60] **Lacava, C.**, May, S., Richardson, D., Reed, G., Sorel, M., Petropoulos, P., "All-optical Wavelength Conversion of Phase-encoded Signals in Silicon-rich Silicon Nitride Waveguides". In: *Conference on Lasers and Electro-Optics 2018*. 2018, JTu2A.64.

[C61] Meng, F., Li, K., Thomson, D., **Lacava, C.**, Wilson, P., Reed, G., "Ultra Wide-Band Inductive Peaking VCO with Cascode Noise Reduction". In: *2018 IEEE International Symposium on Circuits and Systems (ISCAS)*. Vol. 4. 1. 2018, pp. 6–10.

[C62] Xomalis, A., Demirtzioglou, I., Plum, E., Jung, Y., **Lacava, C.**, MacDonald, K., Petropoulos, P., Richardson, D. J., Zheludev, N. I., "Fibre-optic metadevice for signal processing with 1 THz bandwidth". In: *Proc. SPIE 10671, Metamaterials XI, 1067121*. 2018.

[C63] Demirtzioglou, I., **Lacava, C.**, Shakoor, A., Khokhar, A., Jung, Y., Thomson, D., Petropoulos, P., "Silicon Grating Coupler for Mode Order Conversion". In: *CLEO: Applications and Technology 2019*. 2019, JTh2A.74.

[C64] Korai, U., Wang, Z., **Lacava, C.**, Chen, L. R., Strain, M., Glesk, I., "Measurement of Optical Pulsewidth in the Picosecond Regime Using a Non-linear Fiber and Power Meter". In: *CLEO Science and Innovations 2019*. 2019, SW3H.5.

[C65] **Lacava, C.**, Bucio, T. D., Khokhar, A., Horak, P., Jung, Y., Gardes, F., Richardson, D., Petropoulos, P., Parmigiani, F., "Ultra Broadband Bragg Scattering Four Wave Mixing in Silicon Rich Silicon Nitride Waveguides". In: *OFC 2019*. Vol. 1. 2019, W1C.5.

[C66] Lamy, M., Finot, C., **Lacava, C.**, Roelkens, G., Kuyken, B., Petropoulos, P., Hammani, K., "Si and Si-rich silicon-nitride waveguides for optical transmissions and wavelength conversion around 2 um". In: *European Conference on Integrate d Optics*. 2019.

[C67] Taengnoi, N., Bottrill, K., **Lacava, C.**, Richardson, D., Petropoulos, P., "AMI for Nonlinearity Mitigation in O-Band Transmission". In: *OFC 2019*. 2019, Th2A.33.

[C68] Taengnoi, N., Bottrill, K. R., Hong, Y., Thipparapu, N. K., **Lacava, C.**, Sahu, J. K., Richardson, D. J., Petropoulos, P., "Reach extension of PAM4 signals in O-band transmission by application of alternate-mark-inversion". In: *European Conference on Optical Communication 2019*. Vol. 2019. CP765. 2019, pp. 8–11.

[C69] Hong, Y., Li, K., **Lacava, C.**, Liu, S., Thomson, D., Meng, F., Ruan, X., Zhang, F., Reed, G. T., Petropoulos, P., "Beyond 100-Gb/s direct-detection transmission using an optical receiver co-integrated with a 28-nm CMOS gain-tunable fully-differential TIA". In: *Optics InfoBase Conference Papers* Part F174- (2020), pp. 4–6.

[C70] Woods, J., Daykin, J., Tong, A., **Lacava, C.**, Petropoulos, P., Tropper, A., Horak, P., Wilkinson, J., V. Apostolopoulos, "Tantalum pentoxide waveguides for spectral broadening of vertical external cavity surface emitting lasers". In: *SPIE Europe 2020*. 2020.

[C71] Wu, D., Shen, L., **Lacava, C.**, Petropoulos, P., Hawkins, T., Ballato, J., Gibson, U. J., Peacock, A. C., "Tapered submicron silicon core fiber for broadband wavelength conversion". In: *CLEO Science and Innovation 2020*. Vol. 1. 2020, SM1P.5. ISBN: 9781943580767. DOI: `10.1364/cleo{\_}si.2020.sm1p.5`.

Conference Proceedings - Invited and Post-Deadline Contributions

[C-I72] Petropoulos, P., Ettabib, M., Bottrill, K., **Lacava, C.**, Parmigiani, F., Hammani, K., Brun, M., Labeye, P., Nicoletti, S., Bogris, A., Kapsalis, A., Syvridis, D., "Advanced nonlinear signal processing in silicon-based waveguides (Invited)". In: *2015 20th European Conference on Networks and Optical Communications, NOC 2015*. 2015.

[C-I73] **Lacava, C.**, Liu, Z., Thomson, D., Ke, L., Fedeli, J. M., Richardson, D. J., Reed, G. T., Petropoulos, P., "Silicon photonic Mach Zehnder modulators for next-generation short-reach optical communication networks (Invited)". In: *Proceedings of SPIE - The International Society for Optical Engineering*. Vol. 9772. 2016, p. 977209.

[C-I74] Thomson, D., Littlejohns, C., Li, K., Nedeljkovic, M., Khokhar, A., Gardes, F., Mashanovich, G., **Lacava, C.**, Petropoulos, P., Richardson, D., Rouifed, M., Qiu, H., Xin, T., Hu, T., Zhang, Z., Wang, H., Chiu, P.-W., Li, Y.-F., Hsu, S., Reed, G., "Integrated silicon optical modulators (Invited)". In: *PIERS 2016*. 2016.

[C-I75] Gardes, F., **Lacava, C.**, Debnath, K., Bucio, T. D., Banakar, M., Stankovic, S., Alattili, A., Khokhar, A., Saito, S., Petropoulos, P., Molina, I., Halir, R., Ortega-Moñux, A., Wanguemert-, J., Chen, Y., He, J., Cheben, P., Schmid, J. H., "Tunable index back end of line platform for enhanced integrated photonics (Invited)". In: *Group IV Photonics (GFP), 2017*. 2017.

[C-I76] **Lacava, C.** "Low Loss Si-rich Silicon Nitride For Nonlinear Signal Processing Applications (Invited)". In: *OSA CLEO Pacific Rim 2017*. 2017.

[C-I77] **Lacava, C.**, Thomson, D., Li, K., Demirtzioglou, I., Shakoor, A., Richardson, D., Zhang, F., Reed, G., Petropoulos, P., "Silicon photonic modulators for high speed optical analog links (Invited)". In: *Photonics in Switching*. Vol. Part F57-P. 2017.

[C-I78] Plum, E., Papaioannou, M., Xomalis, A., Karvounis, A., Nalla, V., Demirtzioglou, I., Jung, Y., MacDonald, K. F., **Lacava, C.**, Petropoulos, P., Richardson, D. J., Zheludev, N. I., "Coherent Information Processing on Metasurfaces at 40 Gbit / s and Beyond (Invited)". In: *PIERS 2017*. 2017.

[C-I79] Xomalis, A., Demirtzioglou, I., Nalla, V., Plum, E., Jung, Y., **Lacava, C.**, Macdonald, K., Petropoulos, P., Richardson, D. J., Zheludev, N. I., "Fibre-optic metadevice for all-optical coherent signal processing at 40 Gbit/s". In: *OSA CLEO Pacific Rim 2017 (Post-deadline Paper)*. 2017.

[C-I80] **Lacava, C.** "Silicon photonics-based all optical signal processing devices (Invited)". In: *OSA CLEO Pacific Rim 2018*. 2018.

[C-I81] Bucio, T. D., De Paoli, G., Gardes, F. Y., Grabska, K. M., Ilie, S. T., Khokhar, A. Z., **Lacava, C.**, Petropoulos, P., Skandalos, I., "Mid-Index Silicon Nitride Devices for Enhanced Linear and Non-Linear Photonic Functionalities (Invited)". In: *IEEE International Conference on Group IV Photonics GFP* 2019-Augus (2019), pp. 2019–2020.

[C-I82] Gardes, F. Y., Domınguez Bucio, T., Paoli, G., Ilie, S. T., Skandalos, I., **Lacava, C.**, Milosevic, M., Jantzen, S. L., Khokhar, A. Z., Petropoulos, P., "Tunable index silicon nitride for extended silicon photonics applications (Invited)". In: *Asia Communications and Photonics Conference 2019* Part F138- (2019), pp. 1–2.

[C-I83] **Lacava, C.** “Advanced nonlinear optics with integrated waveguides”. In: *IEEE Summer Topical Meetings 2020*. 2020.

[C-I84] **Lacava, C.**, Parmigiani, F., Gardes, F., Dominguez Bucio, T., Petropoulos, P., “Silicon-rich silicon nitride CMOS compatible photonics (Invited)”. In: *SPIE Europe 2020*. 2020.

Patent Applications

1. Riccardo Marchetti, **Cosimo Lacava**, Periklis Petropoulos, Paolo Minzioni, Graham Reed, Ilaria Cristiani. ”Granting couplers for a silicon on insulator waveguide, and methods of designing, fabricating and using the grating couplers”. (filed in the US: P248545US)