PhD contract offer

Start: October 2025

Application of DBD Plasma Technology for the Removal of Antibiotics in Wastewater Treatment

General information

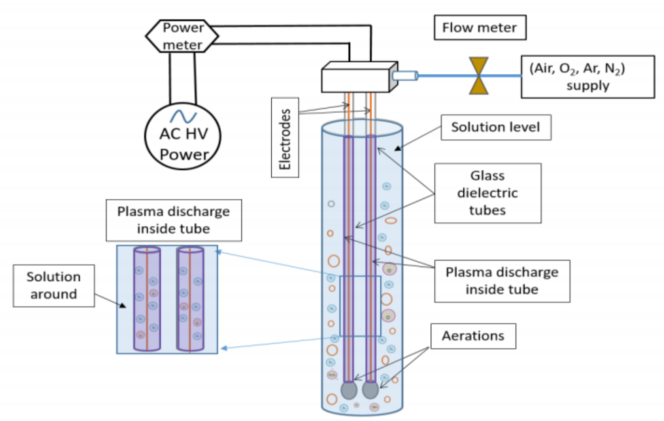
Place of work: Nancy, France (Institut Jean Lamour)
Type of contract: PhD contract (government funding)
Duration of the contract: 36 months, **Proportion of work:** Full time
Expected date of employment: October 1, 2025
Remuneration: 2,044.12 €/month
Desired level of studies: Master's degree in plasma physics-chemistry or equivalent
Director of the thesis: Thomas Gries, **Co-supervisor:** Nguyen Truong Son

1. Subject

Context:
Antibiotics are commonly found in environmental compartments like surface water and groundwater, and are classified as emerging contaminants due to their persistence and contribution to antibiotic resistance, a critical global health issue. In recent years, plasma discharge in liquids has attracted significant attention, largely due to its broad potential in areas like chemical processing, biotechnology, environmental solutions, and medical advancements [1-3]. Plasma-liquid interactions represent a novel tool to efficiently activate and decontaminate water based on the unique reactivity of the plasma medium. These interactions of plasma with liquid induce a cascade of physical and chemical effects. Plasma-liquid interaction reactions produce a considerable amount of chemically active species that form at the plasma-liquid interface. These species are then transferred from the interface into the bulk liquid, where they can initiate desirable reactions in biological samples. Among the most important species [4] identified within bulk liquids are OH, O, O_3, NO, H, H_2O_2, NO_2^-, O_2^-, NO_3^-, and OH^-. These compounds (also called Reactive Oxygen Nitrogen Species – RONS) have been proven to be efficient in destruction of organic pollutants [5,6].
Over time, atmospheric pressure plasma sources such as dielectric barrier discharges (DBD) have been studied as potential processes that can be used for wastewater treatment [5]. For example, Karoui et al. [7] have used a combination of plasma and photocatalytic methods to treat Ciprofloxacin (CIP). They showed that the concentration of Ciprofloxacin decreases by more than 45% after 70 minutes of treatment with an initial concentration of Ciprofloxacin of 6 mg/L (voltage 18 kV; frequency 350 Hz and air flow rate 240 L/h). In an interdisciplinary collaboration, scientists from Romania and France (GREMI) [8] used the DBD plasma method to treat water mixed with two antibiotic compounds, amoxicillin (AMX), and sulfamethoxazole (SMX). They showed that by using the non-thermal plasma method, the antibiotics are completely removed within 40 minutes with an applied voltage of 13-15 kV at frequencies of 1000 Hz and 600 Hz.
While plasma treatment has proven its effectiveness in removing a wide range of contaminants, there are still many challenges. For instance, pollutants are not always completely removed, the processes are energy- and time-consuming, and the treatment capacities and contaminant concentrations addressed remain quite limited. There is also a lack of suitable configurations for easy scale-up. Moreover,

understanding the mechanisms involved in plasma-liquid interactions remains a major focus of ongoing research, requiring more comprehensive investigation. Specifically, the formation and interaction of reactive species in the plasma media, and their transport across the plasma-liquid boundary, are critical areas that needs deepened investigations.

Objectives and methods:
From the outstanding issues mentioned above, this project is designed to focus on the following main objectives:
1: Investigate the potential of the DBD plasma discharge (Figure bellow) as a green alternative to eliminate antibiotics in water such as SMX and CIP. These two antibiotics are persistent environmental contaminants that are not effectively removed by conventional wastewater treatment processes. Both antibiotics pose ecotoxic risks, and contribute to the development of antibiotic-resistant bacteria, a growing public health concern. Rather than focusing on the treatment of new antibiotic compounds, the main goal of this PhD project is to develop a scalable, plasma-based system that can effectively remove antibiotics like these and be transferred to real-life applications.



2: Research using tightly controlled approaches to ***clarify plasma-liquid interaction processes***, in particular the transport and reaction of species generated in the plasma environment with the liquid.

References:
[1] F. Rezaei et al., Materials 12:17 (2019) 2751
[2] Y. Yong et al., Plasma discharge in liquid: water treatment and applications. CRC press (2017)
[3] Metelmann et al., Comprehensive clinical plasma medicine: cold physical plasma for medical application. Springer (2018)
[4] P. J. Bruggeman et al., Plasma Sources Sci. Technol. 25 (2016) 053002
[5] Y. He et al., Water 14 (2022) 1351
[6] R. A. Priatama et al., Int. J. Mol. Sci. 23 (2022) 4609
[7] S. Karoui et al., Journal of Water Process Engineering 50 (2022) 103207
[8] B. Florin, et al., Plasma Processes and Polymers 20 (2023) 2300020.

2. Works plans

Within the framework of the project, the PhD student will carry out the following tasks:

Literature review and problem definition
- Review of existing water treatment methods for antibiotic removal and the limitations.
- Understanding non-thermal plasma (NTP) technology and its potential in water decontamination.

Experimental setup development and optimization
- Design and optimization of the plasma discharge system for water treatment.
- Study the effect of various plasma parameters (e.g., power, gas composition, flow rates) on antibiotic removal efficiency.
- Optimization of treatment conditions for maximum degradation efficiency.

Spectroscopic and analytical characterization

- Perform emission and absorption spectroscopy measurements to monitor plasma activity.
- Use chromatography to identify degradation by-products and ensure non-toxicity.
- Specific procedures will be developed to analyse species formed in both plasma and liquid environments, such as O_3, H_2O_2, NO_2^-, NO_3^-, and OH radicals.
- Analyse reaction pathways and kinetics of antibiotic breakdown in water.

Publication and knowledge dissemination

- Compile and publish research findings in peer-reviewed journals and present at conferences.

The work program as envisaged for this thesis is summarized in the table below:

Task	Activity	1st Year		2nd Year		3rd Year	
		S1	S2	S1	S2	S1	S2
1	Literature review and implementation of new designs configurations						
2	Optimization of treatment conditions for maximum degradation efficiency						
2	Study the properties and characteristic of plasma						
3	Study the plasma – liquid interactions (to analyse species formed in both plasma and liquid environments)						
4	Development and collaborations						

3. Requirements for candidates

Educational background

- Master's degree (or equivalent) in **Physics**, **Chemistry**, **Environmental Science**, **Chemical Engineering**, or related fields.
- Strong foundation in **plasma physics**, **water treatment technologies**, or **environmental chemistry** is highly desirable.
- Knowledge of analytical methods such as **chromatography**, **mass spectrometry**, or **spectroscopic techniques** is a plus.

Technical skills

- Proficiency in **laboratory work**, including designing and setting up of experiments.
- Basic data analysis skills (e.g., Origin) for interpreting experimental results.
- Familiarity with **instrumentation** for chemical and physical characterization is a plus.

Problem-solving and innovation

- Ability to think critically and propose innovative solutions for complex scientific challenges.
- Strong interest in interdisciplinary work involving **plasma technology** and **environmental applications**.

Communication skills

- Good written and oral communication skills in **English** (knowledge of French is an advantage but not mandatory).
- Ability to write research articles and present findings at international conferences.

Teamwork and collaboration

- Ability to work both independently and as part of a **multidisciplinary team**.
- Willingness to collaborate with other research groups for practical applications.

Motivation

- High motivation to conduct **cutting-edge research** in the field of water decontamination and sustainable technologies.

Keywords

Non thermal plasma; plasma liquid interactions; wastewater treatment; dielectric barrier discharge; advanced oxidation technologies; pharmaceutical residues;

Work context

The PhD student will work within the Plasmas Processes Surfaces (PPS) team of the Jean Lamour Institute (IJL), in the ARTEM campus in Nancy. It will be fully funded by a ministerial grant for a period of 36 months. Visits to external laboratories with which we collaborate are possible, depending on funding.

About the Jean Lamour Institute

The Jean Lamour Institute (IJL) is a joint research unit of CNRS and the University of Lorraine. It is affiliated with the CNRS Institute of Chemistry. Specialized in materials science and process engineering, its research areas cover the following fields: materials, metallurgy, plasmas, surfaces, nanomaterials, and electronics. The IJL has 183 researchers and faculty members, 91 engineering, technical, and administrative staff, 150 PhD students, and 25 post-doctoral researchers. It collaborates with more than 150 industrial partners, and its academic collaborations extend across approximately thirty countries. Its exceptional instrumental facilities are spread across 4 sites, with the main site being a new building located on the ARTEM campus in Nancy, which will be the primary location for the PhD work.

Constraints and Risks

The open position is in a sector that falls under the protection of the Nation's scientific and technical potential and therefore requires, in accordance with regulations, that the recruitment be authorized by the competent authority of MESRI (Ministry of Higher Education, Research and Innovation).

Application procedures

The application file includes the following elements:
- Curriculum Vitae.
- Cover letter.
- Copy or certificate of the master's degree.
- Grades and ranking of the two years of the master's degree (M1 and M2).
- Letter(s) of recommendation.
- Copy of the identity card or passport.

Applications must be sent before **March 31, 2025** by e-mail to:

- Dr. Thomas Gries: *thomas.gries@univ-lorraine.fr*
- Dr. Nguyen Truong Son: *truong-son.nguyen@univ-lorraine.fr*