Stability Analysis of Plasma-Activated Water

Experimental design and decision-oriented scientific case study

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B.Sc. in Physics Engineering

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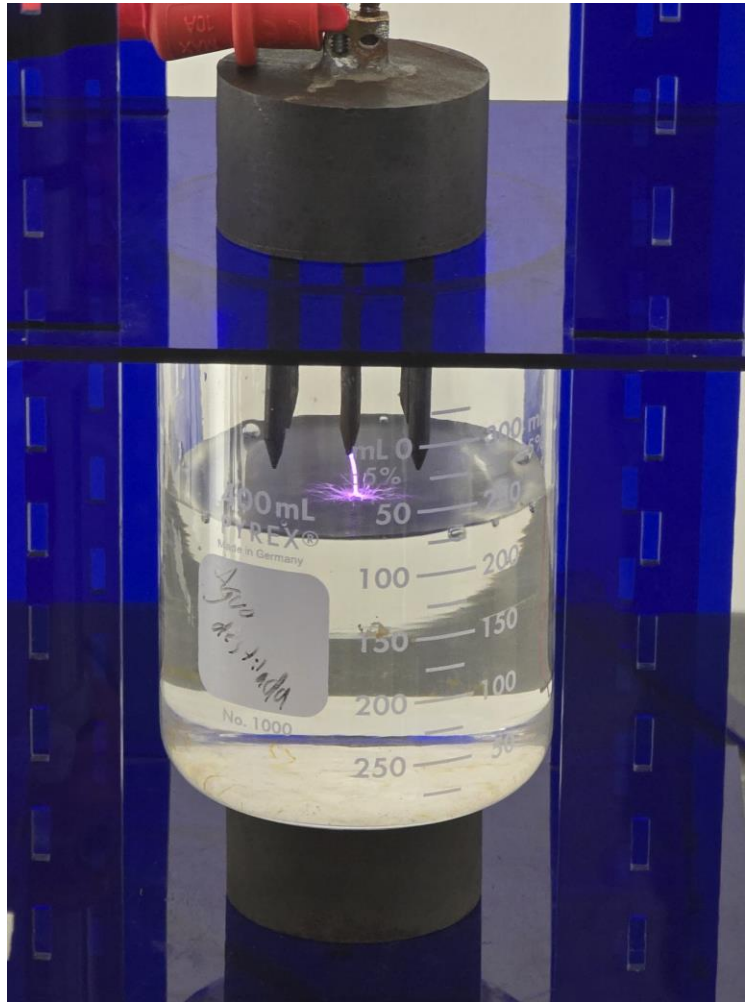
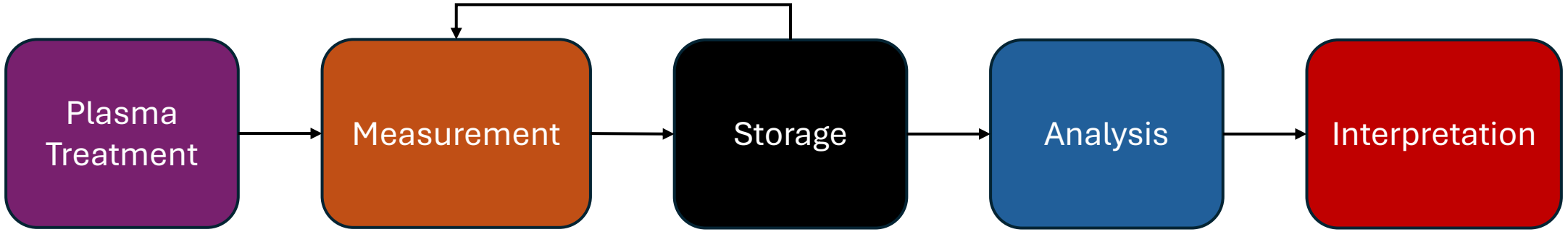
Introduction

- Plasma-activated water (PAW) is water treated with using a plasma discharge.
- The influence of operating variables on the physicochemical properties of PAW (pH, electrical conductivity, and redox potential), as well as their temporal evolution, is not yet fully understood.
- This project aims to establish a scientific basis for future research through the evaluation of PAW physicochemical properties.



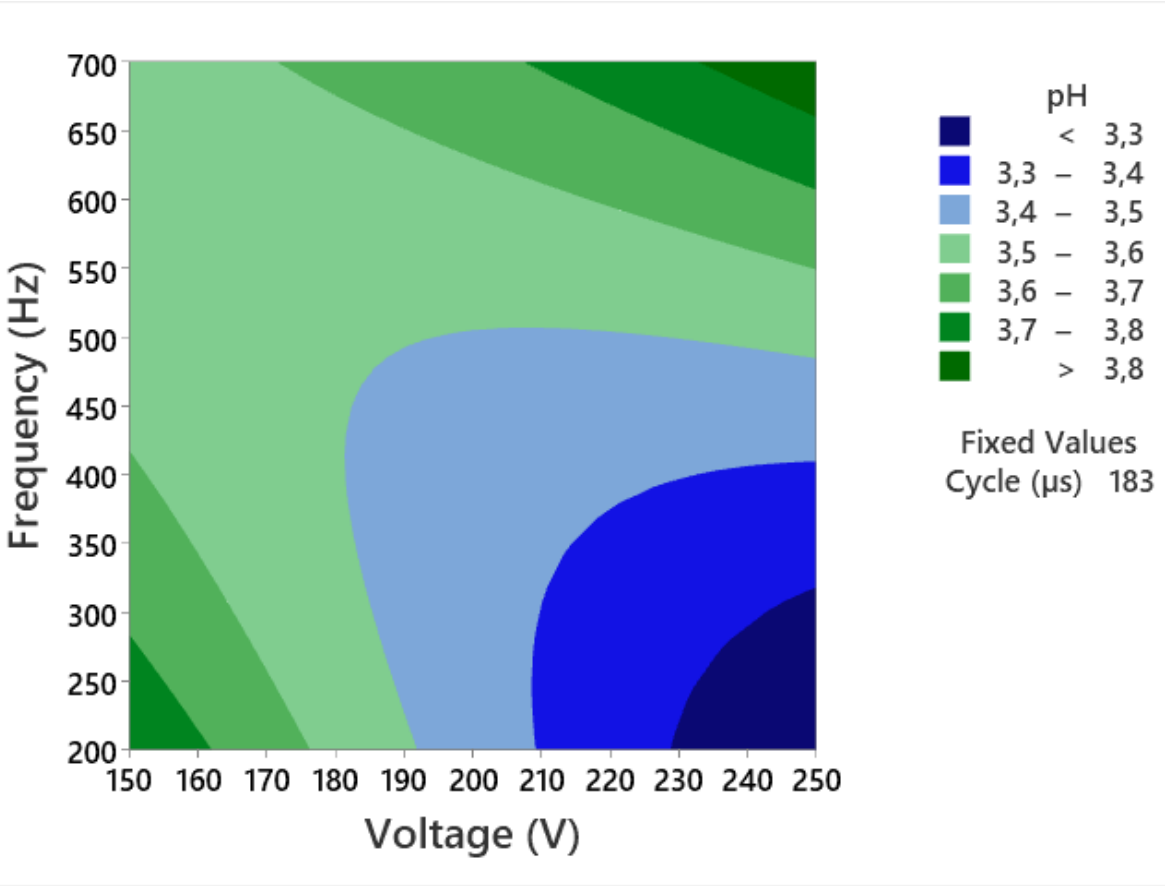
Experimental Design and Methodology

- Extensive state-of-art literature review.
- Box-Behnken design:
  - Evaluation of how operational parameters influence the physicochemical variables.
- Linear Mixed-effect Model:
  - Assessment of the temporal evolution of physicochemical variables after storage.



Key Results

- Contour plot analysis allowed the identification of operational regions where physicochemical properties reach desirable values.
- No statistically significant main effects were identified within the explored operational range, indicating a stable response behavior.
- The Linear Mixed-Effect Model shows stability for pH and electrical conductivity after two weeks of storage.



Interpretation & Decision-Making

- Contour plot analysis enabled the identification of operational parameters that enhance the magnitude of key physicochemical properties.
- The observed stability of pH, and electrical conductivity after two weeks of storage provides operational flexibility for experimental research.
- Overall, this project opens new research pathways in the characterization, optimization, and temporal evolution of plasma-activated water properties.

Learnings and transferability

- Design of Experiments (DoE) enables maximum information extraction under experimental constraints.
- Statistical rigor enabled transparent decision-making, suitable for industrial or regulatory environments.
- This approach bridges physics-based reasoning and data-driven decision-making.
- The methodology provides a reproducible framework for scaling, optimization and robustness analysis.

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