


IMT Mines Alès
École Mines-Télécom


SCIENCE & CREATIVITY TO INVENT A SUSTAINABLE WORLD

PhD Position in

Physico-chemistry of Materials

Institution	IMT Mines Alès (Ecole Nationale Supérieure des Mines d'Alès)
Main job assignment	Teaching and Research center on WWW.
Administrative residence	Alès (Département du Gard – Région Occitanie)
Starting date	

1. Context

The Institut Mines-Télécom (IMT), a major institution within the meaning of the Education Code, is a public scientific, cultural and professional institution (EPSCP) placed under the principal supervision of the ministers responsible for industry and digital technology. It is the largest group of engineering schools in France, with 11 public engineering schools spread across the country, which train 13,500 engineers and PhDs each year. The ITM employs 4,500 people and has an annual budget of €400M, 40% of which comes from its own resources. IMT has 2 Carnot institutes, 35 industrial chairs, produces 2100 A rank publications annually, 60 patents and carries out 110M€ of contractual research.

Created in 1843, IMT Mines Alès currently has 1,400 students (including 250 foreigners) and 380 staff. The school has 3 research and teaching centers of high scientific and technological level, which work in the fields of materials and civil engineering (C2MA), environment and risks (CREER), artificial intelligence and industrial and digital engineering (CERIS). It has 12 technological platforms and has 1,600 partner companies.

2. Research project

Title : Experimental study of pyrolysis and flame propagation on plates of model materials representative of cables sheaths

Keywords : Fire, pyrolysis, combustion, polymers, cables

Description of the thesis subject

Half of the fire outbreaks recorded in French nuclear power plants between 2018 and 2020 occurred in electrical cabinets and panels [1]. This equipment can in fact suffer electrical failures, such as a short circuit, overheating or an electric arc, which can ignite nearby electrical cables and potentially lead to the spread of fire outside this equipment via the cable routes. In order to assess the consequences of such fires on organs important to nuclear safety, fire analyzes need tools capable of evaluating the power of a fire which propagates on electrical cable trays. Research work carried out in collaboration between the Materials Center (IMT Mines Alès) and the Fire Experiments Laboratory (ASNR) made it possible to characterize the propagation of fire along a horizontal layer of electrical cables present on nuclear installations. [2]-[3], in order to provide simplified assessments of the power of an electrical cable fire. This work was notably carried out using the CISCCO (Combustible Ignition and Spreading under Controlled COditions) test device which, thanks to its radiant panels, allows combustible materials to be exposed to controlled heat flows in order to ignite them and propagate the flames on the combustible surface studied.

In order to conduct more precise predictions of fire propagation on electrical cable trays and the resulting fire power, fire analyzes also aim to use calculation tools that rely on detailed pyrolysis and propagation models. To go further in understanding and validating these models, the fire community agrees on the need for perfectly instrumented analytical experiments. To our knowledge, the potential of such experimental tests, carried out under controlled conditions, to characterize pyrolysis and flame propagation on a medium scale, has remained unexplored to date, and the proposed project aims to fill this gap in scientific knowledge. To this end, innovative metrological developments have recently been carried out on the CISCCO testing device, with the addition of the measurement of the mass of fuel, which makes it possible to quantify the mass flow rate of pyrolysis, and that of the temperatures within the combustible materials.

The proposed PhD thesis aims to **experimentally characterize, using the CISCCO test device, pyrolysis and fire propagation on plates of model materials for electrical cable sheaths** present on nuclear installations, and containing in particular polyvinyl chloride [4] or halogen-free flame retardants [5]. The proposed geometry provides a simpler framework for investigation than the complex geometry presented by a sheet of electrical cables. Particular attention will be paid to the **influence of the type of model material studied, the preheating of the plates** (temperature and kinetics of preheating), **their dimensions** (width and thickness) **and their orientation** (up to 45°), on pyrolysis and fire propagation.

It is expected to be able to provide a database that will be used by the fire research community, both analytically and in terms of numerical simulations. These experiments could provide data that can be used in the context of international benchmarks.

3. Team supervision and PhD registration

The doctoral student will be supervised at IMT Mines Alès by teacher-researchers from the Materials Center (C2MA), in the Polymers, Composites and Hybrids (PCH) research unit and at ASNR Cadarache by engineer-researchers from the Fire Experiments Fire (LEF)

Doctoral school : Sciences Chimiques Balard (ED 459)

4. Candidate profile

We are looking for a student with an **engineering or master's degree** and good knowledge of thermal, pyrolysis and combustion. Knowledge of polymer materials would be a plus. The subject requires a taste for experimental work and data analysis. The person must be rigorous, organized and open-minded to discuss with both combustion specialists and materials specialists.

5. References

[1] L'IRSN et les feux électriques : des recherches de grande intensité !, édition Française de Scientific American, pour la Science n°536, Juin 2022, https://www.pourlascience.fr/sr/article-partenaire/l-irsn-et-les-feux-electriques-des-recherches-de-grande-intensite-23871.php

[2] Meinier, R. (2021). Étude expérimentale et analytique de l'inflammation et de la propagation du feu sur un chemin de câbles électriques. IMT Mines d'Alès.

[3] Zavaleta, P., Meinier, R., Suard, S., Sonnier, R., Ferry, L. Flame Spread Experiments on a Horizontal Preheated Cable Layer. Fire Technol 60, 641–667 (2024). https://doi.org/10.1007/s10694-023-01521-5

[4] Meinier, R., Fellah, M., Sonnier, R., Zavaleta, P., Suard, S., Ferry, L. Ignition and Charring of PVC-Based Electric Cables. Fire Technol 58, 689–707 (2022). https://doi.org/10.1007/s10694-021-01168-0

[5] Meinier, R., Sonnier, R., Zavaleta, P., Suard, S., Ferry, L. Fire behavior of halogen-free flame retardant electrical cables with the cone calorimeter, Journal of Hazardous Materials http://dx.doi.org/10.1016/j.jhazmat.2017.08.027

6. Contacts

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