



## Ph.D Thesis

### Multi-scale modeling of $\text{UO}_2$ plasticity: on the role of irradiation defects

The Uranium dioxide ( $\text{UO}_2$ ) is used in fuel pellets of nuclear power plants. Its mechanical behavior under irradiation has a major impact on fuel cladding structural integrity assessment under normal and off-normal operating conditions. One issue concerning the fuel mechanical behavior is a detailed understanding of deformation processes at the scale of the microstructure heterogeneity in order to be able to predict stress and strain inside the grains and at their interfaces.

The main goal of the Ph.D thesis is to develop a constitutive model based on dislocation interactions with irradiation defects. This model is needed to compute inelastic strains induced at high temperature and under irradiation. First, interaction between defects will be characterized using the LAMMPS molecular dynamics (MD) package. Then, atomistically-informed dislocation dynamics (DD) simulations will be performed to quantify strain hardening induced by irradiation defects using the NUMODIS code. Finally, the constitutive law and its parameters will be integrated within the finite-element (FEM) framework developed at the laboratory.

The Ph. D thesis will be done at the MATEIS laboratory (INSA-Lyon) and at the Fuel Study Department in CEA Cadarache, where a high expertise level is available in the field of multi-scale and multi-physics materials modeling. Three CEA's laboratories will be involved in the codirecting of this Ph-D thesis, with the LSC and LC2M in Cadarache for FE and DM techniques and the LC2M in Saclay for DD. Results valorization will be done through publication and international conference participation in order to have discussions with foreign researchers and/or to share experiences with other domain of activities outside of the nuclear field.

The selected student will hold a master degree in materials science or condensed matter physics. He/she should have a pronounced interest for theoretical modeling and basic knowledge in programming. Regarding geographical constraints imposed by the project, the applicant should be ready to move for short and long term stays in Lyon/Paris/Cadarache. Good writing and oral skills are expected in french and/or english. CV and application letters should be sent to [bruno.michel@cea.fr](mailto:bruno.michel@cea.fr) and [jonathan.amodeo@insa-lyon.fr](mailto:jonathan.amodeo@insa-lyon.fr).