## Séminaire présenté par Adrien COUET

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Room Alnot 4-014, IJL

# Understanding and anticipating material degradation in extreme environments: from alloy design to fundamental mechanisms

One of the most decisive factors in the rapid deployment of advanced nuclear reactors, whether fission or fusion, with major gains in safety and efficiency, is undoubtedly the development and qualification of irradiation- and corrosion-resistant materials, which form the structural components and first barriers of reactor cores. However, the discovery, improvement and evaluation of such materials in the extreme environments of these reactors are demanding, time-consuming and costly processes, severely hampering the innovation and qualification of materials for nuclear power.
This seminar highlights research into the irradiation and corrosion of compositionally complex alloys (CCAs) for structural components, fuel cladding and walls exposed to plasma. The “top-down” approach adopted is based on two components:
(i) an integrated high-throughput research platform combining alloy development, testing and characterization to explore vast spaces of compositions;
(ii) targeted, finely-controlled experiments, coupled with atomic-scale modeling and characterization, to reveal degradation mechanisms.
This “top-down” approach enables us to understand the fundamental degradation mechanisms and develop predictive models, based on machine learning, to anticipate the behavior of CCAs under high-dose irradiation and molten-salt corrosion conditions. The ultimate goal is to accelerate the discovery of new materials for advanced nuclear reactors, both fission and fusion.

Adrien Couet is Professor in the Nuclear Engineering and Engineering Physics Department at the University of Wisconsin-Madison, where he heads the MaDCoR (Materials Degradation under Corrosion and Radiation) laboratory. Previously, he worked as a nuclear materials research engineer at EdF (Électricité de France), focusing on high-temperature aqueous corrosion and corrosion modeling of nuclear materials. He was recruited by EDF after earning a PhD in nuclear and mechanical engineering from Penn State University in 2014, with a thesis focusing on nuclear fuel cladding corrosion.
For almost ten years at UW-Madison, Pr. Couet has been developing a research program focused on the fundamental understanding of materials degradation in extreme environments, particularly in light water and molten salt reactors, relying on state-of-the-art characterization techniques and modeling based on first principles. More recently, it has also taken an interest in alloy design through high-throughput experimentation and machine learning-assisted modeling.
The MaDCoR laboratory's research activities cover fuel cladding corrosion in PWRs, the development of structural materials for molten-salt reactors, and the design of irradiation-resistant compositionally complex alloys (CCAs) for nuclear fission and fusion technologies. Pr. Couet is also responsible for the UW Ion Beam Laboratory, and is co-organizer of the Nuclear Innovation Bootcamp, a program designed to train future entrepreneurs in the nuclear sector.

**Séminaire organisé par l’équipe 206**