
Affiliation

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Educations

2018-2021 Ph.D. in Physics (Optics)
University of Naples Federico II, Naples, Italy
Thesis title: Vector field patterning of light: Methods and applications.
Supervisor: Prof. Lorenzo Marrucci.

2013-2016 M.Sc. in Photonics
Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran.
Thesis title: Generation of light carrying orbital angular momentum using optical fibers.
Supervisor: Dr. Rahman Nouroozi.

2008-2012 B.Sc. in Physic
Isfahan University of Technology (IUT), Isfahan, Iran.
Thesis title: Studying and coating of manganese nano ferrite by spin coating method.
Supervisor: Dr. Parviz Kameli.

Research Experiences

Post-doc “Optical and Electrical Characterization of Flame-Formed Carbon Nanoparticles”-CNR-STEMS: 18/05/2022 to 18/11/2023

Due to their exceptional physical, mechanical, chemical, thermal, and optical properties Carbon nanoparticles (CNPs) have received a lot of interest in science and industries. In fact, Nano-sized carbon elements can be created through various methods including carbonization, heating, activation, and grinding. Additionally, combustion-generated carbon

particles and nanoparticles have attracted huge attention in the past and present for a wide range of uses. They found their applications in a variety of biomedical and research projects such as sensing, energy storage, and optoelectronics due to their low toxicity of carbon and a readily available supply. Hence, we focused on tailoring the properties of flame-formed carbon nanoparticles (CNPs) to fit them for applications. Here, our interests lie in the combustion-generated CNPs. In fact, different types of carbonaceous particles, ranging from organic carbon nanoparticles with average sizes of a few nanometers to soot particles in the form of chain-like aggregates of primary spherical particles, can be generated depending on flame conditions. Therefore, our approach is to synthesize carbon nanomaterial devices by deposition (thin film) of a proper amount of material (to obtain desired thickness) of flame-formed carbon nanoparticles on a substrate.

CNPs were produced in a lightly sooting laminar-premixed ethylene/air flame stabilized on a McKenna burner. The selected flame configuration allows the production of carbon nanoparticles of different sizes (from a few up to tens of nanometers) and different physicochemical properties. Later, we performed electrical, optical, and structural characterization of the collected CNPs and CNP film, the latter by Raman spectroscopy to understand the properties and applications of the produced nanostructured thin film. In the specific case of sensing applications, we investigated the implementation of CNPs in gas (ethanol) and temperature sensing. As the need to use gases in different technologies and industries has increased, the demand to monitor and control them has attracted huge attention as well. Therefore, we simply benefit from flame-made CNPs to fabricate ethanol sensors. When it comes to energy storage devices, carbon nanoparticles can play a role in improving and miniaturizing the device. Therefore, we studied the possibility of using these thin films as supercapacitors by applying high amount of ethanol to our CNP thin films.

In general, based on the desired application, we can change the deposited material and customize the additive material on the CNPs thin films.

Furthermore, in collaboration with Istituto Nazionale di Astrofisica (INAF), we are currently studying the effect of superhydrogenation on these carbonaceous materials through UV-Vis and Infrared spectroscopy.

Ph.D.

“Vector Field Patterning of Light: Methods and Applications”-University of Naples, Federico II: 01/01/2018 to 10/09/2021

As modifying and controlling the polarization and amplitude of light have many applications, my research centered on beam tailoring (wavefront shaping and polarization manipulation) using Spatially Varying Axis Plates (SVAPs). We experimentally showed the possibility of field patterning and hence generation of polarization singularities such as lemon, star and the rarest one, monstar. To obtain our aim, we proved that a properly designed SVAP results in generation of desired wavefront and polarization structure. These polarization singularities were characterized using a spatially-resolved polarimetric system and have applications in quantum and classical Physics from communications to astronomy.

In addition, we reported a theoretical application for a q-plate (the most common

form of SVAP) to improve the coupling efficiency in single-mode step index high contrast Nanofibers by amplitude and polarization manipulation. We proved that we could achieve the highest possible efficiency using this technique via wavefront shaping. The result can have promising applications in quantum and classical regimes. To achieve the goal, we used a helical beam generated by a properly designed q-plate attached at the fiber facet to match the polarization structure of the input beam to the fundamental mode of the optical fiber HE_{11} . Moreover, we have shown that there can be an optimized input amplitude for scalar mode matching. We have also demonstrated that as the refractive index contrast between core and cladding of the fiber increases, the polarization matching becomes the dominant effect. In this way, I enhanced my knowledge on optical fibers (especially nanofibers), wavefront shaping, and Nano Optics. Throughout this research, I learnt to write code and do simulations with Python and Mathematica.

M.Sc.

“Generation of Light Carrying Orbital Angular Momentum Using Optical Fibers”- Institute for Advanced Studies in Basic Sciences (IASBS)

We experimentally generated the light carrying orbital angular momentum with a new method by using optical fiber polarization controllers. These kinds of beams have helical wave front. The light beam carrying orbital angular momentum (OAM) was generated using a phase difference between two guided polarized orthogonal modes (Hermit- Gaussian HG_{10} and HG_{01}) in a fiber. The phase difference was achieved with an external stress applied to the fiber using two kinds of optical fiber polarization controllers (inline and a 3-paddle). The advantage of using this method is that we could control also the polarization state of the output beam.

The first order fork pattern obtained from interference between the beam and plane wave showed the generation of beam carrying the OAM with $l=1$ topological charge.

B.Sc.

“Studying and Coating of Manganese Nano Ferrite by Spin Coating Method”- Isfahan University of Technology (IUT)

We aimed at studying the crystalline structure of manganese Nano ferrite and coating it on a silica substrate. Therefore, first, the substance ($MnFe_2O_4$) was synthesized. Then, it was coated on the silica substrate by spin coating technique. Next, it was exposed to X-ray. In the next step, the obtain graph from X-ray exposure was analyzed. The peak in the graph indicated the crystalline structure of our substance.

Workshops and Conferences

15-18 Feb. 2015

Workshop on Structured Waves: Concepts and Applications in Modern Physics, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran, 15-18 February 2015.

26-28 Jan. 2016	22nd Iranian Conference on Optics & Photonics & 8th Conference on Photonics Engineering and Technology, Yazd university, Yazd, Iran, January 26- 28, 2016.
17-23 Sep. 2016	IASBS-ICTP International Workshop on Structured Light and Matter: Concepts and Applications, Institute for Advanced Studies in Basic Sciences (IASBS), Zanjan, Iran, 17-23 September, 2016.
3-7 Sep. 2018	Advanced School on Theories and Applications of Liquid Crystals, Naples, Italy, 3-7 September 2018.
10-21 Feb. 2020	Winter College on Optics: Quantum Photonics and Information, ICTP, Trieste, Italy, 10-21 Feb. 2020.
5-8 June 2022	44th Meeting of The Italian Section of the Combustion Institute - Combustion for Sustainability, Naples, Italy, 5-8 June 2022

Publications and Posters

Posters

1. “Generation of the light carrying orbital angular momentum using an in-line optical fiber polarization controller”, **P. Darvehi**, R. Nouroozi, 22nd Iranian Conference on Optics & Photonics & 8th Conference on Photonics Engineering and Technology, Yazd university, January 26-28, 2016, Yazd, Iran.
2. “Generation of the light carrying orbital angular momentum using in-line and 3-paddle optical fiber polarization controllers”, **P. Darvehi**, R. Nouroozi, IASBS-ICTP International Workshop on Structured Light and Matter: Concepts and Applications, Institute for Advanced Studies in Basic Sciences (IASBS), 17-23 September, 2016, Zanjan, Iran.
3. “Polarization effect in dielectric optical fibers: Vector mode matching”, **P. Darvehi**, R. Barboza, A. Babazade, L. Marrucci., Winter College on Optics: Quantum Photonics and Information, ICTP, 10-21 Feb. 2020, Trieste, Italy.
4. “Electrical Properties of Flame-Formed Carbon Nanoparticles”, **P. Darvehi**, F. Migliorini, M. Commодо, R. Dondè, S. De Iuliis, P. Minutolo, A. D’Anna, 44th Meeting of The Italian Section of the Combustion Institute - Combustion for Sustainability, 5-8 June 2022, Napoli, Italy.
5. “Flame-Formed Carbon Nanoparticles for Sensing and Capacitive Applications”, **P. Darvehi**, P. Minutolo, A. D’Anna, M. Commодо., 11th European Combustion Meeting (ECM 2023), 26-28 April 2023, Rouen, France.
6. “Electric field-assisted flame synthesis of Carbon Nanoparticles films”, A. Parisi, **P. Darvehi**, G. De Falco, M. Sirignano, P. Minutolo, M. Commодо, B. Apicella, C. Russo, R. Griffo, C. Carotenuto, F. Di Natale, European Aerosol Conference (EAC2023), 3-8 September 2023, Malaga, Spain.

Publications

1. “Increasing the topological diversity of light with modulated Poincaré beams”, **Darvehi, P.**, Vicuña-Hernández, V., Marrucci, L., Piedipalumbo, E., Santamato, E., & Piccirillo, B. *Journal of Optics* 23, no. 5 (2021): 054002.
2. “Device for generating modulated Poincaré beams”, **Darvehi, P.**, Vicuña-Hernández, V., Marrucci, L., Piedipalumbo, E., Santamato, E., & Piccirillo, B., *Proceeding: OSA Optical Design and Fabrication Congress*, 27 June - 01 July 2021
3. “Engineering monstar polarization disclination through geometric phase”, Vicuña-Hernández, V. **Darvehi, P.**, Marrucci, L., Piccirillo, B, *arXiv preprint arXiv: 2208.03472*
4. “Spatial mode analysis of optical beams carrying monstar disclinations “, Vicuña-Hernández, V., Cardano, F., **Darvehi, P.**, Marrucci, L., Rubano, A. and Piccirillo, B., *Journal of Optics*. 2023

Submitted

1. “Tailoring the temperature coefficient of resistance of flame-formed carbon nanoparticles thin films by electric fields assisted deposition”, Parisi, A., **Darvehi, P.**, De Falco, G., Sirignano, M., Commoco, M., di Natale, F., Minutolo, P., *Fuel Processing Technology*, 2023
2. “Application of flame-formed carbon nanoparticle films for ethanol sensing” **Darvehi, P.**, Basta, L., Commoco, M., Minutolo, P., D’Anna, A. *Particuology*, November 2023.

In Preparation

- 1.”Flame-formed composite carbon nanoparticle thin films for supercapacitive applications”,**Darvehi, P.**, De Falco, G., Commoco, M., Minutolo, P. , D’Anna, A.
2. “Infrared spectroscopy of superhydrogenated carbon nanoparticles”, **Darvehi, P.**, Cozzolino, F., Basta, L., Commoco, M., Minutolo, P. , D’Anna, A. Mennella, V.
3. “Polarization effects in single mode step index fibers: Vector mode matching”, **Darvehi, P.**, Barboza, R., Babazade, A., Marrucci, L.

Awards and Honors

- The best poster presentation in “Winter College on Optics: Quantum Photonics and Information”, ICTP, Trieste, Italy, 10-21 Feb. 2020.

Research area

- Optical Fibers
- Orbital Angular Momentum of Light
- Structured light
- Polarization Singularities
- Wave-front shaping
- Polarization manipulation
- Vector field patterning of light
- Nano-optics (Nanofibers)
- Carbon nanoparticles
- Carbon based sensors
- Spectroscopy
- Electro-optical measurements
- Electro-chemical characterization

Research interests

- Quantum Optics
- Nano Optics
- Photonics Crystals
- Nonlinear Optics
- Integrated Optics
- Optical fibers
- Structured Light
- Lab-on-chip
- Semiconductors
- Carbon nanoparticles
- Electronics
- Supercapacitors
- Sensors

Computer Skills

Scientific software

Python
Mathematica
Zemax
Blender
Opus

Others	Microsoft Office Latex Windows Photoshop
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Languages

Persian	Native
English	I can speak and write fluently
Italian	Intermediate
French	Elementary

Work Experiences

Teaching	I worked as a Physics tutor for high school students from 2011-2015, Iran.
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Translating	I have the experience of translating English texts into Persian from 2015-2016.
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Academic Services

- Journal reviewer for “Optics Express” and “Photonics Research”

Responsibilities

- Being engaged in ICTP organizer committee as an interpreter.
- Being the organizer of Ph.D. students workshop 2020 (Physics Department of the University of Naples, Federico II).
- Being co-supervisor of master students.

References

Prof. Lorenzo Marrucci

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Prof. Bruno Piccirillo

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signature

