2D SIMULATION OF THE INTERACTION OF A NANOSECOND PULSED DISCHARGE WITH A PREMIXED FLAME

Research context :
In the framework of the joint french-german (ANR-DFG) research project DRACO started in 2014, we investigate the use of nanosecond pulsed discharges as an actuator for active control of combustion instabilities, without the drawbacks of traditional actuators such as loudspeakers or fuel valves.
These last years, plasma discharges at atmospheric pressure have received renewed attention in regards of their ability to enhance the reactivity of a variety of flows for applications ranging from surface treatment to the crucial issue of lean flame stabilization and ignition for aeronautical or automotive engines. Among the different types of discharges at atmospheric pressure, nanosecond pulsed discharges appear to be particularly promising. In [1] the use of non-equilibrium plasma discharges to control flame dynamics was successfully tested. In the DRACO project, one of the objectives is to better understand and optimize the coupling between the plasma and the flame dynamics.

[1] D.A. Lacoste, D.A. Xu, J.P. Moeck, C.O. Laux, Dynamic response of a turbulent lean-premixed flame to nanosecond repetitively pulsed discharges, Proc. Combust. Inst. 34 (2), pp 3259-3266, 2013

Description of the postdoctoral researcher work
The post-doctoral researcher will carry out multiscale simulations of a dedicated experiment that will be done at TU Berlin during the spring of 2015 to study the interaction of a nanosecond pulsed discharge with a premixed CH4/air flame at atmospheric pressure. The flame will be stabilized in a quartz tube and a nanosecond discharge, parallel to the flame front will be generated between two point electrodes in the tube.
First, the timescales of the nanosecond discharge will be decoupled and the post-doctoral researcher will simulate a laminar premixed flame in CH4/air to be used as initial condition for the discharge code. Then he/she will work on the simulation of a 2D nanosecond pulsed discharge between pin electrodes in a non-uniform and non-isothermal CH4/air mixture at atmospheric pressure based on an existing 2D code developed for air discharge simulations in point to plane geometries. Then, depending on the distance between the nanosecond discharge and the flame front, the influence of the flame front on the discharge dynamics will be studied. Different discharge regimes will be studied, with either low-energy nanosecond glow discharges or nanosecond spark discharges.
In a second step, a kinetic scheme taking into account charged species in the flame front will be implemented to study the dynamic coupling of the plasma with the flame. Finally, a detailed kinetic scheme will be implemented to compute the production of NO by the plasma coupled to the flame.
During his/her work, the post-doctoral researcher will interact with experimentalists at TU Berlin to compare and validate his/her results and discuss experimental and numerical results.

Profile: PhD in numerical simulations of combustion or of low-temperature plasmas.

Duration: 12 months, starting as early as possible in 2015

Salary: 2500 euros gross per month (including medical insurance).

Location: LPP Laboratory, Palaiseau, France

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