

Professional Background: Denis Garoli, born in Padova, got a master Degree in Physics in the 2003 at Padova University. He awarded the PhD in Space Science and Technology at University of Padova with a thesis on the development of innovative technologies for the environmental conservation. In 2011 he got a Degree in Biotechnology at Padova University. He is interested in several research topics such as: material science, nanofabrication, plasmonics, biosensing, single-molecule detection and manipulation, DNA nanotechnology, 1D and 2D materials and nanoelectronics. From 2016 to 2019 he co-coordinated the Horizon 2020 FET project ProseqO (budget 3ME): PROtein SEQuencing using Optical single molecule real-time detection. The project regarded the development of new technologies for single molecule detection and manipulation with the final goal of DNA/RNA and protein sequencing. Within this project he also started a continuous collaboration with the Biotech company AbAnalitica in Padova (partner in FET project) where he is still coordinating and supporting different R&D projects and activities. In 2020 he won the Horizon 2020 FET project DNA-Fairylights (coordinator role – budget 3.1 ME). The project regards the development of a disruptive new technology for DNA data storage. In 2022 he won the Horizon EU MSCA doctoral network project DYNAMO (coordinator role – budget 2.7ME). This project regards the development of single molecule spectroscopic techniques to perform protein analysis. The project will be focused on the training of a large number of PhD candidates. Finally, in 2022 he won the Horizon EU – Pathfinder Open project 3D-BRICKS (coordinator role – budget 3.6 ME). The project regards the development of a disruptive new technology for 3D bio-nanoelectronics. The main results of his research during these years regard the design, fabrication and test of innovative plasmonic devices for several applications, from material science, to biosensing and optical beam manipulation. During the recent years he's mainly focused on nanopore technology for single molecule detection. In this period (last 5 years) his scientific outcome counts a large number of peer-review papers (among the others Nano Letters, Nature Comm., Nature Nanotech., ACS Nano, ACS Photonics, ACS Sensors, Adv. En. Mat., Nanoscale, etc.).

Education:

- 27/09/2011 • **Degree in Biotechnology** at the University of Padova with the thesis “Integrated Biosensing techniques. The case of Mycobacterium TB mutations identification”.
- 28/3/2008 • **Ph.D. in Space Science and Technology** at the Center of Studies and Activities for Space “G. Colombo”, University of Padova, with the thesis “Development of Innovative Sensors for Ultraviolet Measurements”.
- 15/12/2003 • **Master's degree in Physics** at the University of Padova with the thesis “Development of a new sensor for the measurements of the total effective irradiance of sun beds”.

Professional experiences and Fellowships

- 01/09/2023 to present • Università degli Studi di Modena e Reggio Emilia
Position: Associate Professor
- 01/09/2014 to present • IIT – Istituto Italiano Tecnologia
Position: Senior researcher
Duties: Team leader and EU grants PI, Design and development of nanofabricated devices.
Supervisor of PhD students and Post-doc researchers
- 01/01/2024 to present • Jiliang University
Position: Visiting Professor
Duties: Design and development of nanofabricated devices. Supervisor of PhD students and Post-doc researchers
- 1/10/2020 to 1/11/2021 • Free University of Bozen
Position: Assistant Professor
Duties: Team leader, teacher of electronics and Supervisor of PhD students and Post-doc researchers
- 10/04/2014 to 1/09/2020 • ABAnalitica – Advanced Biomedicine
Position: Researcher

Duties: Development of RT-PCR and NGS kit for human diagnostic.

01/05/2009 - 31/03/2014 • University of Padova – Laboratory for nanofabrication and nanotechnologies (LANN)
 Position: Researcher
 Duties: Electron Beam and Ion Beam Lithography process. Plasmonic systems. Thin film deposition and characterization. PVD and CVD system design. Raman spectroscopy. SNOM microscopy

01/11/2007 – 30/04/2009 • Media-Lario Technologies
 Position: Process Engineer and Project Manager
 Duties: Design and development of new facilities for thin films deposition and characterization. Thin films development.

01/01/2004 – 31/12/2007 • CNR-INFM, National Institute for the Physics of the Matter.
 Position: Collaborator and PhD Student.
 Duties: Coating Design and characterization for UV monitoring and EUV lithography and Solar Physic.

Research

Principal Research fields (present to past)

- Design and development of innovative technologies for 3D CNT-nanoelectronics. Within a Pathfinder OPEN Horizon 2023 project (with coordinator role – 3.6M euros budget) I'll investigate breakthrough technological solutions for next generation nanoelectronics components (FETs, memories and digital logic gates) by means of DNA and nanomaterials. In particular I've conceived, new approaches and designs to implement, via biofabrication, a brand new family of Carbon-NanoTubes (CNTs) 3D transistors.
- Design and development of innovative technologies for DNA data storage. Single molecule spectroscopy. Within a FET OPEN Horizon 2021 project (with coordinator role – 3.1M euros budget) I'm investigating breakthrough technological solutions for next generation data storage by means of DNA and nanomaterials. In particular I've conceived, theoretically and experimentally demonstrated new approaches to store digital data by means of natural DNA decorated with nanoparticles.
- Design and development of innovative technologies for DNA and protein sequencing. Single molecule spectroscopy. Within a FET OPEN Horizon 2020 project (with co-coordinator role – 3M euros budget) and a MSCA H2020 project (coordinator role – 2.6M euros budget) I'm investigating breakthrough technological solutions for third generation sequencing of biomolecules. In particular I've conceived, theoretically and experimentally demonstrated new plasmonics nanopores based approaches for single molecule detections and sequencing.

Research results (summary)

Google Scholar: <https://scholar.google.com/citations?user=MVx4rIAAAAJ&hl=it&oi=ao>

101 publications in international peer-reviewed journals (25 as first author; 23 as last or corresponding author)

25 conference proceedings

Number of citations: >3100 – *h index*: 32

Participation to courses/workshops, conferences and abroad stay

2004 • Participation to the INFM annual meeting – Genova (IT), June
 2004 • Participation to the SPIE meeting, Denver (CO) USA, August
 2005 • Participation to the NEWRAD/UVNet Workshop, Davos, Switzerland, October
 2006 • Participation to the Italian Meeting “Metrologia & Qualità” – Torino, March
 2007 • Participation to the Italian National School “Detector and Electronics for High Energy Physics, Astrophysics and Space Applications” – INFN Legnaro – March
 2007 • Participation to the Italian National School “Synchrotron radiation application to the study of nano-structured materials and thin films” – ELETTRA Trieste – April
 2007 • Participation to the International Summer School on Adaptive Optics – University Of California – Santa Cruz - August
 2007 • One month stay in Lawrence Livermore National Laboratory (LLNL) – Collaboration for research project on development of multilayer coatings for VUV spectral region.
 2007 • Participation to the 12th ESP (European Society for Photobiology) International Congress – University of Bath – UK
 2009 • Participation to the MNE 09 International Congress – Ghent (BE) - September
 2010 • Participation to the META 10 International Congress – Cairo (Egypt) - February
 2011 • Participation to the SPP5 International Congress – Busan (Korea)

2013 • Participation to the MNE International Congress – London (UK)
 2014 • Participation to the ESGH (The EUROPEAN HUMAN GENETICS CONFERENCE) – Milan
 2015 • Participation to the SPIE meeting, San Diego (CA) USA, August
 2017 • Participation to the SPP8 meeting, Taipei Taiwan, May
 2018 • Participation to the META18 meeting – Organization committee, June (EU)
 2019 • Participation to the SPIE meeting, San Francisco (CA) USA, February
 2019 • Participation to the META19 meeting – Lisboa, July (EU)
 2021 • Participation to the SPIE meeting, Online (EU), April
 2021 • Participation to the META21 meeting – Online, July (EU)
 2022 • Participation to the SPIE meeting, (EU), April
 2022 • Participation as invited to the META22 meeting – Torremolinos, July (EU)
 2022 • Participation as invited to the Single Protein Sequencing meeting – Delft, November (EU)

Oral presentations at conference (last 5 years)

1. **D. Garoli**, "Far Field Transmission of Orbital Angular Momentum Light States – Application to Optical Trapping", ICFO Events, **Invited speaker** – Feb. 2015 (Barcelona)
2. **D. Garoli**, "Nanoporous antennae for infrared plasmonic sensing", SPIE (2015) (Oral)
3. **D. Garoli**, "Far field transmission of Orbital Angular Momentum light states", SPIE (2015) (Oral)
4. **D. Garoli**, "Beaming of helical light from plasmonic vortices via adiabatically tapered nanotip", SPP8, The 8th International Conference on Surface Plasmon Photonics, May 22-26, 2017, Academia Sinica, Taipei, Taiwan
5. **D. Garoli**, "Single molecule sequencing using enhanced optical real-time detection", Single protein sequencing congress 2017 – Delft – **Invited talk**
6. Chiral modes : Mod Chiral modes in optics and electronics of 2D systems - Nov. 2018 Aussois (France) - **Invited**
7. **D. Garoli**, "Plasmonic nanopore prepared on MoS₂ membrane - hybrid nanostructures based on site selective deposition", SPIE 2019 (Oral)
8. **D. Garoli**, "Hybrid plasmonic nanostructures based on controlled deposition of MoS₂ flakes on plasmonic nanostructures", META 2019 – **Invited Talk**
9. **D. Garoli**, "Single molecule sequencing using enhanced optical real-time detection", 2020 – University of Friburg – **Invited talk**
10. **D. Garoli**, "Design and experimental investigation of a chiral plasmonic nanotaper", SPIE (2021) (Oral)
11. **D. Garoli**, "Nanoporous metals, plasmonic properties and applications", SPIE (2021) (Oral)
12. **D. Garoli**, "Mirrors for space telescopes: degradation issues", SPIE (2021) (Oral)
13. **D. Garoli**, "Protein-Tailored Plasmonic Silver Nanorings over Graphene-Coated Nanopores for Localized Enhanced Fluorescence", META2021 – **Invited talk**
14. **D. Garoli**, "Ultrahigh sensitivity SERS detection of DNA and protein translocating through a plasmonic nanopores", SPIE Photonics Europe paper nr. [12131-63] (7 April 2022) (Oral)
15. **D. Garoli**, "Nanoporous metals, plasmonic properties and applications", Workshop and Topical Meeting Novel Optical Materials and Applications NOMA (27 May 2022) (Oral)
16. **D. Garoli**, "Directional plasmonic excitation by helical nanotips", META 2022 (July 2022)
17. **D. Garoli**, Single Protein Sequencing meeting, **Invited Talk** (2022)
18. **D. Garoli**, "Nanoporous metals, principle and applications" NANO22 - World Congress on Nanotechnology 2022
19. (Webinar), **Invited Talk** (2022)
20. **D. Garoli**, "High-Frequency Light Rectification by Nanoscale Plasmonic Conical Antenna in Point-Contact-Insulator-Metal Architecture," **Invited Oral** presentation. SPIE 27 April 2023.
21. **D. Garoli**, "Fabrication of metallic nanopore arrays via plasmonic photochemistry", Oral presentation SPIE 25 April 2023)
22. **D. Garoli**, "Enhanced Optical Spectroscopy for single molecule detection with Plasmonic Nanopores: Challenges and Prospects" nanoGUNE seminar - Donostia - San Sebastian Date, April 2023, **invited Seminar**
23. **D. Garoli**, "Solid-state nanopores modified with aptamers. A platform towards highly specific single-molecule detection" Workshop "DNA:RNA:Protein Nanotechnology - Munich, July 2023, **invited talk**

Service to scientific community:

2018 • META18 meeting – **Session chair and organization committee**, June (EU)
 2021 • META21 meeting – **Session chair and organization committee**, July (EU)

2022 • META22 meeting – Session chair and organization committee, July (EU)
 2023 • META23 meeting – Session chair and organization committee, July (EU)
 2017 • International conference Plasmonica 2017 – Genova Italy – **Session chair and organizer committee**
Expert reviewer for: European Commission “COFOUND - Marie-Curie” and HFSP projects
Reviewer for: Opt. Lett., Opt. Express, ACS Photonics, Nano Letters, J. Opt. Soc. Am. A & B, J. Phys. A, J. Opt., Phys. Lett. A, Opt. Commun., Nature Comm., etc. (<https://publons.com/researcher/1581928/denis-garoli/peer-review/>)
Associate Editor for MDPI Applied Science
Guest Editor for Special Issue: “Nanopore Technology for Single Molecule Detection” – MDPI Materials (https://www.mdpi.com/journal/materials/special_issues/Single_Molecul)
Guest Editor for Special Issue: “Nanomaterial-Based Biosensors for Point-of-Care Diagnostics” – MDPI Biosensors (https://www.mdpi.com/journal/biosensors/special_issues/A8386Q51YXI)
Guest Editor for Special Issue: “Advances in Nanopore Technology” – Frontiers in Nanotechnology (<https://www.frontiersin.org/research-topics/15551/advances-in-nanopore-technology>)
Associate Editor: Frontiers in Chemistry - Nanoscience

Prize and funding

- 2005. Award “Veneto Innovazione 2005”, first place in the category “best collaboration between industry and researchers”
- 2015. H2020 FET Open (id 687089) ProseqO. Co-coordinator role in IIT and AbAnalitica. Leader of several tasks and WPs.
- 2011. Cariplo Foundation Italian Project “SE-CARS”. Budget 200 kEuro. Partner role.
- 2019. Not funded MSCA proposal 842507 – HYPER received the Marie Skłodowska-Curie Actions Seal of Excellence (scored 88%)
- 2020. H2020 FET Open DNA-Fairylight. Coordinator role.
- 2022. Horizon EU – Marie Curie Doctoral Network – DYNAMO – Coordinator role.
- 2022. Horizon EU – Pathfinder Open 3D-BRICKS. Coordinator role

Supervising and mentoring activities.

- 2009. Supervisor of master degree students
- 2016 – 2022. Supervisor of Phd students (*P. Ponzellini* – graduated in 2019 – 7 co-author papers; *E. Calandrini* – graduated in 2018 – 10 co-author papers; *G. Lanzavecchia* – 2 co-author papers; *A. Doricchi* – 2 co-author papers) and Post-docs (*X. Zambrana-Puyalto* – 100% - 4 co-author papers; *G. Giovannini* – 50% - 8 co-author papers; *M. Ardini* – 100% - 2 co-author papers; *M. Mousavi* – 100% - 2 co-author papers; *I. Huang* – 50% - 3 co-author papers; *N. Maccaferri* – 50% - 10 co-author papers) within ProseqO H2020 project.

Major Collaborations.

- CICnanoGUNE – Prof. P. Vavassori
- University of Barcelona – Prof. F. Ritort
- University of Ariel (Israel) – Prof. Y. Gorodetski
- EPF-Ecole d'Ingénieurs (Faculty of Engineering), Sceaux, France – Prof. G. Barbillon
- Chinese Univ. of Hong Kong (CUHK) – Prof. G. Lu
- Nanjing University (China) – Prof. X. Zhang
- Institut Fresnel CNRS (France) – Prof. J. Wenger
- Luxemburg University – Dr. N. Maccaferri
- University of Boston – Prof. M. Wanunu
- University of Rome – Prof. M. Ortolani
- University of Padova – Prof. S. Agnoli
- University of Friburg – Prof. G. Acuna

Industrial Innovation.

- Collaborations with small and medium enterprises in Italy and EU allowed the definition of some proposals

submitted to European Community to access to grants. In 2015 get a grant worth 370kEuro for Alacris Theragnostic (Germany) and 360kEuro for AbAnalitica (Italy). With both these companies he's still collaborating from the scientific and R&D/commercial points of view. In 2020 get a grant worth 190kEuro for 2Elements (Italy), 190kEuro for AbAnalitica (Italy) and 200kEuro for DNAScript (France). With these companies he's still collaborating from the scientific and R&D/commercial points of view.

Patent.

- Patent (Application : 102019000000895) "Metodo e dispositivo per il riconoscimento ottico di molecole" (inventors Francesco De Angelis, Denis Garoli, Walter Rocchia, Andrea Spitaleri, Niko Hildebrandt, Dino Paladin, Moritz Schuette, Hans Rudolf Lehrach – collaboration within H2020 FET Open project)