Influence of dissolved oxygen on the oxidation and stress corrosion cracking of cold-worked austenitic stainless steels in the primary water of pressurized water reactors

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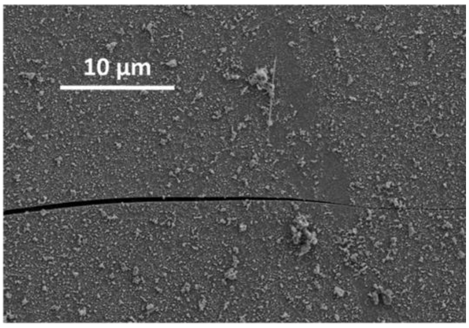

- Oxidation and Stress Corrosion Cracking (SCC) tests
- Oxygenated transients effect (off-normal PWR chemistry)
- Oxidation and cracking network local characterization
- Application to PWR nuclear power plants

Abstract:

As of 2017, Pressurized Water Reactors (PWR) represent 69% of operating nuclear power plants worldwide. Experience on those reactors shows cases of Stress Corrosion Cracking (SCC) affecting cold-worked stainless steel components in the primary circuit. SCC is a degradation phenomenon caused by the interaction of the environment and the applied stress on the material.

In this context, oxygenated transients are reactor operating steps during which dissolved oxygen is present in PWR primary water. These oxygenated transients are considered as a possible detrimental factor of the SCC phenomenon. In nominal conditions, on the contrary, PWR primary water does not contain any dissolved oxygen.

The global aim of this work is to study the influence of oxygenated transients on the SCC susceptibility in PWR primary water of a cold-worked 316L stainless steel, with a special attention paid to the coupling between strain localization and oxidation.

For this purpose, slow strain rate tensile (SSRT) tests are performed on tensile pre-strained specimens in nominal or oxygenated PWR primary water. The resulting cracking networks are correlated to the microstructural and local strain fields obtained by electron backscatter diffraction (EBSD) and digital image correlation (DIC), respectively.

In parallel, the effect of oxygen on oxidation is studied on non-strained and cold-worked specimens, for both water chemistries. To this aim, the kinetics, structure and composition of the oxide films and oxide penetrations (grain boundaries, slip bands) are characterized by Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM).