Curriculum Vitae

PERSONAL INFORMATION

Surname		**Fortunato**
Name		**Marco**
Telephone		**+39 0644585635**
Qualification		**PhD**
E-mail		**marco.fortunato@uniroma1.it**
Nationality		Italian
Date of birth		10/24/1988

• Fixed-term Assistant Professor (RTD)		**Department of Astronautical, Electrical and Energy Engineering, Sapienza University of Rome**
• Title		Development and characterization of graphene-polymer nanocomposites for electromagnetic shielding, sensing and energy harvesting applications
• Date (from – to)		1 April 2020 – today
• Name and type of organisation providing education and training		University of Rome La Sapienza, Piazzale Aldo Moro 5, 00185, Rome, Italy

• Post-doc		**Department of Astronautical, Electrical and Energy Engineering, Sapienza University of Rome**
• Title		Sviluppo di coating piezoresistivi multistrato a base di vernici caricate con grafene con proprietà di schermatura elettromagnetica desiderate
• Date (from – to)		1 December 2018 – 31 March 2020
• Name and type of organisation providing education and training		University of Rome La Sapienza, Piazzale Aldo Moro 5, 00185, Rome, Italy
Duration of the program of study		1 year and 4 months
• Research activity		Development and optimization of the production and characterization processes, trough mechanical, electrical and electro-mechanical measurements of two different piezoresistive sensors: - pressure sensors, to develop smart wearable sanitary devices, based on polymeric foam: PDMS and Ecoflex®, loaded with graphene nanoplatelets (GNPs); - water-based polyurethane paint strain sensors, for structural health monitoring, modified through the use of graphene nanoplatelets (GNPs).

Teaching		• Master lesson “Rischi ed Opportunità Connessi all’uso delle Nanotecnologie e delle Tecnologie Abilitanti” (cod. 30167) titled “Rischi ed opportunità Connessi all’uso delle Nanotecnologie: Materiali, Processi e Principali Applicazioni” for the academic year 2018-2019. • Assistant at the Electrotechnics course for the degree in Aerospace Engineering A.A. 2018-2019 through: - Student support and tutoring activities; - Exercises on single-phase and three-phase circuits in a periodic sinusoidal regime; - Support, supervision and surveillance during the written tests. • Assistant at the “Micro-Nano sensors and actuators laboratory” for the master degree in Engineering of Nanotechnology A.A. 2018-2019 trough: - Laboratory experiences on the production of polymer-based piezoresistive pressure sensors loaded with graphene nanoplatelets (GNPs). • Co-tutor of PhD student Irene Bellagamba, cycle XXXIV, PhD topic : “Sviluppo e caratterizzazione di vernici e film polimerici nanostrutturati e metodologie di prevenzione del rischio d’esposizione a nanomateriali ingegnerizzati”.

Education and training

• PhD		**Electrical, Materials and Nanotechnology Engineering**
• Title of the thesis		Production and Characterization of ZnO/Graphene Devices for Energy Harvesting
• Date (from – to)		1 November 2015 – 30 November 2018
• Name and type of organisation providing education and training		University of Rome La Sapienza, Piazzale Aldo Moro 5, 00185, Rome, Italy
Duration of the program of study		3 years
Qualification date		02/22/2019
Classification		**With honors**
Supervisor		Prof. Maria Sabrina Sarto
• Thesis Summary		Different types of innovative highly performing piezoelectric nanomaterials and nanocomposites: zinc oxide nanostructures (ZnO-NRs and ZnO-NWs) and polyvinylidene fluoride (PVDF) nanocomposites films have been synthesized and characterized for energy harvesting application. In order to evaluate the piezoelectric properties of the produced materials, a novel approach to quantitatively evaluate the effective piezoelectric coefficient d_{33}, trough Piezoresponse Force Microscopy (PFM), has been developed. PFM is one of the most widely used techniques for the characterization of piezoelectric materials at nanoscale, since it enables the measurement of the piezo-displacement with picometer resolution. In particular, in order to have a quantitative information on the d_{33} a calibration protocol was developed. Flexible nanogenerators were also fabricated based on PVDF and adopting flexible electrodes based on bilayers consisting of graphene-gold layers. The nanogenerators were tested measuring the piezoelectric response using a commercial mini-shaker. The device was successfully operated and a value of 9.00 pm/V was measured.
• Courses followed during the PhD		Electric and Electromagnetic Design of Micro-Nano Devices; Micro Electromechanical System and Laboratory; Microscopy and Nanocharacterization techniques; Manufacturing Technologies of Nanostructures and Self-assembly Processes.
• Awards		**Winner of the Avvio alla Ricerca project 2017-2018**
• Title		Realization and characterization of nanogenerators based on nano-composites polymeric matrix and nanostructures of zinc oxide and graphene nanoplatelets.

• Master's degree		**Condensed Metter Physics**
Title		**Development and characterization of photovoltaics devices in Cu_2ZnSnS_4 (CZTS)**
• Date (from – to)		March 2012 – February 2015
• Name and type of organisation providing education and training		Roma Tre University, Via della Vasca Navale 84, 00146, Rome, Italy
Duration of the program of study		2 years
Qualification date		02/18/2015
Final mark obtained		**110/110 (summa)**
Supervisor		Prof. Gennaro Conte e Dr. Alberto Mittiga (ENEA)
Thesis Summary		The aim of the thesis was to identify the limiting mechanisms for the V_{oc} and then the conversion efficiency of the photovoltaic cells in CZTS. For this purpose, we analyzed the electric properties of the solar cells in CZTS using different experimental techniques: current-voltage measures (J-V) in light and in dark, and as a function of the temperature, external quantum efficiency measurements, capacitance-voltage measurements and as a function of temperature and the admittance measurements as a function of temperature. During this work, we have found that the methods proposed in the literature to identify the dominant recombination mechanisms are of questionable applicability being based on assumptions not always verified by the experimental point of view and not being able to predict with accuracy the trends observed experimentally. For this reason, in order to analyze more accurately the data, we decided to use two numerical simulation programs. This analysis has led to one of the most important results of the thesis: we identified as one of the main limiting factors of the cells made in ENEA to the presence of a high concentration of defects at the interface CdS/CZTS (order of 10^{13} cm^{-2}).

• Bachelor's degree		**Physics**
• Date (from – to)		September 2007 – December 2011
• Name and type of organisation providing education and training		University of Rome La Sapienza, Piazzale Aldo Moro 5, 00185, Rome, Italy
Duration of the program of study		3 years
Qualification date		12/20/2011
Final mark obtained		**98/110**
Title		**Solar cells: physics, technology and applications**
Supervisor		Prof. Giovanni Vittorio Pallottino
Thesis Summary		The aim of the thesis was to analyze the basic functioning of the photovoltaic devices and the efficiency of the solar cells, highlighting in particular the possibility of improving the efficiency using multijunction solar cells, also called tandem cells. We analyzed the general aspects, focusing on the characteristics of the tandem cells made with III-V semiconductors. In this thesis, we described the p-n junction, which represents the base structure of the solar cells, and the photovoltaic effect. Also, we discussed the photon-electron interaction, the semiconductor doping, essential step to the fabrication of the p-n junction, and the photoelectric effect in the p-n junction. We described a technological solution to increase the efficiency of the solar cells through the fabrication of multijunction structures. In particular, referring to the spectral response, we can see how the introduction of a series of junctions made with different semiconductor materials, with different energy gap, allows to absorb a wide range of the solar spectrum and thus to obtain cells with high efficiency. We described the problematics linked to the tandem solar cells, such as the agreement between the photocurrents generated in the various cells in series and the electric connection between the various cells.

Publications		**M. Fortunato**, A. Tamburrano, M.P. Bracciale, M.L. Santarelli and M.S. Sarto "Enhancement of the piezoelectric coefficient in PVDF-TrFe/$CoFe_2O_4$ nanocomposites through DC magnetic poling", Beilstein Journal of Nanotechnology 12 (1), 2021. **M. Fortunato**, I. Bellagamba, A. Tamburrano, and M.S. Sarto "Flexible Ecoflex®/Graphene Nanoplatelets Foam for Highly Sensitive Low-Pressure Sensor", Sensors 20(16), 2020. **M. Fortunato**, D. Cavallini, G. De Bellis, F. Marra, A. Tamburrano, F. Sarto, and M.S. Sarto "Phase Inversion in PVDF Films with Enhanced Piezoresponse Through Spin-Coating and Quenching", Polymers, 11(7), 2019. **M. Fortunato**, C.R. Chandraiahgari, G. De Bellis, P. Ballirano F. Sarto, A. Tamburrano and M.S. Sarto "Piezoelectric Effect and Electroactive Phase Nucleation in Self-Standing Films of Unpoled PVDF Nanocomposite Films", Nanomaterials, 8(9), 2018. **M. Fortunato**, H.C. Bidsorkhi, C.R. Chandraiahgari, G. De Bellis, F. Sarto and M.S. Sarto "PFM Characterization of PVDF Nanocomposite Films with Enhanced Piezoelectric Response", IEEE Transaction on Nanotechnology, (17(5), 2018. **M. Fortunato**, C.R. Chandraiahgari, G. De Bellis, P. Ballirano, P. Soltani, S. Kaciulis, L. Caneve, F, Sarto and M.S. Sarto "Piezoelectric Thin Films of ZnO-Nanorods/ Nanowalls Grown by Chemical Bath Deposition", IEEE Transaction on Nanotechnology, 17(2), 2018. **M.Fortunato**, H.C. Bidsorkhi, G. De Bellis, F. Sarto and M.S. Sarto "Piezoelctric Response of Graphene-Filled PVDF Nanocoposites Trought Piezoresponse Force Microscopy (PFM)", Proceedings IEEE Nano 2017, p. 125-129, 2017. H.C. Bidsorkhi, A.G. D'Aloia, G. De Bellis, A. Proietti, A. Rinaldi, **M. Fortunato**, P. Ballirano, M.P. Bracciale, M.L. Santarelli and M. S. Sarto "Nucleation effect of unmodified graphene nanoplatelets on PVDF/GNP film composites", *Materials Today Communications*, 11, 2017. A. Rinaldi, A. Tamburrano, **M. Fortunato** and M.S. Sarto "A Flexible and Highly Sensitive Pressure Sensor Based on a PDMS Foam Coated with Graphene Nanoplatelets", Sensors, 16 (12), 2016.

Works presented at International Conferences		**M.Fortunato**, I. Bellagamba, F. Marra, A. Tamburrano, and M.S. Sarto "Development and Characterization of a Piezoresistive Polyurethane/GNP Coating for Strain Sensing Applications", IEEE NANO 2020, Virtual, 29-31 July 2020, accepted as oral presentation. **M.Fortunato**, I. Bellagamba, L. R. Ballam, A. Tamburrano, and M.S. Sarto "Piezoresistive Flexible Elastomeric Foams Coated with Graphene-Polymer Nanocomposite Film", Graphene 2019, Rome, 25-28 Jun 2019, oral presentation. **M.Fortunato**, F. Marra, I. Bellagamba, L. R. Ballam, A. G. D'aloia, G. De Bellis, A. Tamburrano, and M.S. Sarto "Multifunctional Graphene-based Coatings for Radar Absorbing and Sensing Applications", ET 2019, Viterbo, 20-21 Jun 2019 (poster).

		M.Fortunato, A. Rinaldi, A. Tamburrano, T. Dikonimos, G. De Bellis, N.Lisi, and M.S. Sarto "Graphene-Gold Electrodes for Flexible Nanogenerators Based on Porous Piezoelectric PVDF", Nanoinnovation 2018, Rome, 11-14 September 2018, oral presentation. D. Cavallini, **M. Fortunato**, G.De Bellis and M.S. Sarto "PFM Characterization of Piezoelectric PVDF/ZnO-Nanorod thin films", Nanoinnovation 2018, Rome, 11-14 September 2018, oral presentation. **M.Fortunato**, A. Rinaldi, A. Tamburrano, T. Dikonimos, G. De Bellis, N.Lisi, and M.S. Sarto "Graphene-Gold Electrodes for Flexible Nanogenerators Based on Porous Piezoelectric PVDF Films", IEEE NANO 2018, Cork, 23-26 July 2018 (Poster). D. Cavallini, **M. Fortunato**, G.De Bellis and M.S. Sarto "PFM characterization of PVDF-ZnO hybrid structures for energy harvesting", IEEE NANO 2018, Cork, 23-26 July 2018, oral presentation. **M.Fortunato**, A. Rinaldi, A. Tamburrano, T. Dikonimos, G. De Bellis, N.Lisi, and M.S. Sarto "Elettrodi di Grafene-Oro per Nanogeneratori Flessibili Basati su Films di PVDF Piezoelettrici Porosi", ET 2018, Rome, 13-14 Jun 2018 (Poster). D. Cavallini, **M. Fortunato**, G.De Bellis and M.S. Sarto "Film Polimerici Piezoelettrici in PVDF e nanorod di ZnO e Caratterizzazione Mediante Piezo Force Microscopy", ET 2018, Roma, 13-14 Jun 2018 (Poster), award of best poster. D.Cavallini, C.R. Chandraiahgari, G. De Bellis, **M. Fortunato**, A. Bregnocchi and M.S. Sarto "Synthesis and characterization of zinc-oxide nanostructures for application in cultural heritage", presented at Nanoinnovation 2017. **M.Fortunato**, H.C. Bidsorkhi, G. De Bellis, F. Sarto and M.S. Sarto "Piezoelctric Response of Graphene-Filled PVDF Nanocoposites Trought Piezoresponse Force Microscopy (PFM)", IEEE Nano 2017, oral presentation. C. Malerba, M. Valentini, **M. Fortunato** and A. Mittiga "Characterization and numerical modelling of CZTS-solar cells", Presented at EMRS Spring Meeting, Symposium on "Earth abundant and emerging solar energy conversion materials", Lille, 11-15 May 2015 (Poster).

Work experience, stages, studies abroad		
• Scholarship		
• Date (from – to)		1 December 2016 – 31 January 2017
• Name and type of organisation providing education and training		University of Rome La Sapienza, Piazzale Aldo Moro 5, 00185, Rome, Italy
Title		**Development of graphene-based and zinc oxide nanomaterials for the sensorization of cultural heritage and morphological and functional characterization using AFM and PFM techniques.**
• Type of business or sector		Research
• Project		RESEARCH PROJECT "NANOTECHNOLOGIES AND NANOMATERIALS FOR CULTURAL HERITAGE" -PON03PE_00214_1
• Main activities and responsibilities		In this project both zinc oxide (ZnO) nanorods (NRs) and nanowalls (NWs) were grown through hydrothermal process. This process has been optimized in order to grow nanostructures with a high purity. The best results were obtained using a ZnO seed layer, deposited by dip-coating and growing on it the ZnO nanostructures. The morphology of these nanostructures has been characterized by field emission scanning electron microscopy (FE-SEM) and Atomic Force Microscopy (AFM). Using the piezoelectric module of the atomic force microscope (PFM) it was possible to evaluate the piezoelectric coefficient (d_{33}) of the two nanostructures.

• Study experience abroad		
• Date (from – to)		July 25th 2016 – August 27th 2016
• Name and address of firm/university		Internationalization activities at the University of Bonn, Wegelerstrasse 10, 53115, Bonn, Germany
• Objective of the stage		Learn more about the Piezoresponse Force Microscopy (PFM) technique
• Main activities		During the time spent in the group of Dr. Sorgel of the University of Bonn, I was able to deepen the PFM technique. First, I gained the skills to evaluate the background signal that needs to be subtracted from all the measures taken. It was possible to optimize the choice of parameters (such as frequency and phase) for the nano-scale characterization of piezoelectric materials. Such optimization was carried out using periodically poled lithium niobate (PPLN) as a reference sample. Measurements were made on the capacitors of poly (vinylidenfluoruro-co-

		trifluoroethylene) (P(VDF-TrFE)) made at CNR-IMM Roma Tor Vergata laboratories and commercial polyvinylidene fluoride (PVDF). This work has allowed me to understand the difficulties related to quantitative measurements on samples that have both bottom and top electrodes and how to try to overcome them. In addition, quantitative PFM measurements were made to evaluate the piezoelectric coefficient (d_{33}), both nanorods (NRs) and nanowalls (NWs) of zinc oxide (ZnO). Finally, it was possible to learn the poling technique through the conductive tip of the PFM. During the last week of my stage in Germany I attended the conference "ISAF/ECAPD/PFM 2016", where I was able to follow some interesting tutorials on the subject of PFM and piezoelectric materials in general, and also to meet some colleagues working in the same area and discuss with them different aspects of the technique.

Personal skills and competences

Acquired in the course of life and career but not necessarily evidenced by formal certificates and diplomas.

Mother tongue		**Italian**

Other language(s)

		English
• reading		B2
• writing		B2
• speaking		B2

Signature Marco Fortunato