Valentina Pifferi
CURRICULUM VITAE

RESEARCH ACTIVITIES AND SCIENTIFIC PUBLICATIONS

Educational and Academic Path

- **2005: Scientific high school diploma**, obtained at the "Falcone e Borsellino" high school in Arese (MI) with a score of 100/100
- **2008: Bachelor's Degree in Chemistry** at the University of Milan with a grade of 110/110 cum laude with an experimental thesis entitled: "Gold and silver nanoparticles stabilized by Aloin A and Aloesin" (supervisor: Prof.ssa Francesca Porta)
- **2010**: Master's Degree in Chemical Sciences at the University of Milan with a grade of 110/110 cum laude with an experimental thesis entitled: "Modulation of nanocrystalline TiO2 mesoporosity through template synthesis to obtain second generation photocatalysts "(Supervisor: Prof. Silvia Ardizzone)
- **2014: PhD in Chemical Sciences** at the University of Milan (XXVI cycle), with an experimental thesis entitled: "Advanced materials for electrode modification in trace electroanalysis" (supervisor: Prof. Luigi Falciola)
- **2012: LLP Erasmus Placement** (6 months) at the Laboratories of Prof. C.M.A. Brett of the Universidade de Coimbra (Portugal)
- **2014: INSTM Scholarship** - Lombardy Region as part of the "NANOSENS - Nanomaterials for environmental electrochemical sensors" project (tutor: Prof. Luigi Falciola)
- **2015: Type B post-Doc Research Fellowship** within the CARIPLO project "Nanostructured-initiators for matrix-free, surface-based mass spectrometry imaging of antitumor drugs in tissues" (tutor: Prof. Luigi Falciola)
- **2016: Type B post-Doc Research Fellowship** within the PRIN project "Diagnostic nanostructured devices for monitoring of biomarkers in cancer" (tutor: Prof. Luigi Falciola)
- **2016-2018: Type A post-Doc Research Fellowship** entitled "New frontiers of chemistry" (tutor: Prof. Luigi Falciola)
- **2018-2021: Researcher type B**
- **2018: National Scientific Qualification** for the competition sector 03 / A1 (second band)
- **2021-today: Associate Professor**

My scientific research activity took place within the Department of Physical Chemistry and Electrochemistry (currently the Department of Chemistry) of the University of Milan, apart from a period of 6 months spent in the laboratories of Prof. C.M.A. Brett of the Universidade de Coimbra (Portugal).

Scientific activity has led to the production of

- 49 Scientific publications in indexed international journals,
- 9 Proceeding,
- 1 chapter (V. Pifferi, A. Testolin, L. Falciola, "**CHAPTER 10: Metal-free doped carbons for electroanalytical sensors**") del Libro "Metal-free Functionalized Carbons in Catalysis", RSC Catalysis Series, 31, (2018), 304–325,
- 1 chapter (A. Testolin, V. Pifferi, L. Falciola, "**CHAPTER 3: Detection methods of wastewater contaminants: state of the art and role of nanotechnology**") del libro "Micro and Nano Technologies", Elsevier,
- 1 chapter (W. Aidli, V. Pifferi, L. Falciola, "**Sensing Interfaces: Self-Cleaning Materials for Electroanalytical Applications**") del libro "Encyclopedia of Sensors and Biosensors: Volume 1-4", First Edition, Volume 1-4, (2022), 613–618,

as well as the presentation of

- 54 Oral communications (29 at International Congresses and 25 at National Congresses), of which 1 Keynote and 1 Invited Lectures;
- 65 Poster communications (42 at International Congresses and 23 at National Congresses).

Bibliometric indicators as of 22/05/2023 (source Scopus)

- H-Index: 20
- Total citations: 973
- Academic age: 11 years (2012-2023)
- Maternity leave: 5 months (10/08/2020 - 14/01/2021)

Main Research Activity

My scientific activity begins after the conclusion of the three-year and master's studies (in which I dealt with the synthesis and characterization of metal nanoparticles and semiconductor oxides) by undertaking the period of the PhD. **The main research activity concerns the development of new electrode materials and new electroanalytical methodologies to be used in the fields of sensors, trace analysis, environmental analysis and quality control.**

The path of the research doctorate took place linearly, starting with the acquisition of methodological rigor, in which I learned the use of voltammetric techniques for the qualitative (in particular cyclic voltammetry) and quantitative (pulsed and amperometric techniques) study of pollutants present in traces in water (benzidines) and in more complex matrices (for example furans in coffee), using both conventional (glassy carbon, platinum, gold, BDD) and non conventional (screen-printed electrodes) electrodes. This was followed by a period of 6 months within an LLP-Erasmus Placement scholarship at the Laboratories of Prof. C.M.A. Brett of the Universidade de Coimbra (Portugal) dedicated to learning electrochemical impedance spectroscopy, particularly useful for the characterization of electrodes modified with nanomaterials. The PhD period concluded with the application of all the previously learned methodologies, for the modification, characterization (with cyclic voltammetry and electrochemical impedance spectroscopy) and application of electrodes based on different types of nanomaterials and nanostructures in order to develop new electroanalytical methods for the detection of various pollutants.

In the following years, as post-Doc, and then as type b researcher, I exploited all the skills acquired during the doctorate to deepen the study of new electrode materials with electroanalytical applications on two areas.
The first area concerns the understanding of the mechanisms of diffusion and pre-concentration of the analyte within the non-electroactive layers that cover the electrode surface. This issue is often little addressed, since it deals with partially or totally insulating materials, but it is of key interest for the construction of sensors with interaction centers for the target molecule, with improved architecture or with filters for interferents. In particular, different types of materials, organic and inorganic, were investigated:

1) proton conducting polymers, in particular poly (arylethersulphone) sulphonate (in collaboration with the group of Prof. Di Silvestro of the Department of Chemistry), which with its negatively charged sulphonic groups allows to increase the response of positively charged molecules, compared to conventional electrodes. In addition, the architecture and therefore also the electrochemical behavior can be varied according to the solvent chosen for the deposit, the degree of sulfonation, branching, temperature and drying pressure. Recent studies are using multivariate analysis (principal component analysis) to fully understand these systems and their application for the determination of lead in water. Furthermore, this type of polymer is also being used as a doping agent for an electron conducting polymer (PEDOT) to modify its electrochemical behavior;
2) polymeric brushes (in collaboration with the University of Eastern Piedmont, with the PSI of Villigen and the ETH of Zurich), both cationic and anionic, used alone or copolymerized, capable of modifying the electrochemical properties of silicon wafers, normally used in electronic circuits. These properties can be modified and improved both by making use of micropatterning and by using polymers that have particular swelling properties dependent on the electrolyte, allowing the production of pH sensors;
3) nanometric layers of silica capable of drastically modifying the diffusion of molecules within them (in collaboration with the group of Prof. Ardizzone of the Department of Chemistry). In the case of uniform layers, the shape of the voltammetric signal can be modified and theoretical models reported in the literature can be experimentally confirmed. By using mesoporous layers instead, it is possible to even increase the electrochemical response with respect to the uncovered electrode and use them as dimensional anti-fouling filters in biological matrices, for example for the determination of dopamine, an important neurotransmitter.

The second area on which my scientific research has focused is the study of hybrid materials for the production of electroanalytical sensors designed specifically for the application, in which each component is chosen to offer the system a particular advantage. Furthermore, the combination of multiple materials in nanometric form often leads not only to compounds with properties that are the sum of the individual properties of each component, but rather to nanocomposites with completely unexpected peculiarities. In this context:

1) bimetallic systems based on gold and palladium were electrochemically characterized, studying how much the type of support chosen (carbon nanofibers with different amount of oxygen and degree of graphitization), affects the properties of the material (in collaboration with Prof. Prati del Department of Chemistry). The same approach is used in the case of gold nanoparticles on carbon nanotubes and for Au-Pt and Au-Ag bimetallic systems;
2) the photoactivity of titanium dioxide combined with the versatility of graphene made possible to obtain a hybrid material with increased photoelectrochemical properties (in collaboration with the group of Prof. Ilaria Palchetti of

the University of Florence and Dr. Chiara Ingrosso of the CNR from Bari). In particular, the electrochemical characterization both under illumination (photocurrent measurements) and in the dark, has allowed the understanding of the phenomena deriving from the electronic passage titania / graphene. These devices can be used for the study of nanostructured diagnostic systems for the monitoring of tumor biomarkers (Project funded by MIUR - PRIN 2012). Within this project, rod systems of gold on titanium dioxide and systems with multiple layers of graphene and hybrid systems with nanoparticles of gold and graphene are also under investigation, with promising results for the detection of arsenic, dopamine, micro-RNA, and Vitamin C;

3) the exploitation of the convergent diffusion on metal centers, in this case silver nanoparticles, combined with the photorenewability properties of titanium dioxide (in collaboration with the group of Prof. Ardizzone of the Department of Chemistry), have allowed the production of the first photo-renewable sensor for the determination of dopamine. In this system each element has been inserted for a specific purpose: the silica layer has allowed a distribution of the silver nanoparticles able to ensure a convergent diffusion, the silver nanoparticles act as reaction centers of the target, the dioxide layer of External titanium imparts self-cleaning characteristics to the device, when irradiated with UV light (both from high-power lamps up to commercially available lamps), allowing the continuous reuse of the sensor. This system has proved extremely useful not only for dopamine but also for the detection of two other neurotransmitters, norepinephrine and serotonin, in biological fluids, such as plasma and cerebrospinal fluid. Furthermore, the peculiar behavior of the silver-titanium dioxide interphase, capable of placing the two materials in intimate contact, was explained using an innovative electrochemical-theoretical approach (in collaboration with the Group of Prof. Ceotto and Dr. Lo Presti of the Department of Chemistry), leading to unexpected conclusions. This same approach will be applied to the gold-titanium dioxide interface and will be deepened by further photoelectrochemical studies. The principle of photo-renewability of titanium dioxide has recently been used for the production of robust and reusable sensors for pH and conductivity to be installed in pipes for the continuous monitoring of drinking water, with interesting results, within the DRINKABLE project Cariplo foundation, in collaboration with Dr. Manuela Antonelli (Politecnico di Milano) and the Integrated Water Service of the city of Milan - Metropolitana Milanese SpA;
4) tin oxide on graphene oxide, synthesized in different proportions, was electrochemically characterized to fully understand the properties necessary for the construction of sensors for the detection of ethanol, acetone and ethylbenzene in the gas phase (in collaboration with the group of Prof. Cappelletti of the Department of Chemistry).

Finally, as Associate Professor, in addition to continuing the studies concerning the previous two points and putting together the results obtained, I am developing new photoelectrochemical sensors with hybrid materials that are able to exploit the absorption of light in the UV-vis spectrum to increase their electroanalytical performances. These materials are based on the use of metal nanoparticles, which possess an intense plasmon band, in contact with a layer of titanium dioxide, forming the so-called heterojunctions, and have been used for the determination of ciprofloxacin (antibiotic). Other types of materials and analytes are also being studied in parallel with a deep chemical-physical characterization to fully understand their functioning.

Other Research Activities and scientific collaborations within the Department

- optimization of electrochemical and electroanalytical methodologies complemented by theoretical-computational studies and structural studies with synchrotron light (XRD, EXAFS) for the study of nanometric semiconductors (TiO2, ZnO) through characterization with uncommon techniques such as Photovoltage and Photocurrent in order to obtain information about the position of the quasi Fermi level and the electron-hole recombination rate, fundamental for the properties of these samples to be used as photocatalysts and to better understand how the addition of dopants can affect their electronic characteristics (in collaboration with Prof. Silvia Ardizzone, Dr. Giuseppe Cappelletti, Dr. Michele Ceotto, Dr. Leonardo Lo Presti - University of Milan). In this context, I spent two short periods at the synchrotron in Grenoble and Trieste;
- physico-chemical characterization and study of the absorption of polluting molecules by polyaminoamide hydrogels also containing cyclodextrins for applications in analytical and sensor chemistry, environmental chemistry and medicine (in collaboration with Prof. Elisabetta Ranucci, Prof. Paolo Ferruti, Dr. Amedea Manfredi - University of Milan). In this context, a new line of research is starting based on the construction of electrodes modified with electrospun polymers with controlled porosity, containing cyclodextrins, capable of absorbing and therefore pre-concentrating the reference analyte on the electrode for subsequent voltammetric determination. It is expected that the pre-concentration effect, together with the possible change of diffusive mechanism, from linear to thin layer, can increase the sensitivities of the method, lowering the detection limits towards polluting molecules belonging to the class of priority emerging contaminants.

Other Research Lines and scientific collaborations outside the Department

Given the strong interdisciplinary nature of the research topics and the skills acquired in the analytical and physico-chemical characterization of materials, I have collaborated and collaborate with other Research Groups outside the Chemistry Department of the University of Milan, in order to solve, with the aid of electrochemical techniques, analytical problems of various kinds. In particular, collaborations with the following scientific realities should be noted:

- Prof. Christopher Brett (University of Coimbra - Portugal): construction and electroanalytical and electrochemical characterization (using voltammetric techniques and with impedance spectroscopy) of electrodes modified with innovative materials (carbon nanotubes, graphene, conductive polymers);
- Dr. Silvia Franz (Politecnico di Milano): electrochemical and electroanalytical characterization of new modified electrodes based on nanostructured materials (nanowires, nanopores and nanotubes of gold, silver, carbon, titanium dioxide,…);
- Dr. Chiara Ingrosso and Dr. Roberto Comparelli (CNR - Bari): chemical-physical characterization of titanium dioxide and grafene based nanomaterials;
- Prof. Ilaria Palchetti (Università degli Studi di Firenze): biosensors;
- Prof. Giampietro Farronato e Dr. Marco Tremolati (Dipartimento di Scienze Biomediche, Chirurgiche ed Odontoiatriche, UNIMI): studio e messa a punto di tecniche analitiche ed elettroanalitiche per la caratterizzazione di materiali per la pratica odontoiatrica;
- Dr. Enrico Davoli (Mario Negri Institute, Milan): study of semiconductor nanoparticles for application in nano-PALDI / TOF imaging [Project funded by Fondazione Cariplo - 2012];
- Integrated Water Service of the city of Milan - Metropolitana Milanese S.p.A .: study and optimization of analytical and electroanalytical methods for the determination of emerging pollutants in water for human consumption;
- Dr. Manuela Antonelli (Polytechnic of Milan): study of the properties of vegetable and mineral activated carbon for the removal of organic micropollutants from groundwater;
- Prof. Marcella Guarino and Dr. Valentina Ferrante (Department of Environmental Sciences and Policies): study of new sensors and electronic noses for the assessment of air quality in veterinary diagnostics.
- Prof. Ligia Maria Moretto (Cà Foscari University - Venice): electrodes were characterized and applied for the determination of polluting molecules such as benzidine, tetramethylbenzidine, tolidine and o-toluidine, obtained using innovative supports (PPCE, Pyrolysed Photoresist Carbon Electrode obtained with lithographic technique).
- Dr. Stefano Cinti (University of Naples Federico II): characterization of carbon based inks deposited on supports of different materials and porosity (ceramic, plastic, filter paper and office paper).
- Prof. Schmuki (WW4-LKO - University of Erlangen-Nuremberg): study of titanium dioxide nanotubes of different lengths capable of offering different responses depending on the type of probe molecule, the pH of the solution and the ionic strength.

Technological Transfer

The great applicative potential of the skills acquired in the field of analytical and electroanalytical techniques and chemical-physical characterization of materials, has allowed me to develop various collaborations and/or third party contracts with the following industrial companies and research laboratories:

- Parco Tecnologico Padano (Italy): characterization of different types of cream to determine the stability of whipped cream;
- BWT (Best Water Technology) - Group (Austria): analysis of the effectiveness of the purification of water for human consumption with the aid of filter jugs;
- De Nora S.P.A. (Italy): electrochemical tests of anodes covered with innovative materials.

TEACHING, SUPPLEMENTARY TEACHING AND STUDENT SERVICE ACTIVITIES

Teaching Activity

- Lecturer in Analytical Chemistry I / Laboratory of Analytical Chemistry I for the Bachelor's degree course in Chemistry for the academic years 2018/2019, 2019/2020, 2020/2021, 2021/2022, 2022/2023.
- Lecturer in Analytical Chemistry I / Laboratory of Analytical Chemistry I for the Bachelor's degree course in Industrial Chemistry for the academic years 2018/2019, 2019/2020, 2020/2021, 2021/2022, 2022/2023.
- Lecturer in Nanotechnology for biomedical applications and biosensors teaching for the master's degree course in Molecular biotechnology and bioinformatics for the academic years 2021/2022, 2022/2023.
- Lecturer in Environmental control and sustainability management for the master's degree course in Industrial Chemistry for the academic years 2021/2022, 2022/2023.

I collaborated with the organization and provided assistance in educational laboratories for various courses of the three-year degree courses in Chemistry and Industrial Chemistry, Industrial and Environmental Biotechnologies of the University of Milan:

- Laboratory of Analytical Techniques for the Bachelor's degree Course in Industrial and Environmental Biotechnologies;
- Physical Chemistry Laboratory I for the Bachelor's degree Course in Chemistry.

In addition, I have held seminars for the teaching of the Master's Degree Courses in Chemistry and Industrial Chemistry and for the Doctoral Courses in Chemical Sciences and Industrial Chemistry.

- Seminar "Advanced Electroanalysis: from macro to micro ... to nano" within the course of Advanced Electroanalytical Chemistry (from 2014 to today) for the Master's Degree Course in Chemical Sciences;
- Seminar within the teaching "Methods of monitoring and treatment of drinking water" (2016) for the PhD courses in Chemical Sciences and Industrial Chemistry.
- Seminar within the teaching "Surface modification for electrocatalysis and electroanalytical applications" (2019) for the PhD courses in Chemical Sciences and Industrial Chemistry.

Bachelor's and Master's Degree THESES

Supervisor of 15 Bachelor's Degree Theses and 6 Master's Degree Theses, co-supervisor of 12 Bachelor's Degree Theses and 9 Master's Degree Theses.

Other activities

- In collaboration with the teachers of the School, I held informative and orientation scientific seminars for various classes of the High Schools, on the following topics: "Energy and sustainable development", with construction and practical demonstration of the operation of a fuel cell (Fuel cell) and Grätzel photovoltaic cells; "The chemistry of colors in painting", with experiences in the laboratory aimed at discovering the elements that can be found in the pigments used in painting.

- I have participated in various events in the context of orientation initiatives, the Scientific Degrees Project and science dissemination initiatives organized by the Department and its Orientation Commission:

    1) 2011: participation in the "Science Adventure: Chemistry on Show" initiative, orientation activities for high school students; "PH: what it is and how to measure it", with guided practical demonstration in the laboratory;
    2) 2013: organization and participation in the Summer School initiative - One day as a Researcher, orientation activities for high school students with presentation of the research activities of the Department of Physical Chemistry and Electrochemistry;
    3) 2015-2016: participation in MeetMeTonight, with activities related to the monitoring and disinfection of drinking water.
    4) 2018-2019: Chemistry Introduction Laboratories "We determine vitamin C in food samples with colorimetric and amperometric redox titrations".
    5) 2018-today: scientific dissemination with activities in lower secondary schools entitled "Water ... transparent

gold", an initiative in collaboration with the Royal Society of Chemistry, Italy local section.

6) 2019: theoretical and practical teacher training seminar " La Chimica è difficile?...ma va!" organized in collaboration with Federchimica.
7) 2019: Festival of sustainable development, intervention "Drinking water: controls and quality".
8) 2022: participation in the FOCUS LIVE 2022 event, the Workshops told by Mondadori Education and Fatti, non fake! in collaboration with the University of Milan to experiment and understand both everyday chemistry and the chemistry of the future.

- Furthermore, for the Italian Chemical Society:
  1) Teacher-coach in Analytical Chemistry for high school students who participated in the Chemistry Olympics 2011 (Turkey), 2013 (Russia) and 2014 (Vietnam).