Rayhane Zribi

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Doctor in Engineering and Chemistry of Materials and Construction, specializing in chemical and optical sensors based on 2D materials for biomedical and environmental applications.

International experience in research and development, with expertise in nanomaterial synthesis, advanced characterization and design of innovative sensors.

EDUCATION

Ph.D in Engineering and Chemistry of Materials and Construction

01/10/2019- 31/03/2023

Engineering Department, University of Messina, Italy.

- *Thesis title:* " Two-dimensional Molybdenum disulfide electrochemical-based sensors for biomedical applications".
- *Supervisor:* Prof. Giovanni Neri.
- *Date of Defense:* 03/07/2023.
- *Final vote:* excellent with additional title "Doctor Europaeus" (ottimo con Lode con Menzione).

The PhD project focuses mainly on one of the most famous 2D transition metal dichalcogenides, molybdenum disulfide (MoS_2), a very famous semiconductor that changes its band gap from indirect to direct by changing the number of layers, in addition to other 2D materials.

Recently, this material has been used in different research applications, including chemical sensors, which have been growing due to the real need to replace the expensive techniques currently used. The thesis work was carried out in collaboration between CNR-IPCF Messina and the University of Messina, in which the synthesis of the materials and the physicochemical characterization were carried out at CNR-IPCF Messina while the development of the sensors was carried out at the University of Messina for the detection of different biomolecules and pesticides.

During the PhD program, two highly impactful milestones were undertaken, demonstrating a strong commitment to the advancement of research and global collaboration. The first was a 3-month research internship at **École Polytechnique de Paris in France**.

The second was a 6-month in-depth research internship at the Department of Mechanical Engineering at **Iowa State University in the United States**. These experiences not only enriched technical expertise but also fostered valuable international exposure and interdisciplinary collaboration.

Master's Degree in Physics of materials and nanostructures **01/10/2016 - 31/10/2018**

Department of Physics, University of Sfax, Tunisia

- *Thesis title:* " Development of new molybdenum disulfide nanosheets biosensor".
- *Supervisor:* Prof. Ramzi Maalej.
- *Date of Defense:* 30/10/2018.

The Master thesis focuses on the development of advanced chemo-(bio)sensors based on novel two-dimensional (2D) nanomaterials for tyrosine detection. Recently, 2D materials have been used for electrochemical sensing due to their atomic thin-film structure, large surface-to-volume ratio, high adsorption capacity, high surface activities and promising semiconducting properties.

Bachelor's degree in fundamental Physics **15/09/2013 – 09/06/2016**

Department of Physics, University of Sfax, Tunisia.

High School degree in Mathematics **15/09/2009 – 30/06/2013**

Habib Bourguiba high school, Sfax, Tunisia.

ACADEMIC POSITIONS

✓**Postdoctoral fellowship** **15/03/2024 – to present**

Funded by European Union – NextGenerationEU, National Research Council, institute of physical-chemical processes CNR-IPCF, Messina, Italy.

Postdoctoral fellowship under the framework of the research program "Synthetically engineered emissive peptide nucleic acids (PNAs) for medical diagnostics based on optical techniques and surface-effects-amplified Raman spectroscopy (SERS)".

✓**Postdoctoral fellowship** **15/11/2023- 14/03/2024**

Funded by Engineering Department, University of Messina, Italy.

Postdoctoral fellowship for carrying out the activity of green materials and technologies for the development of sensors based on nanomaterials and 2D materials for environmental monitoring.

✓**Postdoctoral fellowship** **15/05/2023 – 14/11/2023**

Funded by Engineering Department, University of Messina, Italy

Postdoctoral fellowship for research activity for the development of chemical sensors based on 2D materials for monitoring in the marine environment.

✓**Visiting scholarship** **01/12/2018 - 30/07/2019**

Funded by INSTM

Internship at the University of Messina (Italy) at the Engineering department inside the "sensor's laboratory" under the supervision of Prof. Giovanni Neri, for the development of advanced chemo-(bio)sensors for biomedical applications.

INTERNSHIPS AND EXCHANGE PROGRAMS

✓ **Visiting scholar** **10/07/2022 - 31/12/2022**

Department of Mechanical Engineering, Iowa State University, Iowa, USA.

The visiting period was conducted inside the laboratory of "Claussen Lab" under the supervision of Prof. Jonathan Claussen, in collaboration with Prof. Carmen Gomes.

Gained skills: Printing sensors using Laser Induced Graphene technique for the development of enzymatic and enzyme-free electrochemical sensors based on transition metals dichalcogenides materials for pesticides and biomolecules detection.

✓ **Visiting scholar** **18/03/2022 - 23/06/2022**

Ecole Polytechnique de Paris, Palaiseau, Paris, France.

The visiting period was conducted inside the laboratory of "Physics of Interfaces and Thin films-LPICM" under the direction of Prof. Yvan Bonnassieux, under the supervision of Prof. Aleix Guell in collaboration with Prof. Razvigor Ossikovski.

Gained skills: Trainings on Scanning Electron Microscope and Atomic Force Microscope for the characterization of nanomaterials.

✓ **ERASMUS+ KA107** **23/09/2016 - 28/07/2017**

Department of Physics, University of Messina, Italy.

During this exchange program, the first year of Master course in physics was concluded.

PARTICIPATION TO SCIENTIFIC PROJECTS

❖ **Synthetically Engineered EMissive PNA for Medical Diagnostics based on Optical and Surface-Enhanced Raman Techniques – SEMPER.**

Institute : IPCF-CNR Messina, Italy.

Post : postdoctoral grant

Duration : 15/03/2024 – to present

Activity : Characterization and detection of peptide nucleic acids (PNA) and miRNA using advanced Raman spectroscopic techniques that exploit surface plasmonic effects for local electromagnetic field amplification (SERS) using optical tweezers coupled with Raman spectroscopy (Horiba XploRA, in-house Raman tweezers) for the development of miR biosensors in microfluidic chip.

- **Active matter: from fundamental science to technological applications.**

Institute : IPCF-CNR Messina, Italy.

Post : associate with collaboration assignment

Duration : 10/2019- 03/2024

Activity : Development and characterization of 2D Materials for sensor's development.

- **Development of biomaterials and eco-friendly technologies for environmental protection - MATECAMB".**

Institute : Department of Engineering, University of Messina, Italy.

Post : postdoctoral grant

Duration : 15/11/2023 – 14/03/2024.

Activity : green materials and technologies for the development of sensors based on nanomaterials and 2D materials for environmental monitoring.

- **ARS01_00333 "Innovative technologies for control, monitoring and safety at sea" (TETI)**

Institute : Department of Engineering, University of Messina, Italy.

Post : postdoctoral grant

Duration : 15/05/2023 – 14/11/2023

Activity : development of chemical sensors based on 2D materials for monitoring in the marine environment.

SCIENTIFIC PUBLICATIONS

1. Belaid, S.; **Zribi, R.*;** Chelly, M.; Saadaoui, E.; Fazio, E.; Neri, G.*. Silver nanoparticles synthesized using Eucalyptus salmonophloia essential oil as potential electrode material for the electrochemical sensing of dopamine. Microchem. J. 2025, 208, 112493. https://doi.org/10.1016/j.microc.2024.112493 .

2. Wali, R.; **Zribi, R.*;** Maalej, R.; Foti, A.; Gucciardi, P.G.; Cheikhrouhou-Koubaa, W.; Neri, G. 2D-MoS_2-chitosan nanocomposite: a novel electrochemical platform for highly selective and sensitive dopamine detection. SUBMITTED.

3. **Zribi, R.†;** Johnson, Z.T.†; Ellis, G.; Banwart, C.; Opare-Addo, J.; Hooe, S.L.; Breger, J.C.; Foti, A.; Gucciardi, P.G.; Smith, E.A.; Gomes, C.L.; Medintz, I.L.; Neri, G.; Claussen, J.C. Molybdenum Disulfide/Diselenide-Laser-Induced Graphene-Glycine Oxidase Composite for Electrochemical Sensing of Glyphosate. ACS Appl. Mater. Interfaces. 2025, 17, 1, 247–259. https://doi.org/10.1021/acsami.4c14042 .

4. **Zribi, R.**; Crispi, S.; Giusi, D.; Zhukush, M.; Ampelli, C.; Shen, C.; Raza, M.H.; Pinna, N.; Neri, G. Gas Sensing and Electrochemical Properties of CNT/WS_2 Core−shell Nanostructures. ACS Appl. Nano Mater. 2024, 7, 4998−5008. https://doi.org/10.1021/acsanm.3c05751.

5. Nocito, G.; **Zribi, R.;** Chelly, M.; Pulvirenti, L.; Nicotra, G.; Bongiorno, C.; Arrigo, A.; Fazio, B.; Neri, G.; Nastasi, F.; Conoci, S. Photochemical synthesis, characterization, and electrochemical sensing properties of CDs-AuNPs nanohybrids. Nanoscale, 2024. https://doi.org/10.1039/D3NR05897B.

6. **Zribi, R.**; Ferlazzo, A.; Fazio, E.; Condorelli, M.; D'Urso, L.;Neri, G.; Corsaro, C.; Neri, F.; Compagnini, G.; Neri, G. "Ag Nanoplates Modified-Screen Printed Carbon Electrode to Improve Electrochemical Performances Toward a Selective H_2O_2 Detection". IEEE Transactions on Instrumentation and Measurement , 2023, 72, 1-8, Art no. 6002708. https://doi.org/10.1109/TIM.2023.3253902.

7. **Zribi, R.**; Foti, A.; Donato, M.G.; Gucciardi, P.G.; Neri, G. Electrochemical and sensing properties of 2D-MoS_2 nanosheets produced via liquid cascade centrifugation. Electrochimica Acta. 2022, 141433. https://doi.org/10.1016/j.electacta.2022.141433.

8. Abid, K.; **Zribi, R.**; Maalej, R.; Foti, A.; Khaskhoussi, A.;Gucciardi, P.G.; Neri, G. Electrochemical and sensing properties of AuNps-2D-MoS_2/SPCE for folic acid determination. FlatChem. 2022, 100433. https://doi.org/10.1016/j.flatc.2022.100433.

9. **Zribi, R.**; Foti, A.; Donato, M.G.; Gucciardi, P.G.; Neri, G. Fabrication of a Novel Electrochemical Sensor Based on Carbon Cloth Matrix Functionalized with MoO_3 and 2D-MoS_2 Layers for Riboflavin Determination. Sensors. 2021, 21,4, 1371. https://doi.org/10.3390/s21041371.

10. Chelly, M.†; Chelly, S. †; **Zribi, R.**; Bouaziz-Ketata, H.;Gdoura, R.; Nehru, L.; Veerapandi, G.; Sekar, C.; Neri, G. Synthesis of Silver and Gold Nanoparticles from Rumex roseus Plant Extract and Their Application in Electrochemical Sensors. Nanomaterials. 2021, 11, 739. *(**Zribi, R.** is considered as 2nd author).* https://doi.org/10.3390/nano11030739.

11. Chelly, S. †; Chelly, M. †; **Zribi, R.**; Gdoura, R.; Bouaziz-Ketata, H.; Neri, G. Electrochemical Detection of Dopamine and Riboflavine on a Screen-Printed Carbon Electrode Modified by AuNPs Derived from Rhanterium suaveolens Plant Extract. ACS Omega. 2021, 6, 37, 23666–23675. *(**Zribi, R.** is considered as 2nd author).* https://doi.org/10.1021/acsomega.1c00793.

12. **Zribi, R.**; Maalej, R.; Messina, E.; Gillibert, R.; Donato, M.G.;Marag`o, O.M.; Gucciardi, P.G.; Leonardi, S.G.; Neri, G. Exfoliated 2D-MoS_2 nanosheets on carbon and gold screen printed electrodes for enzyme-free electrochemical sensing of tyrosine. Sens.Actuators B Chem. 2020, 303, 127229. https://doi.org/10.1016/j.snb.2019.127229.

13. **Zribi, R.**; Maalej,R.; Gillibert, R.; Donato, M.G; Gucciardi,P.G; Leonardi, S.L; Neri, G. Simultaneous and selective determination of dopamine and tyrosine in the presence of uric acid

with 2D-MoS_2 nanosheets modified screen-printed carbon electrodes. FlatChem. 2020, 100187. https://doi.org/10.1016/j.flatc.2020.100187.

14. **Zribi, R.**; Neri,G. Mo-Based Layered Nanostructures for the Electrochemical Sensing of Biomolecules. Sensors. 2020, 20(18), 5404. https://doi.org/10.3390/s20185404.

15. Abid, K.; Belkhir, N.H.; Jaber, S B.; **Zribi, R.**; Donato, M.G.;Di Marco,G.; Gucciardi, P.G.; Neri, G.; Maâlej, R. Photoinduced Enhanced Raman Spectroscopy with Hybrid Au@WS_2 Nanosheets. J. Phys. Chem.C. 2020, 124, 20350−20358. https://doi.org/10.1021/acs.jpcc.0c04664.

CONFERENCE PAPERS

1. **Zribi, R.**; Raza, M.H.; Pinna, N.; Neri, G. Electrochemical Performance of WS2-CNT Core–Shell Heterostructures for the Detection of Vitamin B_2. Presented at the XXXV EUROSENSORS Conference, Lecce, Italy, 10–13 September 2023, Proceedings 2024, 97(1), 39. https://doi.org/10.3390/proceedings2024097039.

2. **Zribi, R.**; Fazio, E.; Condorelli, M.; D'Urso, L.;Neri, G.; Corsaro, C.; Neri, F.; Compagnini, G.; Neri, G. H_2O_2 electrochemical sensing properties of size-tunable triangular Ag nanoplates. Presented at IEEE International Symposium on Medical Measurements and Applications (MeMeA), Messina, Italy, 2022, 1-5, https://doi.org/10.1109/MeMeA54994.2022.9856416 .

PARTICIPATION TO SCHOOLS

1. **Fifth School of Optical Biosensors and Biophotonics.**

03/06/2024- 07/06/2024

Lecce, Italy.

2. **Eurosensors 2023.**

10/09/2023

Lecce, Italy.

3. **E-talk " Towards environmental application from 2D materials".**

26/05/2021

Online

4. **E-talk "Nanotechnology- smart materials: Research: Commercialization".**

21/03/2021

Online

RESEARCH EXPERTISE AND GENERAL SKILLS

✓ *Synthesis and Fabrication:* Expertise in synthesizing 2D materials using low-cost, large-scale methods, such as Liquid Phase Exfoliation and Liquid Cascade Centrifugation.

✓ *Nanomaterials Characterization:* Proficient in characterizing nanomaterials using a wide range of techniques, including Raman spectroscopy, UV-Vis spectroscopy, Scanning Electron Microscopy (SEM), Atomic Force Microscopy (AFM), Dynamic Light Scattering (DLS), and FT-IR spectroscopy.

✓ *Sensor Development:* Skilled in developing various chemical and optical sensors for applications in medical diagnostics, environmental monitoring, and food safety assurance.

✓ *Nanoparticles Aggregation & SERS:* Experience in using optical forces to aggregate nanoparticles and induce surface-enhanced Raman scattering (SERS) from integrated molecules for the development of biosensors in a microfluidic chip.

✓ *Multilingual Communication:* Fluent in Arabic, French, English, and Italian. Excellent verbal and written communication skills in multiple languages.

✓ *Teamwork and adaptability:* Demonstrated ability to collaborate effectively within diverse and multidisciplinary teams with a high level of adaptability and flexibility in dynamic work environments.

PARTICIPATION AUX CONFERENCES

List of conferences where I was invited as an "Invited speaker" or where I gave an oral or poster presentation:

- **Rayhane Zribi**, Zachary T. Johnson, Ratiba Wali, Antonino Foti, Pietro Giuseppe Gucciardi, Jonathan Claussen, Carmen Gomez, Ramzi Maalej, Giovanni Neri.
  "Innovative 2D material sensors: A new era in medical and environmental technologies"
  International Conference on Functional Materials & the International Conference on Ecological Economics and Water, Energy, Environment Resources Management, ICFM 2024 & ICEWE 2024. Yasmine Hammamet, Tunisia, 27-30/10/2024: **Invited speaker**.

- **Rayhane Zribi**, Zachary T. Johnson, Ratiba Wali, Antonino Foti, Pietro G. Gucciardi, Jonathan Claussen, Carmen Gomez, Ramzi Maalej, Giovanni Neri.
  "Two-dimensional Molybdenum disulfide electrochemical based sensors for biomedical and agriculture applications." **Arab-German Plasmonic Sensing Network**. Cairo, Egypt, 23-26/09/2024: **Invited speaker**.

- **Rayhane Zribi**, Ratiba Wali, Antonino Foti, Pietro G. Gucciardi, Ramzi Maalej, Giovanni Neri.
  "2D-MoS_2-chitosan nanocomposite as a novel electrochemical platform for highly selective and sensitive urinary dopamine detection". **Graphene2024 Conference**. Madrid, Spain, 25-28/06/2024: **Oral presentation**. https://www.grapheneconf.com/2024/program.php?d=26 .

- **Rayhane Zribi**, Nesrine Hafienne, Giovanni Neri.
  "Hydrogen sulfide sensing properties of Cu_XS-In heterojunctions". **XXII Conferenza**

Nazionale Sensori e Microsistemi. Bologna, Italy, 7-9/02/2024: **Poster presentation**. http://www.aisem.eu/wp-content/uploads/2024/01/AISEM24-programma.pdf

- **Rayhane Zribi**, Muhammad Hamid Raza, Nicola Pinna, Giovanni Neri. Electrochemical *"Performance of WS_2-CNT Core-Shell Heterostructures for Detection of Vitamin B_2."* **Eurosensors school and conference**. Lecce, Italy, 10-13/09/2023: **Oral presentation**. https://www.eurosensors2023.eu/wp-content/uploads/2023/09/eurosensors2023-program-web.pdf.

- **Rayhane Zribi**, Enza Fazio, Marcello Condorelli, Luisa D'Urso, Giulia Neri, Carmelo Corsaro, Fortunato Neri, Giuseppe Compagnini, Giovanni Neri.
  "H_2O_2 electrochemical sensing properties of plasmon-enhanced Ag nanoplates." **Medical Measurement and Applications, MeMeA**. Taormina, Italy, 22-24/06/2022: **Oral presentation**.
  https://confcats-event-sessions.s3.amazonaws.com/memea22/uploads/MEMEA-2022_fullprogram_v3.pdf.

- **Rayhane Zribi**, Antonino Foti, Maria Grazie Donato, Pietro. G. Gucciardi, Giovanni Neri. *"Electrochemical and sensing properties of 2D-MoS2 nanosheets produced via liquid cascade centrifugation at different rate."* **Congresso Nazionale della Società Chimica Italiana, SCI**. Virtual conference. 14-23/09/2021: **Oral presentation**. (email of organizer: education@searchon.it).

- **Rayhane Zribi**, Giovanni Neri.
  "Fabrication of a Novel Electrochemical Sensor Based on Carbon Cloth Matrix Functionalized with MoO_3 and 2D-MoS_2 Layers for Riboflavin Determination." **New times "New trends in Materials science and Engineering**". 14-18/06/2021: virtual conference. **Oral presentation**. https://www.new-times.org/wp-content/uploads/2021/11/Book-of-Abstracts-NEW-TIMES_.pdf.

- **Rayhane Zribi**, Ramzi Maalej, Pietro G. Gucciardi, Giovanni Neri.
  "2D-MoS_2 nanosheets for the electrochemical detection of biomarkers."
  Associazione Italiana di Chimica per Ingegneria, AICIng, Lipari, Italy, 27-29/06/2019: **Poster and flash presentation.** http://www.aicing.it/wp-content/uploads/ATTI-VIII-Worksh_DEFINITIVO.pdf.