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

PhD position within the MOPERE team

Radiation effects of non-metallic materials for optical systems in extreme environments

Duration: 36 months

Location: Saint-Etienne, France

Expected start date: Oct 1st 2024

Description

Non-metallic commercial materials are increasingly used as part of equipment and complex devices operating in extreme high-radiation conditions. Radiation tolerant systems have nowadays become fundamental for a very wide range of applications, from particle accelerators, high-power targets, fission and fusion technologies, to medical physics, space missions and the management of radioactive waste. Along with the development of such technologies, the doses absorbed by functional materials and components are increasing. In most cases, components are exposed to complex mixed radiation fields and often operation environments are extreme in terms of other ageing factors too e.g. temperature, mechanical stresses, atmosphere.

Data concerning the radiation effects on polymeric commercial materials and integrated systems are extremely scarce in the literature. When available, they are often incomplete and difficult to compare, due to a lack of systematic assessment regarding the dependence of the investigated properties on several parameters. Within this context, radiation studies on polymeric materials specifically for the development of optical and photonic technologies for extreme application are needed. Commercial components such as 3D printed plastic materials, lubricants, glues, optical fiber coatings, cables, insulators, glasses, adhesives, elastomers are essential for the development of complex integrated assemblies requiring radiation qualification.

Lubricating oil irradiated at 8 MGy of dose in reactor.
[M. Ferrari et al., NIM B vol.497 pp. 1-9 (**2021**)]

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) focuses on the study of optical materials operating in radiation environments. The PhD will be developed within this team, which is equipped with three X-ray irradiation facilities.

This PhD topic is focused on: the study of the radiation effects on commercial polymeric materials of interest in different irradiation conditions, with special focus on extreme high-radiation applications.

Topics and activities that are covered by this PhD

- High-dose irradiations targeting kGy and MGy dose levels, using the in-house X-ray sources: development of novel setups and irradiation methodologies for specific materials;
- Use of the laboratory instruments required for various macroscopic and microscopic post-irradiation characterizations, e.g. tensile tests for optical fiber coatings and elastomers, spectroscopy techniques such as Raman and FT-IR;
- Planning and realization of irradiation campaigns in different radiation environments, such as gamma sources, mixed neutron and gamma fields, proton and electron beams, accessed through scientific collaborations;
- Experimental study of radiation effects as a function of various parameters, such as dose rate, temperature, atmosphere, radiation type and energy spectrum;
- Identification of functional endpoints and development of rad-hard solutions for components to be used in specific applications;
- Analysis of collected results to deepen the knowledge of radiation-induced effects;
- Use of Monte Carlo tools for radiation transport and dosimetry simulation in samples having a variety of possible geometries, and irradiated in different irradiation conditions;

The investigated phenomena will be tackled with a multi-scale approach, ranging from the understanding of radiation to matter interaction to functional tests on integrated devices.

This project will be partly executed in collaboration with international industrial partners and via academic collaborations. One of the goals of this PhD is to contribute to the use of the tested materials in real application conditions, e.g. CERN's particle accelerators system and its experimental areas.

Requirements

We are looking for candidates who meet the following criteria:

- MSc degree or equivalent in applied/experimental physics, engineering, materials science, chemistry or science in general.
- Analytic and experimental skills proven by MSc-work or work experience.
- Interest in practical work to run experiments.
- Flexible attitude and adaptability towards the operation of experimental settings.
- 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).

The following additions would be a great asset:

- Background in radiation physics or polymer science.
- Experience with Monte Carlo simulation tools such as PHITS, FLUKA, Geant4, MCNP
- Experience with dosimetry.
- Experience with programs such as Matlab, C++.

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 June 30th 2024.

Contact

For further information on this position, please contact:

Prof. Matteo Ferrari CPJ (PhD Thesis Supervisor)

matteo.ferrari@univ-st-etienne.fr

How to apply

Applicants should send the following documents directly to Prof. Matteo Ferrari:

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

Note: All employment at the Hubert Curien Laboratory is decided on the sole basis of qualifications, competence, integrity and organizational need. All are encouraged to apply to job openings regardless of their origin, identity, health, beliefs and orientations.