Phase transformations and high-temperature mechanical behavior of a zirconium alloy (M5): effect of thermal history

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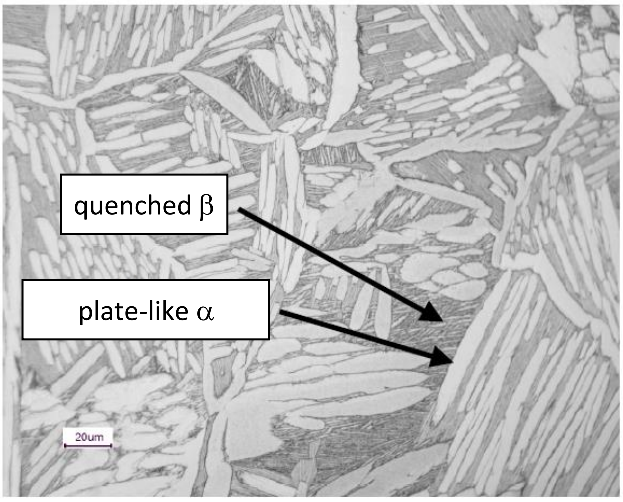

Example of a two-phase microstructure observed after interrupted cooling from the β domain (50% α formed), (Kaddour, 2004).

- Complex temperature transient
- Relationships between thermal history, phase transformations, multi-phased microstructure and creep behavior
- Numerical and analytical models

Abstract:

The safety of light-water nuclear reactors rests heavily on the good behavior of the fuel cladding tubes, made of zirconium alloy. In hypothetical accidental situations, those tubes might be exposed to complex thermomechanical loading. In particular, their temperature may vary non-monotonically, up to more than 800°C, which may cause several partial or full phase transformations, and strong evolution of its microstructure and mechanical properties. The purpose of this work is to study and model phase transformations, resulting microstructural evolution and mechanical behavior of M5® zirconium alloy as a function of thermal history.

To this aim, phase transformation kinetics and mechanisms will be characterized under isothermal and anisothermal conditions, particularly after a first high-temperature treatment. This first part of the project will deepen our understanding of phase transformation mechanisms as a function of thermal history.

Based on this, samples with various model microstructures will then be subjected to creep tests to improve our knowledge of the relation between chemical composition, microstructure and resistance to viscoplastic deformation.

Experimental findings from this work and previous works will be capitalized into analytical and numerical models describing the phase transformations and resulting creep behavior all along the thermal transient.