

Plasma – liquid interaction for water activation and decontamination

Nguyễn Trường Sơn¹, Thierry Belmonte¹, Gérard Henrion¹, Thomas Gries¹, Cédric Noel¹, Gregory Marcos¹

¹Université de Lorraine, CNRS, IJL, F-54000 Nancy, France

Email : truong-son.nguyen@univ-lorraine.fr

Climate change, water contamination, and the growing demand for food caused by urbanization, industrialization, and population growth are among the most pressing challenges facing humanity today. Meeting these challenges requires the development of advanced technologies that can reduce the harmful impact of polluted water sources while at the same time supporting agricultural practices that are both productive and sustainable. The main goal of my work is to investigate the potential of non-thermal plasma as an environmentally friendly alternative to conventional approaches, with particular attention to two areas of application: the treatment of contaminated water and the activation of water for agricultural use.

Non-thermal plasma offers several promising advantages that make it an attractive candidate for these purposes. In agriculture it has the potential to improve productivity by enhancing plant growth, increasing resilience to stress, and raising yields, while reducing reliance on chemical fertilizers and pesticides. In the field of water treatment its strong oxidative properties enable the breakdown of pollutants, the inactivation of pathogens, and the restoration of water quality at a time when natural sources are increasingly threatened by human activities. By integrating these two dimensions, my research aims to show that plasma-based processes can contribute meaningfully to sustainable practices that balance food production with environmental protection.

Achieving this goal requires more than practical demonstrations. It also depends on a deeper understanding of the fundamental mechanisms that govern plasma–liquid interactions, including the formation of reactive species, their behavior in aqueous environments, and their influence on biological systems. Careful evaluation of energy efficiency is essential to determine whether these processes can be viable at larger scales. Equally important is strict adherence to safety standards, since the responsible implementation of plasma technologies in industrial and agricultural contexts must ensure both human and environmental well-being.

Because of the complexity of these challenges, my work places strong emphasis on interdisciplinary collaboration. It draws knowledge from plasma physics, chemistry, environmental science, biology, and agronomy in order to establish a solid scientific foundation for both current applications and future possibilities. My broader ambition is that this research will contribute to the emergence of a new scientific field that directly addresses environmental and agricultural concerns through plasma technology. By encouraging dialogue between scientific communities and promoting the responsible use of innovative methods, I hope my work will help define pathways toward practices that preserve natural resources, strengthen food security, and support global sustainability in the long term.