6 MONTHS INTERSHIP

Thermophysical analysis of chemical interactions at high temperature of advanced Accident Tolerant Fuel

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Prolongation of the subject by a Ph-D thesis: Yes

Summary : :

The development of accident-tolerant fuel cladding is one of the promising way to improve the safety of nuclear reactors. Among the most advanced research directions, the chromium-coated zirconium alloy is being carefully evaluated under extreme conditions. The work of the internship focuses on the study of thermochemical interactions of the Cr-O-Zr ternary system at high temperatures (T> 1473 K). This scientific work will be carried out within a research group combining experimental and modelling approaches.

Detailed description :

In order to increase the safety margins of pressurized water reactors (PWRs), many studies are being conducted on the development of accident tolerant fuel rods (ATFs). The strategy implemented aims, in an accident situation, to have assemblies with increased resistance to oxidation and better retention of fission products. The option currently chosen in France would be a UO_2 type fuel (possibly doped or not with chromium oxide) and a cladding tube based on a zirconium alloy covered with a chromium deposit. The work proposed is part of the evaluation of the behavior of these new materials in case of a serious accident and their impact on the progress of the consequences scenario, in particular by using the evaluation tools developed at IRSN. The methodology is based on a coupled analysis of fuel and fission product chemistry and microstructure under nominal and accident conditions. In addition, it is necessary to launch this proactive research on this new R&D theme as IRSN will have to expertise on the relevance of the materials chosen by nuclear fuel designers.
The main objective of the study is to be able to evaluate the impact of the additional mass of chromium on the behavior of corium (mixture of molten materials). More specifically, this work aims to establish high temperature phase equilibria in the Zr-Cr-O system, through a combined approach between laboratory scale experiments and thermochemical modelling. The research project associates the complementary skills of the UCCS (crystallographic and microstructural development and characterization), IM2NP (thermal and calorimetric analyses) and IRSN (CALPHAD modelling).
Once these data have been established, they will provide first elements to define the criteria of potential failures of ATF fuel elements in severe (extreme) conditions.

Required skills :

The candidate will have a significant background in materials science, solid-state chemistry or a solid formation in characterization techniques and a strong motivation for experimental work and data analysis. He/she will become autonomous in the techniques of sample preparation and for measurements of chemical and physical properties. On the basis of the results obtained, the subject will be broaden in order to orientate the project toward a Ph-D thesis work. It is expected that the successful candidate will actively participate in the discussions and work of the research group formed around this major project.

Practical information:
Location: Villeneuve d'Ascq Science Campus (4 months) Faculty of Sciences of St Jérôme in Marseille (2 months)
Duration: 6 months, mainly in the first half of 2020.
Nature of the contract: French Intership Agreement (580€/month plus the defrayal (stay in Marseille)).