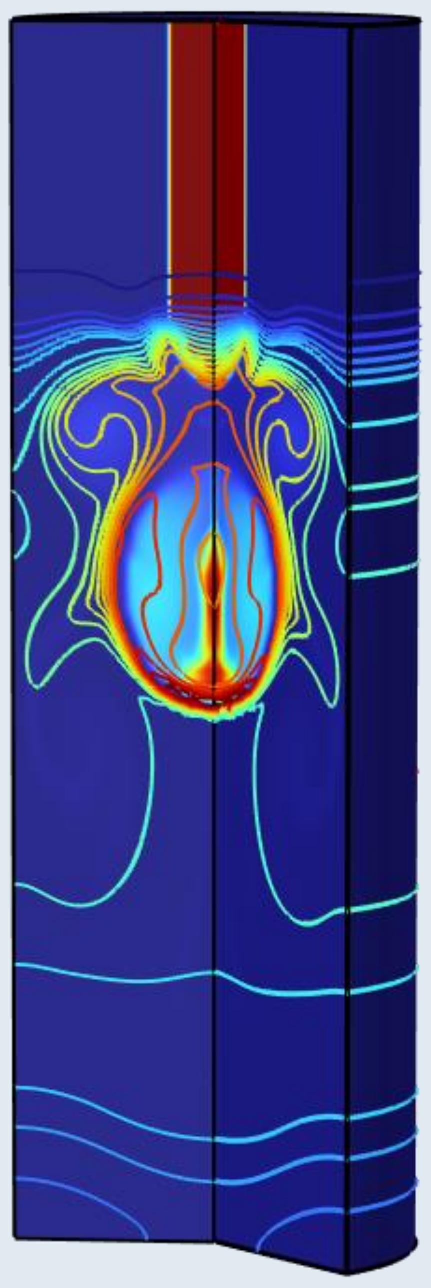

Numerical Simulation of Laser Ignition of Metallic Rods Under Oxygen Pressure

Characterization of materials flammability is essential for the design of equipment for oxygen service. This study attempts to develop a numerical model equivalent of the standardized ASTM G 124-18 flammability test method.

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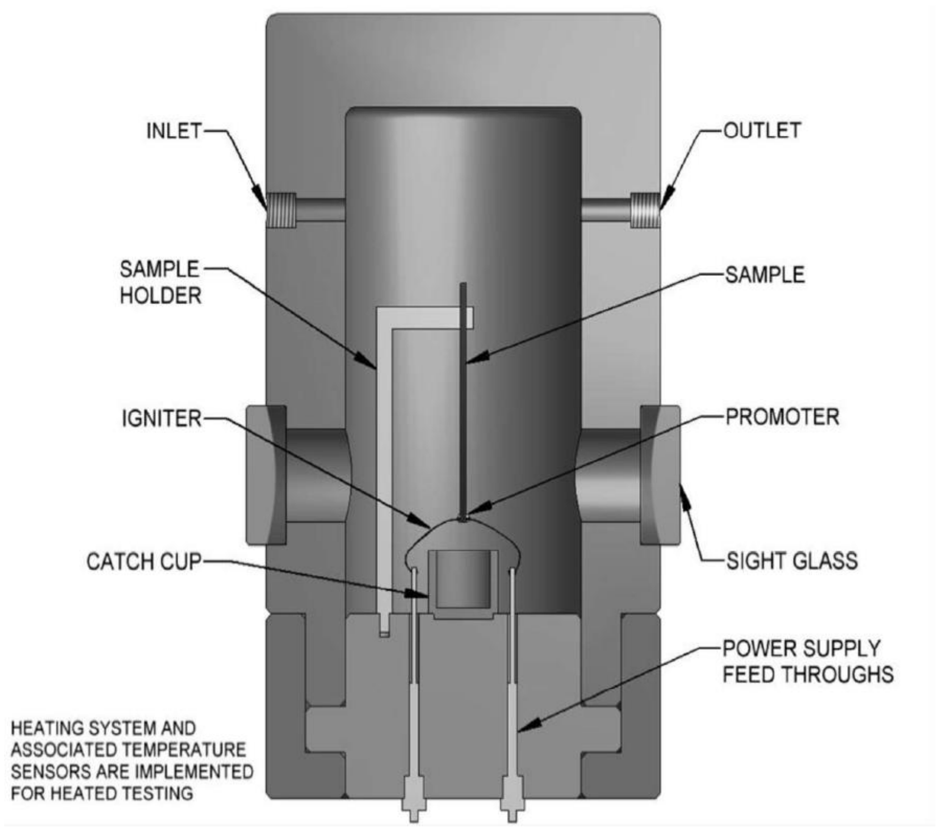
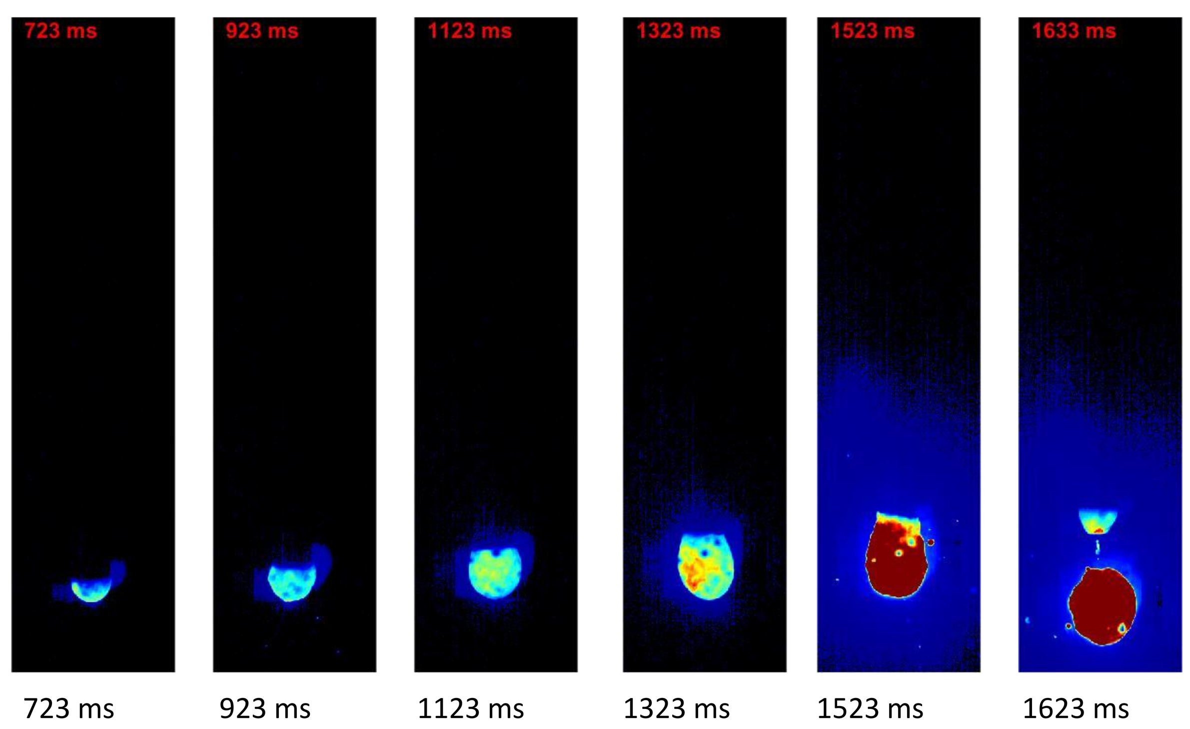
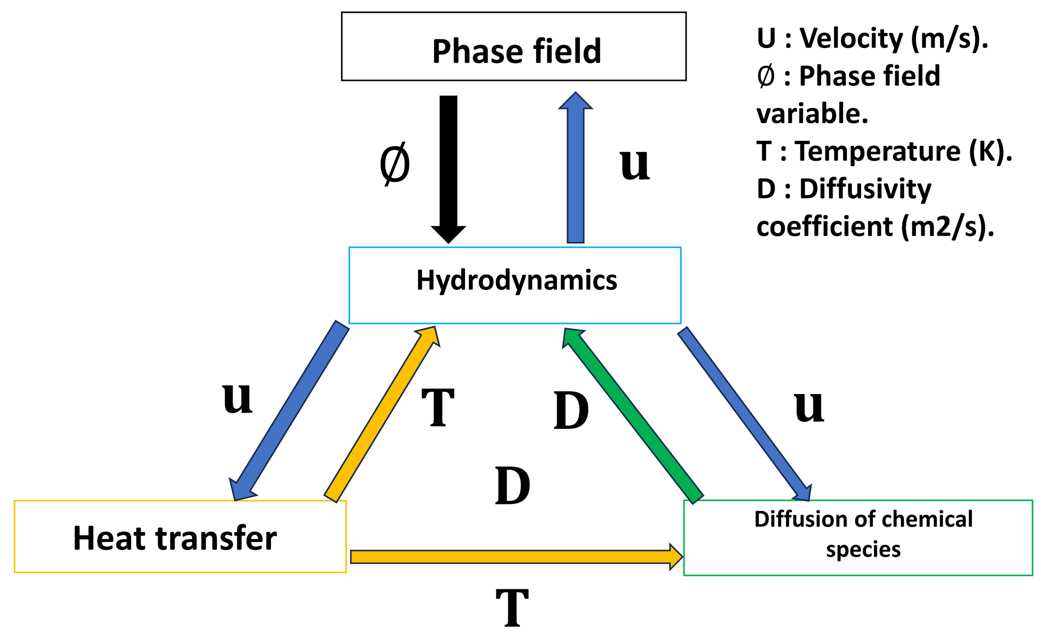
Introduction and Objectives

The presence of oxygen in installations involving metallic components can influence their flammability threshold and thus lead to combustion ignitions. In order to classify metals according to their degree of flammability many studies have been conducted leading to the creation of ASTM G124-18 standardized flammability test. The aim of this work is to develop a numerical standardized equivalent for this test, including laser ignition as heat source and involving heat transfer, fluid flows, and diffusion of chemical species, coupled under a Phase Field approach and enhanced with an adaptative mesh refinement. A second stage will involve a sensitivity study on the various parameters to determine their relevance in the model, which then will be determined using inverse estimation methods so that they can be implemented in the model to carry out the experimental validation part. Finally, after ensuring that it is representative of reality, the model will be transposed to geometries closer to those of real oxygen service facilities and for various alloys.







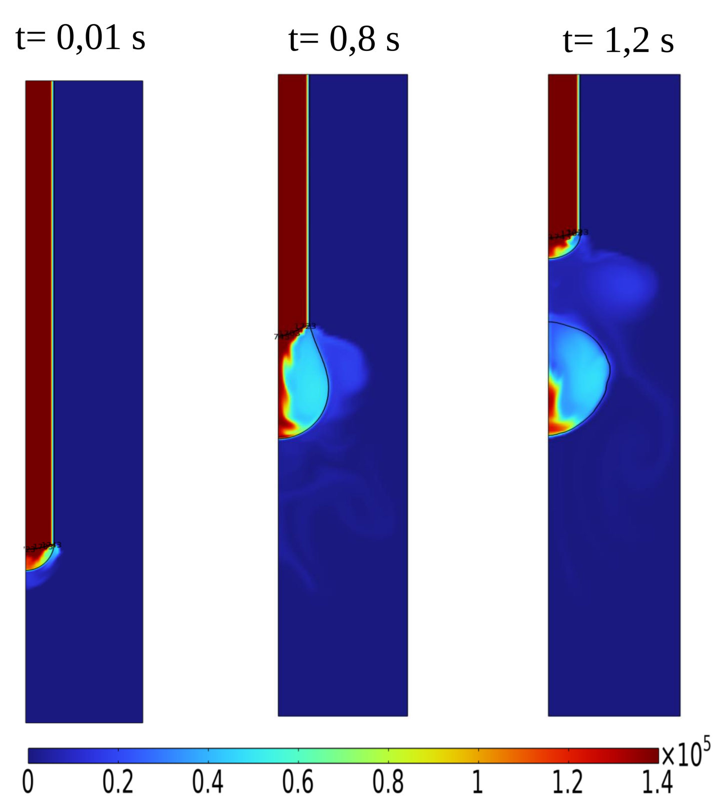
- An Adaptive Mesh Refinement is used, reducing the total degrees of freedom from 241736 to 61472.

Figure 1. a. Illustration of the experimental set-up, b. Experimental results for an iron rod and c. Summary of physics included in the model

Results

Results from this work can be observed in figure 2, and many remarks can be made:

- From Figure 2.a, we can observe that the phase field is well suited for reproducing the interface dynamic, including drop formation and detachment.
- The region inside the iron drop where the concentration decreases is assumed to correspond to iron oxide formation.
- As for the temperature evolution in Figure 2.b, a rapid increase in slope can be observed at approximately 0.06s, corresponding to the initiation of the combustion reaction.



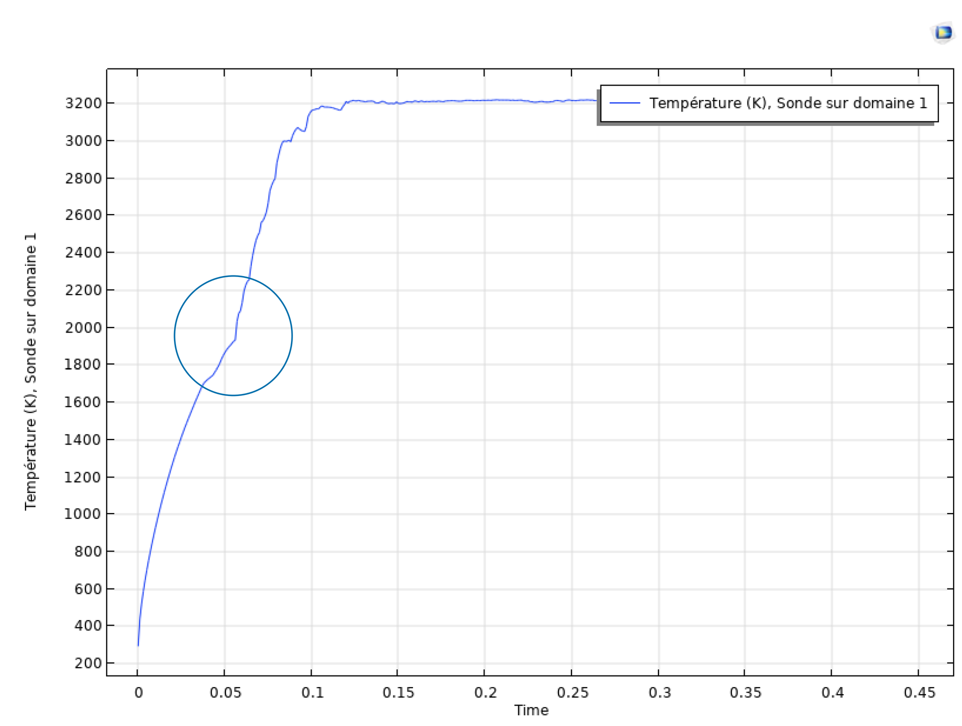


Figure 2.a. Iron concentration field evolution
b. Evolution of the maximal temperature

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[1] . V .Bruyere, C. Touvrey, P. Namy. *A Phase Field Approach to Model Laser Power Control in Spot Laser Welding*. COMSOL Conference in Cambridge, 2014.

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