XAFS investigations of Y-Ti-enriched nanometric oxides in ODS ferritic steels after neutron irradiation in Experimental Reactors

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The speciation and structural evolution of yttrium-titanium-enriched nanometric oxides in Oxide Dispersion Strengthened (ODS) ferritic steels have been investigated by X-Ray Absorption Fine Structure (XAFS) spectroscopy and X-Ray Diffraction (XRD) after neutron irradiation up to about 80 dpa in different experimental reactors~~)~~. The local order and structure evolutions during neutron irradiation are crucial to understand the phase stability of the nanometric precipitates (size of the smallest < 3 nm) homogeneously dispersed in ODS materials, responsible of their excellent creep properties.

Here we focus on the results obtained by XAFS at the MARS beamline, located at the Synchrotron SOLEIL facility, which is dedicated to the analysis of radioactive materials. The local structure and speciation of Y-Ti enriched oxides have been characterized by Y K- and Ti K-edges XAFS analysis (including X-ray Absorption Near Edge Spectroscopy (XANES) and Extended X-ray Absorption Fine Structure (EXAFS)~~)~~ in fluorescence mode for neutron irradiated samples for: i) DY, a Fe-12,9Cr-1,46Mo-0,08Mn-0,03Si-2,03Ti-0,45Y (chemical composition in weight percent (Wt%)~~)~~, irradiated as fuel pin cladding tubes in PHÉNIX (France); ii) MA957, a commercial Fe-13,9Cr-0,98Ti-0,26Y (Wt%), irradiated as tensile specimen in SUPERPHÉNIX (France), BOR 60 (Russia) and OSIRIS (France).
XAFS spectroscopy provides a practical and simple way to study elements of dilute species over the whole sample volume. However, the interpretation of XAFS data for industrial material where the absorbing atom studied is located in various secondary phases, even in the matrix, is more challenging than for a quite homogeneous and "pure" material. For this reason, other techniques, such as TEM and XRD have been used, providing complementary information useful to analyze the XAFS data.

This presentation will also concern the results obtained by XAFS as a function of the position of the samples during irradiation leading to variations of the neutron flux and temperatures.

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