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Quantification of the α(O) and Prior-β phase fractions and their oxygen contents in high temperature (HT) oxidised Zr alloys (Zy-4, M5™)

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ABSTRACT

This paper describes a methodology which allows us to quantify the α(O) and Prior-β phase fractions and their oxygen contents in high temperature (HT) oxidised fuel cladding tubes. The methodology has mainly been applied to Framatome-ANP's Zy-4 and M5™ alloys. One of the practical objectives is to be able to quantify the local « ECR » of HT oxidised cladding tubes i.e. to characterize locally the resultant clad microstructure after a LOCA test leading to an inhomogeneous oxidation of the cladding tube, for example: due to azimuthal and/or axial thermal gradients along the tube, due to secondary oxidation in the vicinity of a failure, etc.

After describing the experimental methodology, we illustrate an application which consists of a study of the influence of the oxidation mode, that is :

(1) Conventional Furnace Heating (FH) vs. Induction Heating (IH)
(2) Single Face (SF) vs. Double Face (DF) oxidation mode

on M5™ oxidised at 1000°C for a variety of oxidation times, including the «break-away» phenomenon occurrence. This last study has shown no significant influences of the heating (FH vs. IH) and of the oxidation (SF vs. DF) modes on the α(o) thickness evolution and thus on the break-away occurrence at 1000°C on M5™ alloy. This allowed us to check the consistency between the two main HT-oxidation facilities used in CEA labs on non-irradiated clads (i.e., "Dezirox" and "Cinog" facilities).