CURRICULUM VITAE

Personal Information:

Dr. Filippo Bonafè
Date of birth: 14/10/1996, Bologna (BO), Italy
Current Role: Post-Doctoral Fellow, Interdepartmental Centre for Industrial Research in Advanced Mechanical Engineering Applications and Materials Technology, University of Bologna
Adress: Viale Berti Pichat 6/2 40127 Bologna
Nationality: Italian
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Education:

- **2020 – 2024 - PhD in Nanoscience for Medicine and the Environment at University of Bologna**
  Thesis: "Organic Mixed Ionic-Electronic Conductors for Bioelectronic Interfaces" | Supervisor: Prof. Beatrice Fraboni - Co-supervisor: Prof. Tobias Cramer
  Date of defence: 21st June 2024 | Final Grade: Excellent
- **2018 – 2020 – Master's Degree in Material Physics and Nanoscience, University of Bologna**
  Thesis: "Charge transport and accumulation in degenerately doped semiconducting polymers with mixed ionic-electronic conductivity" | Supervisor: Prof. Tobias Cramer – Co-supervisor: Dr. Francesco Decataldo
  Date of defence: 19th October 2020 | Final Grade: 110/110 *summa cum laude*
- **2015 – 2018 – Bachelor's Degree in Physics, University of Bologna**
  Thesis: "Study and characterization of oxygen sensors based on organic electrochemical transistors for cell culture applications"
  Supervisor: Prof. Beatrice Fraboni | Co-supervisor: Dr. Marta Tessarolo|
  Date of defence: 21st October 2018 | Final Grade: 110/110 *summa cum laude*

Research:

- **Feb 2025 – now– Postdoctoral Research Fellow** at the Interdepartmental Centre for Industrial Research in Advanced Mechanical Engineering Applications and Materials Technology, University of Bologna, Italy | Supervisor: Prof. Beatrice Fraboni
  Project: design and fabrication of electronic sensors based on organic/hybrid thin film semiconductors
- **Feb 2024 – Jan 2025– Postdoctoral Research Fellow** at the Department of Physics and Astronomy, University of Bologna, Italy | Supervisor: Prof. Tobias Cramer
  Project: Physics of Microstructured Bioelectronic Devices
- **Mar 2022 – Aug 2022 - Visiting scholar at the University of Cambridge**, Department of Electrical Engineering, Bioelectronics Laboratory, Cambridge, UK | Supervisor: Prof. George Malliaras
  Project: Development of polymer-based soft robots for bioelectronics interfaces

Publications in peer-reviewed scientific journals:

- **F. Bonafè**, Filippo, M. Bazzani, B. Fraboni, T. Cramer, *Dissipative charge transport in organic mixed ionic-electronic conductor channels*, Nature Communications, **(2025)**, 16, pp. 1 - 9

- **F. Bonafè**, C. Dong, G. G. Malliaras, T. Cramer, B. Fraboni, *Subsurface Profiling of Ion Migration and Swelling in Conducting Polymer Actuators with Modulated Electrochemical Atomic Force Microscopy*, ACS Applied Materials & Interfaces, **(2024)** 16 (28)
- **F. Bonafè**, F. Decataldo, T. Cramer, B. Fraboni*, Ionic Solvent Shell Drives Electroactuation in Organic Mixed Ionic-Electronic Conductors*, Advanced Science **(2024)**, 11, 2308746
- C. Dong, A. Carnicer-Lombarte, **F. Bonafè** *et* al, *Electrochemically actuated microelectrodes for minimally invasive peripheral nerve interfaces*, Nature Materials **(2024),** 23, 969–976
- F. Mariani, F. Decataldo, **F. Bonafè**, M. Tessarolo, T. Cramer, I. Gualandi, B. Fraboni, and E. Scavetta, *High-Endurance Long-Term Potentiation in Neuromorphic Organic Electrochemical Transistors by PEDOT:PSS Electrochemical Polymerization on the Gate Electrode*, ACS Applied Materials & Interfaces, **(2023)**
- **F. Bonafè**, F. Decataldo, I. Zironi *et al.*, *AC amplification gain in organic electrochemical transistors for impedance-based single cell sensors*, Nature Communications **(2022)**, 5423
- **F. Bonafè**, *Flexible microelectrode array based on PEDOT:PSS for neural recording and stimulation*, Il Nuovo Cimento C **(2022)** 6 (122)
- F. Decataldo, **F. Bonafè**, F. Mariani *et al.*, *Oxygen Gas Sensing Using a Hydrogel-Based Organic Electrochemical Transistor for Work Safety Applications.* Polymers **(2022)**, 14, 102
- **F. Bonafè,** F. Decataldo, B. Fraboni, T. Cramer, *Charge Carrier Mobility in Organic Mixed Ionic–Electronic Conductors by the Electrolyte-Gated van der Pauw Method,* Advanced Electronic Materials **(2021)**, 7, 2100086

Manuscripts under Revision:

- D. Arcangeli, F. Mariani, I. Gualandi, F. Decataldo, **F. Bonafè**, D. Tonelli, B. Fraboni, E. Scavetta, *Potentiometric detection of calcium ion using an organic electrochemical transistor*, submitted to ACS Sensors, **(2025)**

Manuscripts in preparation:

- **F. Bonafè**, S. Fabiano, B. Fraboni, T. Cramer, *Electrochemical strain wave microscopy in operating organic electrochemical transistors* **(2025)**

Peer revisions in scientific journals:

- Science (co-revision) **(2025)**
- Biosensors and Bioelectronics **(2024)**
- Journal of Nanobiotechnology **(2024)**
- Cellulose **(2024)**
- Nanoscale **(2023)**

Presentations to peer-reviewed, internationally established conferences:

- **Poster Presentation**: "*Nanoscale investigation of mixed ionic-electronic transport in conductive polymers with modulated-electrochemical atomic force microscopy*", F. Bonafè, F. Decataldo, C. Dong, G. G. Malliaras, T. Cramer, B. Fraboni; OrbItaly International Congress, 23rd – 25th September 2024
- **Oral talk**: "*Nanoscale investigation of mixed ionic-electronic transport in conductive polymers with modulated-electrochemical atomic force microscopy*", F. Bonafè, F. Decataldo, C. Dong, G. G.

Malliaras, T. Cramer, B. Fraboni; 110° Congress of the Italian Physics Society, 9th – 13th September 2024

- **Oral talk**: "*Nanoscale Investigations of Electroactuation in Conductive Polymers for Bioelectronics with Modulated-Electrochemical Atomic Force Microscopy*", F. Bonafè, F. Decataldo, C. Dong, G. G. Malliaras, T. Cramer, B. Fraboni; International Conference on Science and Technology of Synthetic Electronics Materials (ICSM) 2024, 23rd – 29th June 2024
- **Oral talk**: "*Nanoscale Investigations of Electroactuation in Conductive Polymers for Bioelectronics with Modulated-Electrochemical Atomic Force Microscopy*", F. Bonafè, F. Decataldo, C. Dong, G. G. Malliaras, T. Cramer, B. Fraboni; BioEl WinterSchool, 2024, 16th – 23rd March 2024
- **Oral talk**: "*AFM-Enabled Spectroscopy and Microscopy of Electroswelling: Insights into Electrochemical Actuation in Conducting Polymers*", F. Bonafè, F. Decataldo, T. Cramer, B. Fraboni; Materials for Sustainable Development Conference (MATSUS), 16th – 20th October 2023
- **Oral talk**: "*AFM-Enabled Spectroscopy and Microscopy of Electroswelling: Insights into Electrochemical Actuation in Conducting Polymers for Bioelectronics*", F. Bonafè, F. Decataldo, T. Cramer, B. Fraboni; Cambridge Bioelectronic Symposium, 15th – 17th June 2023
- **Oral talk**: "*AC Amplification Gain in Organic Electrochemical Transistors (OECTs) for Impedance-based Single Cell Sensors*", F. Bonafè, F. Decataldo, I. Zironi, D. Remondini, T. Cramer, B. Fraboni; Material Research Society (MRS) Spring Meeting, 10th – 14th April 2023
- **Oral talk**: "*AC Amplification Gain in Organic Electrochemical Transistors for Impedance-based Single Cell Sensors*", F. Bonafè, F. Decataldo, I. Zironi, D. Remondini, T. Cramer, B. Fraboni; International Conference on Mechanics in Medicine and Biology (ICMMB), 19th – 21st September 2022
- **Oral talk**: "*AC Amplification Gain in Organic Electrochemical Transistors for Impedance-based Single Cell Sensors*", F. Bonafè, F. Decataldo, I. Zironi, D. Remondini, T. Cramer, B. Fraboni; OrbItaly International Congress, 3rd – 7th July 2022
- **Poster:** "*Quantitative Understanding of Amplification in Organic Electrochemical Transistor-based Impedance Sensors*", F. Bonafè, F. Decataldo, I. Zironi, D. Remondini, T. Cramer, B. Fraboni; Material Research Society (MRS) Fall Meeting, 6th – 10th December 2021
- **Oral talk**: "*Flexible microelectrode arrays based on PEDOT:PSS for neural recording and stimulation*", F. Bonafè, F. Decataldo, T. Cramer, B. Fraboni; 107° Congress of the Italian Physics Society, 11th – 15th September 2021
- **Poster:** "*Charge Carrier Mobility in Organic Mixed Ionic–Electronic Conductors by the Electrolyte-Gated van der Pauw Method*", F. Bonafè, F. Decataldo, B. Fraboni, T. Cramer; European Material Research Society (E-MRS) Spring Meeting, 1st – 4th June 2021

Seminars:

- *"AFM-enabled spectroscopy and microscopy of electroswelling: insights into electrochemical actuation in conducting polymers*"; Scientific seminar to the staff of the Molecular Foundry, Lawrence Berkeley National Laboratory (USA), 18th April 2023.
- *"Quantitative Understanding of Amplification in Organic Electrochemical Transistor as Single Cell Impedance Sensors",* Scientific seminar to the staff of the Bioelectronics Laboratory, University of Cambridge (UK), 7th March 2022.

Fellowships and Awards:

-Fellowships

- 15/02/2025→ winner of a **Marie Skłodowska-Curie Actions Global Fellowship** (call 2024) with the project *Scalable real-time monitoring of 3D cell cultures with electrical impedance microtomography* (MITO - id. 101201836), grant agreement in preparation

- 01/02/2025 – now → **1-year Postdoctoral fellowship**, CIRI/MAM, University of Bologna, Italy.
- 01/02/2024 –31/01/2025→ **1-year Postdoctoral fellowship**, DIFA, University of Bologna, Italy.
- 01/06/2022 – 31/08/2022 → **3-months visiting scholarship** funded by the University of Bologna for a visiting period at the Bioelectronic Laboratory, University of Cambridge, Cambridge, UK during the PhD course.
- 01/03/2022 – 31/05/2022 → **3-months visiting scholarship** funded by University of Bologna ("Marco Polo Program for a visiting period at the Bioelectronic Laboratory, University of Cambridge, Cambridge, UK)
- 01/11/2017 – 31/12/2020 → **3-years PhD scholarship** funded by the University of Bologna for the PhD course in Nanoscience for Medicine and the Environment

- Awards

- Best Oral Presentation Award at the Materials for Sustainable Development (MATSUS) Conference, October 2023 | Title of the Communication: "*AC Amplification Gain in Organic Electrochemical Transistors (OECTs) for Impedance-based Single Cell Sensors".*
- Best Oral Presentation Award at the Cambridge Bioelectronic Symposium, June 2023 | Title of the Communication: "*AFM-Enabled Spectroscopy and Microscopy of Electroswelling: Insights into Electrochemical Actuation in Conducting Polymers for Bioelectronics".*
- Best Oral Presentation Award at the OrbItaly international congress, July 2022 | Title of the Communication: "*AC Amplification Gain in Organic Electrochemical Transistors (OECTs) for Impedance-based Single Cell Sensors".*
- Best Communication Award at the 107° Congress of the Italian National Society of Physics, September 2021 | Title of the Communication: "*Flexible microelectrode arrays based on PEDOT:PSS for neural recording and stimulation".*

Skills:

Experimental techniques for the characterization of materials and electronic devices:

- *Electrical characterization:* DC electrical measurements (expertise in source-measure units, probe stations, four-point probe techniques) and AC electrical measurements (expertise in function generators, lock-in amplifiers, frequency response analysers)
- *Electrochemical characterization:* Electrochemical impedance spectroscopy, potentiostatic and galvanostatic measurements (expertise in cyclovoltammetry, chronoamperometry and chronopotentiometry, electrochemical depositions and polymerizations)
- *Composition characterization* by fluorescence measurements (XRF)
- *Morphological characterization* by white light interference microscopy, optical polarized microscopy, and SEM
- *Cryogenic and high-vacuum* technologies

Micro-fabrication of thin film devices onto rigid and flexible substrates:

- *Photolithography techniques:* direct laser writing, greyscale lithography, lift-off, dry etching
- *Soft-lithography techniques:* PDMS manufacturing and microtransfer molding
- *Design and fabrication of photolithography masks*
- *Deposition techniques*: thermal evaporation of metallic contacts by physical vapor deposition and e-beam, Parylene deposition, solution growth techniques (spin coating, drop casting, blade coating) for organic semiconductors
- *Surface treatments:* surface functionalization by SAMs deposition, plasma treatments.

Scanning Probe Microscopy techniques:

- *Atomic Force Microscopy* techniques: non-contact mode, tapping mode, contact mode, force-distance spectroscopy, mechanical characterization of soft materials with nanoindentation
- *Electrochemical Atomic Force Microscopy:* modulated electrochemical atomic force microscopy

Bioelectronic measurements:

- *In vitro experiments*: impedance sensing of cell cultures, characterization of long-term electrochemical and mechanical stability of implantable devices, modelling of electrochemical impedance properties
- *In vivo experiments:* electrophysiology measurements with specialized systems (Intan RHS) (both on the central nervous system and on peripheral nerves), development of neural recording and stimulation protocols
- *Biosensing*: electrochemical sensing of ions or gasses in liquid and air environment, characterization of organic neuromorphic biosensors

Major ongoing collaborations:

- Prof. George Malliaras, Dr. Antonio Alfaro Dominguez, Department of Electrical Engineering, University of Cambridge (UK)
  Topic: Dissipative charge transport in conductive hydrogels and eutectogel for bioelectronics
- Prof. Daniel Remondini, Dr. Isabella Zironi, Margherita Cioni, Department of Physics and Astronomy, University of Bologna (IT)
  Topic: Development of high-throughput *in vitro* bioelectronics
- Prof. Roberto Amici, Prof. Matteo Cerri, Dr. Timna Hitrec, Department of Biomedical and Neuromotor Sciences, University of Bologna (IT)
  Topic: *In vivo* recording and stimulation of neural activity in torpor and hibernation states
- Prof. Erica Scavetta, Prof. Isacco Gualandi, Dr. Federica Mariani, Department of Industrial Chemistry, University of Bologna (IT)
  Topic: Development of electrochemical and neuromorphic biosensors

Mentoring and Teaching Activities:

- **A.Y. 2021-2022, 2022-2023, 2023-2024, 2024-2025 Teaching Tutor** for the *Laboratory of Condensed Matter Physics* course, Master's Degree program in Material Physics and Nanoscience, Department of Physics and Astronomy, UNIBO
- **A.Y. 2024-2025 Teaching Tutor** for the *Microscopia con Laboratorio* course, Bachelor's Degree program in Material Science, Department of Physics and Astronomy, UNIBO
- **Co-supervisor for M.Sc. and B.Sc. Thesis**, Department of Physics and Astronomy, UNIBO:
  "Novel Organic Mixed Ionic Electronic Conductors for Bioelectronics" (Aleksandra Širvinskytė, M.Sc., 2025)*, "Dissipative charge transport in organic mixed-ionic electronic conductors"* (Mattia Bazzani, M.Sc., 2024), *"Study of ionic transport in organic electrochemical transistors for highly efficient bioelectronic devices"* (Riccardo Maria Marabini, B.Sc., 2023), *"Electrochemical hydrogen gas sensing with organic semiconductors"* (Chiara Baldoni, M.Sc., 2022)
- **Co-supervisor for internship programs,** Department of Physics and Astronomy, UNIBO: *"Low impedance bioelectronic interfaces"* (Marco Salvi, 2022), *"Microfabrication and electrochemical characterization of flexible microelectrode arrays for bioelectronics"* (Caja Annweiler, 2021)

Notable Facts:

Results reported in the paper "*Electrochemically actuated microelectrodes for minimally invasive peripheral nerve interfaces*" di C. Dong, A. Lombarte, F. Bonafè et. al., published in Nature Materials (2024), were disseminated by magazines and specialized science press:

- *"A new system for creating neural interfaces"*, Unibo Magazine
- *"Robotic nerve 'cuffs' could help treat a range of neurological conditions",* University of Cambridge Research Magazine

Results reported in the paper "*AC amplification gain in organic electrochemical transistors for impedance-based single cell sensors*" di F. Bonafè, et.al., published in Nature Communications (2022), were disseminated by magazines and specialized science press:

- *"A single-cell biosensor"*, Unibo Magazine

Date **Signature**

04/04/2025