Importance of Microstructural Analysis and Modeling in Understanding the Degradation of Materials

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ABSTRACT

In order to establish the importance of microstructural analysis in understanding materials degradation, a materials science based logic was applied to material deformation. In this approach the observed microstructural changes (both topological and microstructural changes at the nano-scale), the chemical compositional changes, and the physical (structure or mechanical property) changes were translated into the resulting stress/strain. The stress/strain information is then fed into modeling tools such as analytical or finite element analysis (FEA) based modeling as input. It is expected that this modeling based analysis will provide insights on life cycle prediction.

This talk will present results from NRC test programs on microstructural changes in materials due to either thermal aging or neutron irradiation based on scanning electron microscopy (SEM), transmission electron microscopy (TEM), atom probe tomography (APT), high energy x-ray diffraction and mechanical testing methods.

In order to demonstrate our vision to model material degradation, we also present our modeling approach to predict the crack growth in corroded materials as an example. The materials investigated were stainless steels used in light water reactor (LWR) reactor pressure vessel internals and cast stainless steel (CASS) components used in LWRs.

A brief discussion on our future research plan to model the microstructural test results using FEA will also be presented.