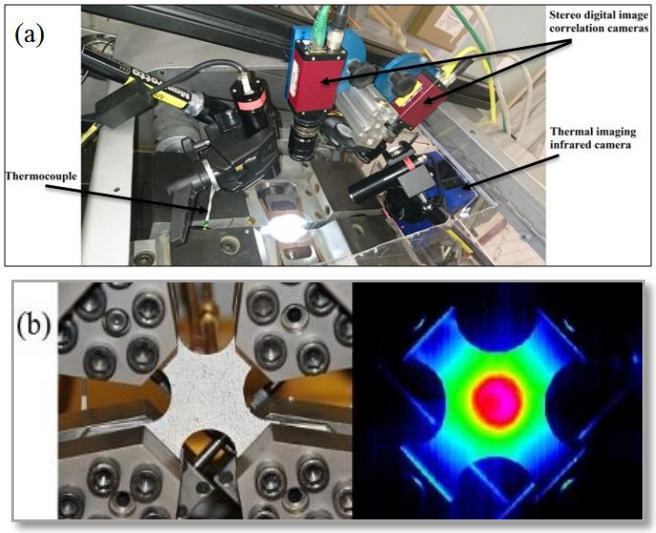
ANISOTHERMAL BEHAVIOR AND FAILURE OF ZIRCALOY-4 FUEL CLADDING: APPLICATION TO RIA

Ahmed CHAÏEB
(2016 – 2019)

Industrial Partner: EDF R&D
Supervisors: Jérôme CRÉPIN - Alain KÖSTER (Centre des Matériaux – Mines ParisTech) - Nathanaël MOZZANI - Aurore PARROT - Antoine AMBARD (EDF R&D - MMC)



- Anisothermal uniaxial tensile tests (up to $\dot{T} = 500\ °C.s^{-1}$)
- Rapid uniaxial tensile tests (up to $\dot{\varepsilon} = 5\ s^{-1}$)
- Field measurements
- Anisothermal biaxial tests
- Numerical simulation of the anisothermal tensile tests

Measuring instruments used for the uniaxial anisothermal tests (a) – Specimen and thermo-graphic field during a biaxial anisothermal tests (b)

Abstract:

The Reactivity Initiated Accident (RIA) is a hypothetical accident scenario affecting the Pressurized Water Reactors' hearts. During this accident, the zirconium alloy clad is subjected to a rapid thermo-mechanical transient that could potentially lead to its rupture.
It's a fast transient (a few ms) during which the tube is simultaneously subjected to a temperature ramp up to 1000°C/s and a strain ramp up to 5/s. Furthermore, the mechanical load during this transient is not uniaxial: the clad experiences a time-dependent non-uniform biaxial mechanical load, making the overall thermo-mechanical history quite complex.
The anisothermal character of the RIA scenario remains a major axis of study because the development of laboratory tests coupling rapid and simultaneous transients of strain and temperature is quite difficult.
A thorough understanding of the effect of a temperature transient on the mechanical response of the clad will enable the consolidation of behavior laws and failure criteria, previously established under isothermal conditions.
The aim of this work is to study of the influence of transient temperature on the mechanical behavior and failure of Zircaloy-4 thanks to the interpretation of these new tests.