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Evaluation of Microstructural Evolution in Isothermally Aged Ferritic Candidate Cladding Materials for Sodium-cooled Fast Reactor Applications

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In Generation IV sodium fast reactors, fuel cladding and core internals are expected to experience higher temperatures and higher burnup than in previously operated reactors. The thermal stability of these components is paramount for safe and economical operation of these plants. In this work, several candidate ferritic and ferritic-martensitic cladding materials (HT9, T91, T92, 9Cr-ODS and 12Cr-ODS) were isothermally aged between 360 °C and 700 °C for times of up to 50,000 hours. Samples were encapsulated in an inert environment prior to aging to eliminate environmental effects. All thermally aged samples will be investigated for presence of potentially deleterious phases, such as g-phase, σ-phase, α-α′ phase separation and kinetically and thermodynamically induced phase changes, and compared to the as-supplied, unaged condition. Characterization techniques will include synchrotron x-ray diffraction on all samples for phase identification and to quantify phase fractions and precipitate sizes as a function of time and temperature. Select conditions will be examined by transmission electron microscopy to obtain complementary information such as precipitate morphologies and local chemical profiles. High resolution, large-area scanning electron microscopy will be used to assess periodicity and the homogeneity of structures and features, as well as determine micro-scale information., such as grain parameters and grain boundary characteristics.

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