Laboratoire Hubert Curien
UMR ▪ CNRS ▪ 5516 ▪ Saint-Étienne

PhD position within the MOPERE team

Development of a predictive model for determining the spectral dependence of radiation-induced attenuation (RIA) in optical fibers

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Duration: 36 months

Location: Saint-Etienne, France

Expected start date: Oct 1st 2026

Description

Optical fibers (OFs) are more and more used for communications or sensing applications in harsh environments, e.g. nuclear power plants, nuclear waste repositories, space... However, such environments are characterized by radiations (photons, neutrons, protons...), extreme temperatures, and in some cases different gases presence. Radiations deteriorate the OF performances, because of two microscopic phenomena: the generation of point defects in the pure or doped core and cladding silica matrix and the glass compaction (at very high total ionizing doses (TIDs) or high neutron fluences). These phenomena give rise to three main macroscopic effects: Radiation-Induced Attenuation (RIA), Radiation-Induced Emission (RIE) and Radiation-Induced Refractive Index Change (RIRIC). Among all these effects, the RIA is the most studied phenomenon, since it consists in the increase of the optical fiber attenuation caused by the absorption bands associated with the radiation-induced point defects peaking from the ultraviolet to near-IR wavelengths. However, it was demonstrated that the radiation impact on optical fiber transmission depends on several parameters [2], such as the OF composition and pre-treatment, the irradiation conditions, i.e. TID, dose-rate, temperature, and the OF profile of use, in particular signal power and wavelength. Despite numerous studies, a predictive model of the spectral dependence of RIA in different categories of optical fibers does not exist.

This thesis will propose a **multi-scale, multi-physics approach**, combining the study of the microscopic mechanisms of generation/recombination of the point defects with the analysis of their macroscopic effects on optical transmission. In particular, the temperature influence on the dynamics of defect formation and recovery will be studied. The aim is to link the key parameters - composition, wavelength, dose and temperature - to the RIA spectral evolution, by identifying the contribution of the various point defects. To achieve this, the thesis will combine numerical modeling, spectral analysis and experimental measurements under various irradiations (PETRA platform for X-rays, and other particles via external collaborations). The expected results will enable RIA to be predicted, providing a robust tool for the future design of sensors and optical systems in extreme radiative environments, for space, nuclear (fusion, fission) and medical applications.

The PhD will be developed within the 'Materials for Optics and Photonics in Extreme Radiation Environments' (**MOPERE**) **team** of the Hubert Curien Laboratory (University Jean Monnet UJM in Saint-Etienne, France.

Topics and activities that are covered by this PhD

- X-rays irradiations targeting dose levels up to MGy, using the PETRA platform whose X-rays irradiators are equipped with thermal plates to vary the irradiation temperature between -120°C and 300°C;

- Realization of on-line RIA measurements of fibers having different compositions at various conditions, such as dose rate, temperature, in presence or absence of gas as H_2, …;

- Post-mortem characterization of the differently irradiated samples, if needed, by combining different spectroscopic techniques such as energy-dispersive X-ray spectroscopy, confocal microscopy, time-resolved photoluminescence, ...

- Development of an analysis code to decompose the RIA spectra as a sum of absorption bands, to identify the involved point defects and their kinetics of generation and recovery;

The investigated phenomena will be tackled with a multi-scale approach, from the macroscopic RIA kinetics to the microscopic mechanisms of generation/recombination of the point defects.

This project will be supported by the industrial company Exail, as part of the LabH6 Joint Laboratory, which will supply optimized custom fibers, enabling different doping and treatments.

Requirements

We are looking for candidates who meet the following criteria:

- Master's degree or engineering diploma in applied physics, optics, photonics or materials science.
- Interest in multi-scale and multi-physics phenomena, combining modeling, theory and experimentations.
- Analytic and experimental skills proven by MSc-work or work experience.
- Good knowledge of scientific tools such as Python or Matlab.
- Positive attitude towards a multidisciplinary environment with multiple stakeholders.
- Good knowledge of the English language (oral and writing) and/or of French language.
- Good communications skills (soft skills), and the ability to work in collaboration with industry.
- Scientific curiosity and experimental rigor.
- Capability to synthesize and communicate scientific results for use in institutional and industrial projects.

The following additions would be a great asset:

- Experience in spectroscopy, optical measurements and fiber characterization techniques.
- A background in fiber optics and materials physics.

The Hubert Curien Laboratory and the MOPERE team

The Hubert Curien Laboratory is a Joint Research Unit (UMR 5516) of the National Center for Scientific Research - CNRS and the Université Jean Monnet - UJM, located at 18 Rue Professor Benoît Lauras in Saint-Etienne, and administratively attached to the Faculty of Science and Technology of the UJM.

Additional information on the Hubert Curien Laboratory and its MOPERE team can be found on the following web page:

https://laboratoirehubertcurien.univ-st-etienne.fr/en/teams/materials-for-optics-and-photonics-in-extreme-radiation-environments.html

Deadline

The application deadline is March 20th 2026.

Contact

For further information on this position, please contact:

Prof. Adriana MORANA (PhD thesis supervisor)

adriana.morana@univ-st-etienne.fr

How to apply

Applicants should send the following documents directly to Prof. Adriana MORANA:

- A complete CV;
- A cover letter;
- A copy of a valid ID document (ID card, passport…)
