

Post-doctoral position:
Numerical study of the effect of additives to solid propellant combustion

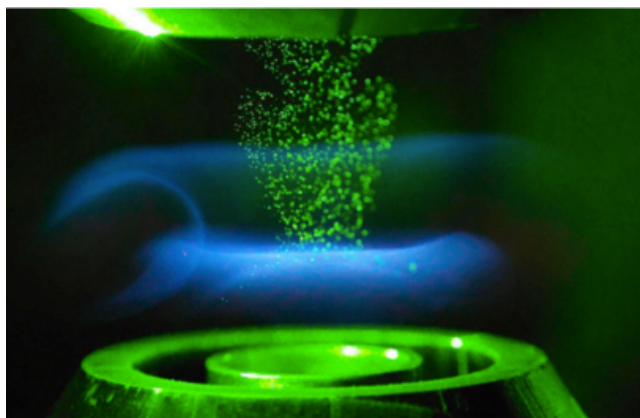
Context

The project lies in the context of the solid propulsion used for rockets. This type of propulsion requires dedicated fuels having very specific energetic characteristics. In particular, the combustion must deliver a very high impulse, which implies a maximization of the combustion temperature. The propellants are especially formulated to meet these requirements and contain additives to facilitate the decomposition of certain components involved in the combustion. If the efficiency of these additives is proven, the fundamental chemical and physical mechanisms are not yet understood, which is an obstacle to the development of new and more efficient but also cleaner molecules. Indeed, regulation leads to the elimination of certain additives (metal salts derived from lead for example) and to their replacement by molecules that are environmentally friendly and at least as effective. The accomplishment of this step requires the physical understanding and the modeling of the influence of additive on the combustion process. In practice, the additives can act in two phases involved in the combustion: surface combustion (release of gaseous species) and gaseous flame. Currently, knowledge of the kinetics involved in these reactions is limited by the complexity of the phenomena involved.

Objectives

The overall objectives of this post-doctoral study are to understand the effects of two additives, iron and bismuth, on the combustion of a solid propellant. To achieve this goal, the post-doctoral fellow will perform the following tasks:

- 1) Identification of the effects of iron and bismuth on the solid propellant decomposition
- 2) Adaptation of a detailed chemical scheme to account for the effect of additives on the combustion process
- 3) Simulation of laminar flames with and without additives. The configuration chosen for this study is the counter-flow laminar flame (see figure below). This elementary configuration, which is frequently used for the study of the combustion of spray and gaseous hydrocarbons, will be adapted for the first time to compute of the structure of flames arising from the decomposition of solid propellants. Detailed chemistry flame simulations will be performed with the REGATH code, developed at EM2C laboratory.



Visualization of a counter-flow spray flame. Source: EM2C-CNRS

Host institution

The post-doctoral fellow will join the numerical combustion team of EM2C-CNRS, located at CentraleSupélec, which is expert in numerical simulations and modeling of laminar and turbulent flames. The fellow will strongly collaborate with UPC laboratory (ENSTA), specialized in combustion chemistry, and with ONERA (French aerospace agency) who will provide experimental data.

Essential Requirements

Applicants will hold a Ph.D. degree in Chemical or Mechanical Engineering. The position requires skills in combustion chemistry and laminar flame simulations.

Application

For application, send a detailed CV which includes the list of publications, a covering letter and the names and contact details of two referees to Benoît Fiorina, Professor at CentraleSupélec, EM2C-CNRS laboratory (benoit.fiorina@centralesupelec.fr).

Gross salary evolves between 2600€ and 3600€ per month, depending on candidate experience.