# Innovate Chemical Processes with Microwave Heating

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Doctoral Programe in Sustainable Chemistry

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## General objective

The selective characteristic of microwave heating is responsible for accelerating and enhancing many heterogeneous chemical reactions. In some cases, the formation of microwave hotspots generate desirable activity of catalytic particles in fixed bed flow systems. In other cases, these hotspots may be responsible for exceeding thermal limits in the system. We aim to optimize and innovate these chemical processes by understanding how hotspots are formed and how they are maintained.

## Specific Objectives

The motivation of this work is to understand the generation of microwave hotspots and the thermal non-equilibrium phenomenon seen in multi-particle systems during microwave heating. Additionally, we aim to i) create relevant benchmark cases that represent a reaction process, ii) answer the obstacles of microwave heating and iiii) meet the challenges of advanced control solutions into improving the microwave heating process.

## Experimental

I) Evaluate differences between experimental measurements and simulation results.

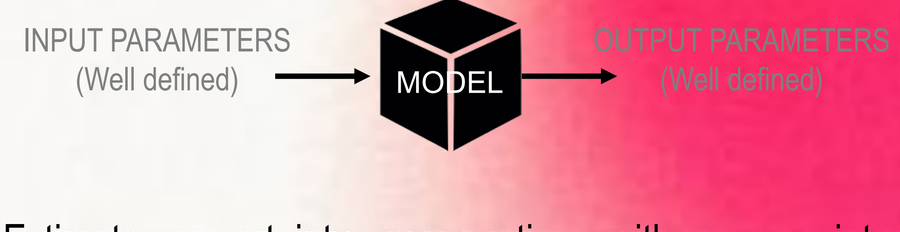
II) Multiscale procedure to characterize thermal and electromagnetic properties of multiple-particle systems.

III) Inverse algorithm to calibrate the kinetic models.

IV) Machine learning approaches for the control of multi-particle and fluid-structured systems.

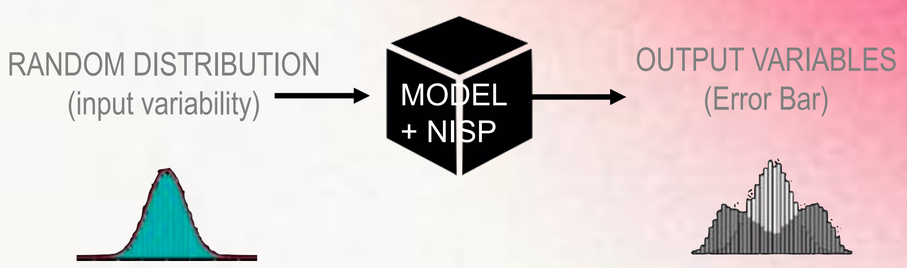
## Numerical Simulations

DETERMINISTIC PROCESS




V) Estimate uncertainty propagation with a non-intrusive spectral projection (NISP) to improve the microwave heating process.

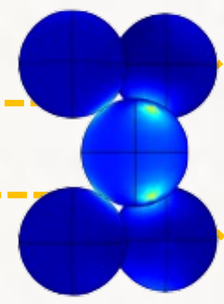
STOCHAISTIC PROCESS




## Applications

Microwave heating of materials has been showing potential in the reduction of energy consumption in energy-intensive industries and fixed-bed flow reactions are an important class of industrial chemical processes.

Advanced control of electromagnetic heating may be key to boost microwave technology into industry as a greener solution for energy intensive processes.



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