ANNOUNCEMENT OF A PhD THESIS POSITION

The Institute of Physics of Nice (INϕNI – CNRS UMR 7010, University of Nice-Sophia Antipolis) invites applications for a PhD thesis on the topic below. The position will be based in Nice (Faculty of Sciences, Parc Valrose), France.

Physical modelling of degradation mechanisms in three optical fibre classes in harsh R-T-H environments: combined effects of radiation (R), temperature (T) and hydrogen (H)

General context

This PhD thesis position is proposed in the framework of the ANR-ANDRA Project CERTYF ("Combined Effects of Radiation, Temperature and hYdrogen on silica-based materials and optical Fibres, 2017-2021) in which the Institute of Physics of Nice is a major partner. This project has been selected and funded following the 2016 joint call for proposals by the French National Agency for Nuclear Waste Management (ANDRA) and the French National Research Agency (ANR) concerning the optimized management of radioactive waste and nuclear plant dismantling. CERTYF is a collaborative research program which also involves the University Jean Monnet (Saint-Étienne, France, project leader) and the French National Institute for Radiological Protection and Nuclear Safety (IRSN). It will be launched by the end of 2017.
Given the possibility of linear deployment and flexibility of optical fibres, fibre-based detectors represent a very promising technology in applications requiring remote and distributed measurements in hardly reachable areas as those of interest for ANDRA. Fibre-based technologies also offer versatility together with reduced weight, size and cost. The implementation of silica-based fibres in harsh radiative environments is however largely limited by an important radiation-induced excess optical loss which develops across the UV and visible spectral ranges (with significant absorption tail at near-infrared wavelengths too). The fibre degradation is commonly characterized by measuring the so-called radiation-induced attenuation – or "RIA" – as a function of wavelength. Containing or predicting the RIA that would affect optical fibres deployed in the complex and changing ANDRA's environments turns out to be a very hard task. The fibre degradation indeed depends on numerous factors as its chemical composition, the power and wavelength of the light it guides, and as ambient parameters regarding the radiation field (ionizing dose rate and total ionizing dose), temperature and the presence of hydrogen. Extrinsic parameters associated with radiation, temperature and hydrogen are referred to as "RTH conditions" and are critical in ANDRA's applications.
The general objectives of the CERTYF project are first to reach a detailed understanding of the basic physical mechanisms governing the RIA development and recovery in RTH conditions through a variety of complementary experimental characterizations using three classes of silica-based optical fibres (standard telecom fibres, radiation-hardened and radiation-sensitive fibres). A consistent framework of most plausible mechanisms should be built that will subsequently serve to develop a physical model.

Thesis work

The Institute of Physics of Nice (INϕNI) is leading 2 crucial work packages (WP) of the CERTYF project: WP 3 "Definition, Manufacturing and Validation of Samples and Setups", and WP5 "Definition and Building of RIA Physical Models". The thesis work will be organized according to these WP, following 2 successive stages. A resolutely experimental phase will first focus on: *i)* The optimization of the various chemical compositions for the three fibre classes and their fabrication at the Institute of Physics of Nice, *ii)* The thorough experimental investigation of the RIA as a function of composition in order to reveal the radiation-induced colour centres responsible for degradation and elucidate their formation and annealing mechanisms in RTH conditions (through thermally stimulated luminescence experiments and their coupling to absorption spectrophotometry measurements to demonstrate ionization mechanisms and carrier redistributions under radiation exposure or annealing and estimate the related activation energies). In the second phase, devoted to modelling and simulation, the PhD Student will contribute to the design and coding of a physical model based on the mechanisms learnt from the first phase. The aim is to build a simulation tool capable of reproducing correctly the cross effects of the ionizing dose, dose rate, temperature, composition and guided light (wavelength and power of the guided radiations, including power distribution due to propagation effects). Simulations should allow the project team to reliably anticipate the behaviour of an optical fibre for given composition and RTH conditions (specified by ANDRA).

Start: last quarter 2017. **Duration**: 3 years.

Qualification: This position offers inter-disciplinary training in materials physics and guided optics, in experimental techniques and modelling. Applicants must have a Master 2 degree (or equivalent), preferably in materials physics or photonics. Candidates should be familiar with optical fibres and materials (semi-conductor/dielectric) physics, radiations and their interactions with matter. Programming skills (Matlab or equivalent) will be an asset.

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