Curriculum vitae di *Gasparini Nicola*

Sottosettori ERC primari: *PE3_4 Electronic properties of materials, surfaces and insulators; PE3_3 Transport properties of condensed matter; PE3_5 Physical properties of semiconductors and insulators; PE3_10 Nanophysics; PE3_12 Molecular electronics; PE4_3 Molecular structures and Structure; PE5_4 Thin films; PE11_12 Semi-conducting and magnetic materials engineering*

Eventuali sottosettori ERC secondario: *PE3_7 Spintronics; PE4_2 Spectroscopy and spectrometric techniques;*

PERSONAL DETAILS

Family name, First name: Gasparini, Nicola

Birthdate: 24/03/1989

Researcher unique identifier(s): ORCID: 0000-0002-3226-8234

URL for web site: https://www.imperial.ac.uk/people/n.gasparini; https://scholar.google.it/citations?user=Wqiu1TsAAAAJ&hl=en

- **Education and key qualifications**

22/06/2017 Institute of Materials for Electronics and Energy Technology (i-MEET), Friedrich-Alexander University Erlangen-Nuremberg (FAU), Germany
Prof. Dr Christoph J. Brabec

2013 M.Sc. Photochemistry and Molecular Materials, University of Bologna, Italy, cum laude.

2011 B.Sc. Chemistry and Organic Chemistry, University of Bologna, Italy, cum laude.

- **Current position(s)**

2022 – current: Senior Lecturer in Electronic Materials – Associate Professor, tenured. Department of Chemistry, Imperial College London, the United Kingdom

- **Previous position(s)**

02/2022- 09/2024:
Lecturer in Chemistry – Assistant Professor, *tenured*. Department of Chemistry, Imperial College London, the United Kingdom

09/2019- 02/2022:
Imperial College Research Fellow: Principal Investigator. Department of Chemistry, Imperial College London, the United Kingdom

09/2017 – 09/2019:
Postdoctoral Fellow: King Abdullah University of Science and Technology (KAUST), Saudi Arabia.

Le seguenti sezioni devono avere lunghezza totale compresa fra 2 e 4 pagine.

RESEARCH ACHIEVEMENTS AND PEER RECOGNITION

Research achievements

Nicola Gasparini's research output consists of 135 peer-reviewed publications with over 13000 citations and an h-index of 56, 2 granted and 2 filed patents, respectively and overall >£1.5M research funding secured.

Below is short description of ten selected publications.

1. Narrowband Detection via Charge Collection Narrowing Organic Photodetector Enabled by Low Bandgap Random Terpolymer for Biometric Sensing.
Matilde Brunetta, Zhuoran Qiao, Adibah Zamhuri, Francesco Furlan, Martina Rimmele, Peter A Gilhooly-Finn, Lewis M Cowen, Filip Aniés, Patipan Sukpoonprom, Stanley Cazaly, Julianna Panidi, Flurin Eisner, Martin Heeney, Bob C Schroeder, Nicola Gasparini. *Advanced Functional Materials*, **2025**, 2422637.
Summary: Achieving spectrally selective organic photodetectors (OPDs) without broadband absorbers and filters is challenging. This study employs charge collection narrowing (CCN) using a thick bulk heterojunction (BHJ) to develop near-infrared (NIR) OPDs. A random terpolymer (ranDPP-2TBT) is combined with the low-bandgap non-fullerene acceptor (IEICO-4F), resulting in OPDs with low dark current (6.88×10^{-9} A cm^{-2}) and a narrowband response (68 nm FWHM, R = 0.13 A W^{-1} at 916 nm). The OPD is successfully demonstrated for real-time biometric heart-rate monitoring via photoplethysmography.

2. Dark Current in Broadband Perovskite–Organic Heterojunction Photodetectors Controlled by Interfacial Energy Band Offset. Davide Nodari, Lucy JF Hart, Oskar J Sandberg, Francesco Furlan, Edoardo Angela, Julianna Panidi, Zhuoran Qiao, Martyn A McLachlan, Piers RF Barnes, James R Durrant, Armin Ardalan, Nicola Gasparini. *Advanced Materials*, **2024**, 36, 2401206.
Summary: Lead halide perovskites and organic semiconductors are promising for photodetectors (PDs), with perovskites excelling in the visible range and organics enabling near-infrared (NIR) detection. This study develops perovskite–organic heterojunction (POH) PDs with absorption up to 950 nm by combining perovskite and a bulk-heterojunction (BHJ) without an intermediate layer. Using the PBDB-T polymer family, the effect of donor energetics on dark current (Jd) is analyzed, revealing that Jd is limited by thermal generation from deep trap states. The best performance is achieved with PM7-based POH, exhibiting ultra-low noise (2×10^{-14} A Hz$^{-1/2}$) and high detectivity (4.7×10^{12} Jones). Finally, the study demonstrates PM7-based POH devices for accurate NIR pulse oximetry, enabling long-distance (2 m) heartbeat monitoring.

3. Pathways to Upscaling Highly Efficient Organic Solar Cells Using Green Solvents: A Study on Device Photophysics in the Transition from Lab-to-Fab.
Eva Mazzolini, Richard A Pacalaj, Yuang Fu, Bhushan R Patil, Rahul Patidar, Xinhui Lu, Trystan M Watson, James R Durrant, Zhe Li, Nicola Gasparini. *Advanced Science*, **2024**, 2402637.
Summary: While nonfullerene acceptors (NFAs) have enabled organic solar cells (OSCs) to achieve 20% efficiency in the lab, scaling them for roll-to-roll fabrication remains challenging. Key issues include green solvent compatibility and understanding charge carrier dynamics during upscaling. This study demonstrates reproducible slot-die-coated devices with 14% efficiency, provided optimal thickness is maintained. For the PM6:Y12 blend, solvent choice significantly impacts charge carrier dynamics more than deposition technique. Devices processed with o-xylene show a 40% lower bimolecular recombination coefficient and 70% higher mobility than those using CB. Blade-coating is also found to be an effective lab-scale optimization method with minimal performance loss when transitioning to upscaling.

4. Ferrocene Derivatives Enable Ultrasensitive Perovskite Photodetectors with Enhanced Reverse Bias Stability" by the authors Eunyoung Hong, William D. J. Tremlett, Lucy Hart, Beier Hu, Zhuoran Qiao, Patipan Sukpoonprom, Sarah Fearn, Edoardo Angela, Matilde Brunetta, Demosthenes C. Koutsogeorgis, Nikolaos Kalfagiannis, Davide Nodari, Martyn A. McLachlan, Piers R. F. Barnes, Artem A. Bakulin, Nicholas J. Long, Nicola Gasparini. *Advanced Functional Materials*, **2025**, 202424556.
Summary: Lead-halide perovskite photodetectors face challenges due to ion migration and parasitic charge injection, leading to device failure. This study introduces an ultra-thin ferrocenyl-bis-phenyl-2-carboxylate

(FcPhc2) layer as a hole-blocking material, creating an energetic barrier that reduces hole injection from the Ag contact. As a result, the device achieves ultra-low noise spectral density (1.2×10^{-14} A $Hz^{-1/2}$) and high specific detectivity (8.1×10^{12} Jones at -0.5 V, 740 nm). FcPhc2 also inhibits I^- oxidation and reduces I_2 formation, improving reverse bias stability without compromising fast response speeds (150 ns, 1.3 MHz at -0.5 V).

5. Strain-induced α-phase Stabilisation for Low Dark Current FAPI-based Photodetectors.
Eunyoung Hong, Davide Nodari, Francesco Furlan, Edoardo Angela, Juliana Panidi, Martyn A. McLachlan, and Nicola Gasparini*. *Advanced Optical Materials*, **2024**, 202302712.
Summary: Despite abundant research on MAPbI3, FAPbI3 has emerged as a prominent candidate, given the broad-spectrum light absorption, however, the stability is low due to the formation of unstable delta-phase. In this work, we investigated the effects of Cs+ on the efficiency and stability of PDs in the CsXFA1-XPbI3 system. With a combination of spectroscopy and morphological analysis, we find that the origin of microstrain relaxation is the uniformly distributed surface texture and increased crystallinity of the perovskite layer, which suppress non-radiative recombination mechanisms. Consequently, we obtained an extremely low Jd of 3.3×10-9 A cm-2 with D* above 1011 Jones. Notably, we demonstrated, for the first time, that such strain-relaxed mixed-cation perovskite has not only a faster photoresponse and greater sensitivity, but also outstanding reverse bias stability under mechanical and thermal stress. The first author of this paper is a student who carried out the MRes project in my group, they were recognised with the best presentation award in the department, presented this work in spring EMRS 2023 and MATSUS 2024 and they chose to continue their study with my group for their PhD.

6. A novel selenophene based non-fullerene acceptor for near-infrared organic photodetectors with ultra-low dark current. Zhuoran Qiao, Qiao He, Alberto D Scaccabarozzi, Julianna Panidi, Adam Marsh, Yang Han, Polina Jacoutot, Davide Nodari, Tianyi Zhang, Amirah Way, Andrew JP White, Thomas D Anthopoulos, Wing Chung Tsoi, Artem A Bakulin, Martin Heeney, Zhuping Fei, Nicola Gasparini. *Journal of Materials Chemistry C*, **2024**, 12, 5766.
Summary: This study introduces a novel non-fullerene acceptor, IDSe, which extends light absorption to 800 nm. When blended with PTQ10, the resulting OPD devices exhibit ultra-low dark current (1.65 nA cm^{-2} at −2 V), high responsivity, and detectivity exceeding 10^{12} Jones at 790 nm. The improved performance is attributed to enhanced and balanced charge carrier mobility compared to PTQ10:IDIC blends. Additionally, large-area devices fabricated using doctor blade coating in air achieved a record-low dark current of 1.2×10^{-7} A cm^{-2} at −2 V. This article is included in the theme collections: 2024 Journal of Materials Chemistry C Most Popular Articles, Journal of Materials Chemistry C Emerging Investigators 2024 and Celebrating our 2024 Prize winners.

7. Tuning Halide Composition Allows Low Dark Current Perovskite Photodetectors With High Specific Detectivity. Francesco Furlan, Davide Nodari, Emanuele Palladino, Edoardo Angela, Lokeshwari Mohan, Joe Briscoe, Matthew J Fuchter, Thomas J Macdonald, Giulia Grancini, Martyn A McLachlan, Nicola Gasparini*. *Advanced Optical Materials*, **2022**, 2201816.
Summary: This has been the first publication in the group on perovskite photodetectors. In this field there is a deficit of efforts focused on understanding the role of perovskite composition and its correlation to device dark current. In this research area, we focused on the effect of tuning the iodide-bromide composition into MAPbI3 and obtained ultra-low Jd values of nA cm-2 with specific detectivity approaching 1013 Jones. We attributed the low Jd of the 15%-Br containing devices to the reduction of trap states, a better charge extraction of photogenerated carriers and an improvement in photoactive layer morphology and crystallinity. Significantly, we observe, for the first time, a linear relationship between the Jd of devices and their open-circuit voltage over the 0 - 15 % Br range and highlight how compositional engineering of the active layer can be an alternative approach to conventional transport layer optimization to improve photodetector performances. This work was the focus on an invited talk I delivered in international conferences including ICE3SCN and MRS. This paper received 7 citations in less than 2 years.

8. Enhanced sub-1 eV detection in organic photodetectors through tuning polymer energetics and microstructure. Polina Jacoutot, Alberto D Scaccabarozzi, Davide Nodari, Julianna Panidi, Zhuoran Qiao, Andriana Schiza, Alkmini D Nega, Antonia Dimitrakopoulou-Strauss, Vasilis G Gregoriou, Martin Heeney, Christos L Chochos, Artem A Bakulin, Nicola Gasparini*. *Science Advances*, **2023**, 9, eadh2694.
Summary: Following the synthetic strategy in the manuscript above, we further modified the chemical structure of low Eg polymers, demonstrating NIR OPD with record performance due to the enhanced

crystallinity and optimised energy alignment, which leads to reduced charge recombination. The high specific detectivity (D*) value in the 1100-1300 nm region is particularly promising for biosensing applications. We demonstrated OPD as a pulse oximeter under NIR illumination, delivering heart rate and blood oxygen saturation readings in real-time without signal amplification. This work has been outlined in Imperial News.

9. Infrared Organic Photodetectors Employing Ultralow Bandgap Polymer and Non-Fullerene Acceptors for Biometric Monitoring. Polina Jacoutot, Alberto D Scaccabarozzi, Tianyi Zhang, Zhuoran Qiao, Filip Aniés, Marios Neophytou, Helen Bristow, Rhea Kumar, Maximilian Moser, Alkmini D Nega, Andriana Schiza, Antonia Dimitrakopoulou-Strauss, Vasilis G Gregoriou, Thomas D Anthopoulos, Martin Heeney, Iain McCulloch, Artem A Bakulin, Christos L Chochos, Nicola Gasparini*. *Small*, **2022**, 18, 2200580.
Summary: In this manuscript, we have designed an ultra-low bandgap (Eg) polymer (Eg <1 eV) for application in short-wavelength detection. In particular, two blends of an ultralow bandgap push–pull polymer TQ-T combined with non-fullerene acceptors were compared to obtain OPDs for sensing in the NIR beyond 1100 nm, which is the cut-off for benchmark Si photodiodes. We elucidated the superior performances of TQ-based devices with optoelectronic characterizations and ultrafast transient absorption spectroscopy combined with morphological analyses. This work demonstrated for the first time real-time contactless heart rate monitoring without the need of any external amplifier. This manuscript was the first milestone in organic photodetectors for my group and has been recognised in the community with over 39 citations in less than two years.

10. Nonfullerene-Based Organic Photodetectors for Ultrahigh Sensitivity Visible Light Detection. Helen Bristow, Polina Jacoutot, Alberto D Scaccabarozzi, Maxime Babics, Maximilian Moser, Andrew Wadsworth, Thomas D Anthopoulos, Artem Bakulin, Iain McCulloch, Nicola Gasparini*. *ACS Applied Materials and Interfaces*, **2020**, 12, 48836.
Summary: This is the first publication led by my research group at Imperial. In this work, we fabricated nonfullerene-based organic photodetectors with low dark current, high responsivity and specific detectivity. The overall sensitivity of our photodetectors exceeds that of a commercially available photodiode.

Peer recognition

Nicola has established a strong reputation in the field of thin-film semiconductors. His contributions to organic and perovskite solar cells and photodetectors are evident through a large number of scientific publications, which have gained quick citations and had considerable influence and impact on the field (135 papers with over 13000 citations and an h-index 56). Upon joining Imperial in late 2019, he embarked on a new research direction in photodetectors, an area previously unexplored at Imperial. In a short period, his research elevated him and his group to a central position in the UK and worldwide and he is emerging a leader in this field. His group published over 75 papers on organic and perovskite photodetectors in top journals such as Advanced Materials, Advanced Functional Materials, Science Advances and Small. In addition to the research output, Nicola secured external funding in solar (EU projects (ENLIGHTENED £500,000, BOOSTER £700,000) and photodetectors (KAUST Research Funding, Opportunity Fund Program $200,000). The importance of Nicola's contributions has been recognised through several awards, including the prestigious 2024 Royal Society of Chemistry Materials Chemistry Early Career Prize and the PRISM 2023 – Young Researcher Award Material Science. In recognition of his cutting-edge research, Nicola was selected among the 25 Young Scientist class of 2020 of the World Economic Forum. As a further clear indicator of esteem, he was part of the recent UK-Taiwan international bilateral meeting organised by the Royal Society, where Nicola was an invited speaker. In addition, Imperial has nominated him to foster collaborations between IISc and Imperial, helping build our international profile and contribute to the successful implementation of Imperial Global, a key pillar of Imperial's strategy.

During his PDRA in KAUST, Nicola secured two patents (WO/2019/123267, WO2019123267A1) and, based on those, co-founded iyris, a spin-out company focusing on transparent solar windows for building integration photovoltaics. The company secured >$900,000, which is now sold to RedSea (redsea.ag), a rising star in desert agriculture. At Imperial, he filed two patents (UK Patent Application No. 2410905.0 and 9015678.0) in collaboration with the Long group on the applications of ferrocene derivatives in optoelectronic devices. The team has been successful with DT Prime projects, which are setting the base for a spin-out company.

Nicola is a key member of the Centre of Processable Electronics at Imperial, where he is a management board member. He is serving as an advisory board member of the EPSRC Prosperity Partnership focused on integrating photovoltaic technology into steel (STRIP), in collaboration with Swansea University and TATA UK. Finally, he is a member of the editorial board of Electronic Materials and Frontiers in Energy Research.

His international reputation in his research field made him serve as reviewer for several high-impact journals, including Science, Science Advances, Nat. Commun., Nat. Photonics, Nat. Materials, Adv. Mater., Adv. Energy Mater. J. Am. Chem. Soc., Angew. Chem. Int. Ed and Energy and Env. Science and grant reviewer for the Deutsche Forschungsgemeinschaft (DFG) German Research Foundation, the Wallenberg Academy Foundation (Sweden), Research Grants Council (RGC) of Hong Kong and the EPRSC (UK).

ADDITIONAL INFORMATION

Other contributions to the research community

In addition to leading his own group, Nicola has taken leading positions in the department. Specifically, he is the lead for the Materials theme and quickly contributes to leadership through input into departmental research strategy. Specific examples being the contribution to the facilities 2040 report and research clusters.

Nicola is the co-director of the Master of Research course in Nanomaterials in the Chemistry department. He coordinates 34 PG students and works with the management group to deal with admissions, recruitment strategies, developing cohort spirit and transferable skills, and coordinating research projects and assessments. Nicola contributes to education at Imperial, serving as the module lead for a fourth-year undergraduate and postgraduate courses, the laboratory coordinator for a first-year physical science laboratory, and the co-coordinator for a solar workshop in the third year. He has been an independent examiner for 30+ MRes final reports in the Chemistry and Physics Department. He has been invited three times to act as the external examiner and four times as the internal examiner for PhD students.

He is the coordinator of the cleanroom ISOS-7 in the Department of Chemistry. His responsibilities lie in making researchers follow H&S procedures, supporting annual maintenance, and providing a collaborative environment for the students and researchers in the cleanroom.

Finally, he is the Energy theme leader for the Department seminar series. In this role, he organises 3-4 annual seminars within the energy framework, inviting national and international academics, industry and policymakers and early career researchers to the department.

Career breaks, diverse career paths and major life events

N/A