Atom Probe Tomography investigation of irradiation, post-irradiation annealing and reirradiation behaviour of model reactor pressure vessel steels

Position offered: 18 months post-doc position starting February 2027

Location:
Groupe de Physique des Matériaux (GPM)
University of Rouen Normandie (URN), National Center for Scientific Research (CNRS) and INSA Rouen Normandie.
Rouen, France

Context and objectives:
Pressurized water reactor (PWR) vessel steels are made of low alloy bainitic steels. In-service neutron irradiation causes an evolution of vessel steel microstructure (in particular, the formation of a high density of nanometric solute clusters) causing a degradation of its mechanical properties (hardening and embrittlement). Post-irradiation annealing could be a way to recover vessel steel microstructure and mechanical properties in order to extend PWR lifetime. However, it is necessary to optimize the PIA conditions to got a full recovery and to investigate the kinetics of reirradiation behavior.

In the European Project EXTEND-LTO (https://www.connect-nm.eu/extend-lto-landing-page/) different model PWR vessel steels, with controlled contents of solutes known to contributed to irradiation embrittlement, are neutron irradiated, annealed and re-irradiated. Their microstructure evolution will be characterized by complementary techniques and will be compared with the irradiation hardening. This approach will provide essential data about irradiation embrittlement and re-embrittlement mechanisms as a function of steel bulk compositions.

The Groupe de Physique des Matériaux (GPM), contributes to this work by performing Atom Probe Tomography (APT) investigation of selected steels in as-received, irradiated, annealed and re-irradiated conditions. APT provides a 3D reconstruction, at nm-scale, of small volumes or mater, giving access to quantitative characteristics (size distribution, chemical composition, shape, number density…) of nm-scale chemical heterogeneities formed under irradiation. It has to be noticed that the samples are neutron irradiated, so that they are slightly radioactive.

Missions and Candidate requirements:
The missions of the successful candidate will be:
- Bibliographic synthesis about post irradiation annealing and reirradiation effects in reactor pressure vessel steels
- Sample preparation (mechanical and electrochemical polishing, focused ion beam machining)
- Characterization of microstructures by Atom probe tomography
- Data analysis and interpretation
- Participation to project progress meetings
- Contribution to the drafting of the deliverables and writing scientific articles

Expected skills and knowledge are:
- Strong knowledge in material science (microstructure, diffusion, phase transformation)
- Complementary knowledge on aging under irradiation of metal alloys is an additional asset
- Technical skills required in scanning electron microscopy / focused ion beam or atom probe tomography
- Team work
- Efficient writing in English
- Ability to work in controlled area (manipulation of radioactive samples)

Gross salary: from 2 759.46 €/month (depending on experience)

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