
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
**DOTTORATO DI RICERCA / PhD PROGRAM IN
INFORMATION TECHNOLOGY AND ELECTRICAL ENGINEERING**

Activities and Publications Report

PhD Student: **Maria Alessandra Cutolo**

Student DR number: DR995133

PhD Cycle: XXXVI

PhD Cycle Chairman: Prof. Stefano Russo

PhD program student's start date: 01/11/2020

PhD program student's end date: 31/10/2023

Supervisor: Prof. Giovanni Breglio

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Co-supervisor: Prof. Andrea Cusano

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Co-supervisor: Prof. Marco Pisco

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PhD scholarship funding entity: No scholarship.

General information

Maria Alessandra Cutolo received in year 2019 the Master Science degree in Electronic Engineering from the University of Napoli Federico II. She attended a curriculum in Electronic Engineering within the PhD program in Information Technology and Electrical Engineering. She did not receive a scholarship.

Study activities

Attended Courses

| Year | Course Title | Type | Credits | Lecturer | Organization |
|-----------------|---|--------|---------|--|--------------|
| 1 st | How to Boost your PhD | course | 3 | Prof. Marino | unina |
| 1 st | Nanotechnologies for electrical Engineering | course | 6 | Prof. Forestiere | unina |
| 1 st | Circuiti e sistemi elettronici per applicazioni biomedicali | course | 9 | Prof. M.Riccio | unina |
| 2 nd | Imprenditorialità Accademica, Prof. P. Rippa | course | 4 | Prof. P. Rippa | unina |
| 2 nd | Matrix Analysis for signal processing with matlab examples. Carotenuto, Aubry, De Maio. | | 2 | Prof. Carotenuto, Prof. Aubry, Prof. De Maio | unina |

Attended PhD Schools

| Year | School title | Location | Credits | Dates | Organization |
|-----------------|--|----------|---------|----------------------|---|
| 2 nd | IV Scuola Nazionale Biosensori Ottici e Biofotonica, | Ischia | 4 | 06/05/22 To 10/05/22 | Ambra Giannetti, Maria Grazia Manera, Ilaria Rea, Genni |
| 2 nd | Ci-Lam summer school | | 4 | 07-22 to 22-07-22 | Prof. Breglio |
| 2 nd | SIE Phd school | | 4 | 5-09-22 to 7-09-22 | - |

Attended Seminars

| Year | Seminar Title | Credits | Lecturer | Lecturer affiliation | Organization |
|-----------------|-----------------------------|---------|---------------|----------------------|------------------------------|
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |

Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXVI Cycle

PhD candidate: Maria Alessandra Cutolo

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|-----------------|---|-----|--|---|------------------------------|
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.4 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.4 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Designing a Socially Assistive Robot for adaptive and personalized assistance to patients with dementia | 0.2 | Prof. Rossi | - | - |
| 1 st | “Telemedicina e-health e <> si può davvero usare il digitale nel percorso assistenziale?” | 0.6 | Prof. Scalvini | - | - |
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.4 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 1 st | Scientific Colloquia at SSM | 0.3 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 2 nd | Cyber security in Akka Technologies. Prof. D. Cotroneo, Prof. S.P. Romano, Dr. R. Natella. 04/11/2021 | 0.4 | Prof. D. Cotroneo, Prof. S.P. Romano, Dr. R. Natella | - | - |
| 2 nd | Exploring the early Universe through the cosmic microwave background. Ing. Coraggio . 04/11/2021 | 0.4 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 2 nd | POWER-LAW GELS, SCOTT-BLAIR AND THE FRACTIONAL CALCULUS OF SOFT MULTI-SCALE MATERIALS, Gareth H. McKinley, 05/05/22 | 0.3 | Gareth H. McKinley | - | - |
| 2 nd | An informal discussion around stochastic control and free boundary problems, Tiziano De Angelis, 12/05/22 | 0.3 | Tiziano De Angelis | - | - |

Activities and Publications – Final Report

UNINA PhD in Information Technology and Electrical Engineering – XXXVI Cycle

PhD candidate: Maria Alessandra Cutolo

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|-----------------|---|-----|-------------------------|-------|------------------------------|
| 2 nd | 5G Networks in action – The private mobile era, Prof. Antonia Tulino, 11/05/22 | 0.4 | Prof. Antonia Tulino | UNINA | University of naples |
| 2 nd | Carbon Footprint and Carbon Neutrality Prof. Antonia Tulino, 16/05/22 | 0.3 | Prof. Antonia Tulino | UNINA | University of naples |
| 2 nd | Fixed Wireless Access, Prof. Antonia Tulino, 17/05/22 | 1 | Prof. Antonia Tulino | UNINA | University of naples |
| 2 nd | BASICS OF QUANTUM THEORY, Prof. Antonia Tulino, 18/05/22 | 0.4 | Prof. Antonia Tulino | UNINA | University of naples |
| 2 nd | Explainable Natural Language Inference, Prof. Francesco Cutugno, 1hour and half. 13/04/22 | 0.3 | Prof. Francesco Cutugno | UNINA | University of naples |
| 3 rd | Quantum Complexity, SCIENTIFIC COLLOQUIA AT SSM | 0.2 | Ing. Coraggio | - | Scuola Superiore Meridionale |
| 3 rd | Entangled relativity, SCIENTIFIC COLLOQUIA AT SSM, | 0.2 | Ing. Coraggio | - | Scuola Superiore Meridionale |

Research activities

During the three years of the course, Dr Maria Alessandra Cutolo worked actively on the issues related to her doctoral path. The research focused on the design, development and characterization of hierarchical structures for SERS applications. Through the use of the Comsol numerical simulator, Maria Alessandra Cutolo carried out a study of a large set of structures based on nano-spheres, analyzing the operation and performance, managing to identify the optimal structure. A parallel study was carried out to confirm the influence of polarization, the stabilization of the model, the variability of results induced by small variations in geometry. Once identified it was manufactured using two different techniques. They were manufactured at SCITEC in Milan. The above structures were then characterized by Dr Maria Alessandra Cutolo from the morphological, spectral and performance SERS. As part of the project MAIA in collaboration with the University of Sannio, carried out a state-of-the-art study on the identification of vibration monitoring enabling technologies for assessing the safety status of a railway infrastructure. In particular, the study focused on fiber optic sensors suitable for detecting vibrations in soils and that have miniaturized dimensions and high sensitivity. Particular attention was paid to the study of sensors based on Fabry-Perot interferometers. In this regard, a numerical model has been developed to design and study the response of such sensors in the presence of acoustic waves, analyzing the effect of the curvature of the Fabry-Perot and evaluating both acoustic and electromagnetic response. As part of the NEON project she was involved. As part of the Neon project, Dr.M.A.Cutolo has been involved in the study and testing of sensors for nano-photonics for new diagnostic and therapeutic approaches in Oncology and Neurology.

Tutoring and supplementary teaching activities

| PhD Year | Courses | Seminars | Research | Tutoring / Supplementary Teaching |
|-----------------|-----------|------------|------------|-----------------------------------|
| 1 st | 23 | 5 | 35 | |
| 2 nd | 18 | 3.8 | 45 | |
| 3 rd | 0 | 0.4 | 60 | |
| Totale | 41 | 9.2 | 140 | |

Research periods in institutions abroad and/or in companies

| PhD Year | Institution / Company | Hosting tutor | Period | Activities |
|-----------------|-----------------------|---|---------------------|--|
| 1 st | - | - | - | - |
| 1 st | - | - | - | - |
| 2 nd | | | | |
| 3 | IHP | Host (PI): Dr. Costanza Lucia Manganelli Host (Head of Department): Prof. Dr. Christian Wenger | 1/06/23 to 31/08/23 | <i>During the months of activity, the efforts towards a preliminary study of the theoretical model at the base of the principle of operation of a nanoantenna array was turned. In particular, the numerical model of a sensor based on an array of nanotriangles with hexagonal symmetry was studied. The numerical model was performed using the Comsol simulator. The structure was analyzed considering an array of Titanium Nitride, a CMOS-compatible material, fabricated on a silica layer on top of a silicon layer. Ellipsoidal measurements at IHP-Leibniz-Institute provided the refractive index of Titanium Nitride, used as input for the simulator. As a first step of the simulated activity, the model was stabilized. A deep insight into the boundary conditions, mesh, and domain size was provided to observe their impact on the calculated electromagnetic. The core of the simulated activity includes a parametric analysis of frequency, size of nanotriangles, thickness of nanotriangles and incident, and polarization angle. The added value of the entire activity is represented by a constant comparison between calculated reflectivity and experimental reflectivity obtained through FTIR (Fourier-transform infrared spectroscopy). Meanwhile, The IHP was supported by the WIAS institute, which provided a consultancy for modeling silicon carriers' transport properties when subjected to an electromagnetic field.</i> |

PhD Thesis

The PhD thesis deals with the study of the creation of self-assembled SERS-active substrates, that is, hierarchical plasmonic structures of nanospheres. The numerical study allows to analyze, through Comsol simulator, different aspects of SERS substrates: stability of the model, influence of geometric parameters, influence of polarization, and influence and performance of plasmonic and non-plasmonic materials. Numerical analysis is carried out to predict SERS and to identify the most promising configurations, offering design criteria and a physical understanding of the conditions that affect the SERS response of self-assembled substrates. Alternative self-assembled manufacturing methods, co-deposition and sequential deposition, were used to make HSN. Following is carried out a morphological and performance analysis (through SERS measurements) that have revealed the formation of well-ordered hierarchical structures, uniform and with SERS characteristics such as to define them more performing than the classic simple nano-configurations spheres. Confirming are not the performance predictions made during numerical analysis but also identifying substrates usable for SERS applications.

Research products

Research results regarding the thesis were presented in 3 lectures and a paper is in submission.

List of scientific publications

- **Authors:** M. A. Cutolo , F. Galeotti, S. Spaziani, G. Quero, V. Calcagno, A. Micco, A. Irace, G. Breglio, M. Pisco, A. Cusano. **Title:** Self Assembled Hierarchical nanostructures: Towards Engineered SERS active platform. *Under submission.*
- **Authors:** Maria Alessandra Cutolo, Giovanni Breglio **Title:** Interferometric Fabry-Perot sensors for ultrasound detection on the tip of an optical fiber, Results in Optics, ISSN 2666-9501, <https://doi.org/10.1016/j.rio.2021.100209>.
- **Authors:** Maria Alessandra Cutolo, Antimo Migliaccio, Lucia Altucci, Antonello Cutolo, Andrea Cusano **Title:** On the Possibility of a Microwave Approach for Rooms and Objects Sterilization. J Clin Case Stu 6(4): dx.doi.org/10.16966/2471-4925.230
- **Authors:** Maria Alessandra Cutolo, Carlo Cafiero, Luigi Califano, Martino Giaquinto, Andrea Cusano, Antonello Cutolo **Title:** Feasibility analysis of an ultrasound on line diagnostic approach for oral and bone surgery. Sci Rep 12, 905 (2022). <https://doi.org/10.1038/s41598-022-04857-0>
- **Authors:** Antonello Cutolo, Angelo Rosario Carotenuto, Maria Alessandra Cutolo, Arsenio Cutolo, Martino Giaquinto, Stefania Palumbo, Andrea Cusano, Massimiliano Fraldi. **Title:** Ultrasound waves in tumors via needle irradiation for precise medicine. Sci Rep 12, 6513 (2022). <https://doi.org/10.1038/s41598-022-10407-5>
- **Authors:** Maria Alessandra Cutolo, Antimo Migliaccio, Lucia Altucci, Antonello Cutolo, Andrea Cusano. **Title:** An Innovative High Frequency Hyperthermia Approach against SARS-Cov-2 and Related Virus: Feasibility Analysis. Archives of Clinical and Biomedical Research 5 (2021): 421-432.
- **Authors:** Sofia Principe, Martino Giaquinto, Alberto Micco, Maria Alessandra Cutolo, Michele Riccio, Giovanni Breglio, Andrea Irace, Armando Ricciardi, Andrea Cusano. **Title:** Thermo-plasmonic lab-on-fiber optodes, Optics & Laser technology, Volume 132, 2020, 106502, ISSN 0030-3992, <https://doi.org/10.1016/j.optlastec.2020.106502>.
- **Authors:** Barbara Rossi, Maria Alessandra Cutolo, Martino Giaquinto, **Title:** Advanced Lab-on-Tip ultrasound detectors: A numerical analysis, Results in Optics, Volume 9, 2022, 100312, ISSN 2666-9501, <https://doi.org/10.1016/j.rio.2022.100312>.
- **Authors:** Aldo Minardo, Romeo Bernini, Gaia Maria Berruti, Giovanni Breglio, Francesco Antonio Bruno, Salvatore Buontempo, Stefania Campopiano, Ester Catalano, Marco Consales, Agnese Coscetta, Andrea Cusano, Maria Alessandra Cutolo, Pasquale Di Palma, Flavio Esposito, Francesco Fienga, Michele Giordano, Antonio Iele, Agostino Iadicicco, Andrea Irace, Mohammed Janneh, Armando Laudati, Marco Leone, Luca Maresca, Vincenzo Romano Marrazzo, Marco Pisco, Giuseppe Quero, Michele Riccio, Anubhav Srivastava, Patrizio Vaiano, Luigi Zeni, Antonello Cutolo. **Title:** Innovative photonic sensors for safety and security, Part I: Fundamentals, Infrastructural and ground transportations, Sensors. 2023; 23(5):2558. <https://doi.org/10.3390/s23052558>
- **Authors:** Antonello Cutolo, Romeo Bernini, Gaia Maria Berruti, Giovanni Breglio, Francesco Antonio Bruno, Salvatore Buontempo, Ester Catalano, Marco Consales, Agnese Coscetta, Andrea Cusano, Maria Alessandra Cutolo, Pasquale Di Palma, Flavio Esposito, Francesco Fienga, Michele Giordano, Antonio Iele, Agostino Iadicicco, Andrea Irace, Mohammed Janneh, Armando Laudati, Marco Leone, Luca

Maresca, Vincenzo Romano Marrazzo, Aldo Minardo, Marco Pisco, Giuseppe Quero, Michele Riccio, Anubhav Srivastava, Patrizio Vaiano, Luigi Zeni, Stefania Campopiano. **Title:** Innovative Photonic Sensors for Safety and Security, Part II: Aerospace and Submarine Applications, Sensors. 2023; 23(5):2417. <https://doi.org/10.3390/s23052417> .

- **Authors:** Giovanni Breglio, Romeo Bernini, Gaia Maria Berruti, Francesco Antonio Bruno, Salvatore Buontempo, Stefania Campopiano, Ester Catalano, Marco Consales, Agnese Coscetta, Antonello Cutolo, Maria Alessandra Cutolo, Pasquale Di Palma, Flavio Esposito, Francesco Fienga, Michele Giordano, Antonio Iele, Agostino Iadicicco, Andrea Irace, Mohammed Janneh, Armando Laudati, Marco Leone, Luca Maresca, Vincenzo Romano Marrazzo, Aldo Minardo, Marco Pisco, Giuseppe Quero, Michele Riccio, Anubhav Srivastava, Patrizio Vaiano, Luigi Zeni, Andrea Cusano **Title:** Innovative Photonic Sensors for Safety and Security, Part III: Environment, Agriculture and Soil Monitoring, Sensors. 2023; 23(6):3187. <https://doi.org/10.3390/s23063187> .

Patents and/or spin offs

1. **Title:** Barcodes and QRcodes for a low cost wireless sensor for structural monitoring, medical and environmental. **Application number:** 10202000003479 . **Date of submission:** 20/02/2020. **Authors:** Cutolo Antonello, Cusano Andrea, Iele Antonio, Bruno Francesco, Cutolo Maria Alessandra
2. **Title:** Innovative in-line control system for drills for bone and hard tissue drilling. **Application number:** 10202000003494. **Date of submission:** 20/02/202. **Authors:** Califano Luigi, Cafiero Carlo, Cusano Andrea, Cutolo Antonello, Giaquinto Martino, Cutolo Maria Alessandra.

Awards and Prizes

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Date 16/10/23

PhD student signature



Supervisor signature


