FUNDAMENTAL UNDERSTANDING OF CRACK GROWTH IN STRUCTURAL COMPONENTS OF GENERATION IV SUPERCritical LIGHT WATER REACTORS

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Goal

Contribute to selection of SCWR structural materials to:

- ensure functionality of in-vessel components
- estimate lifetime of structural components under a variety of normal and offset operating conditions.
Objectives

• Increase understanding of the fundamentals of crack growth in SCWR structural components
• Provide *in-situ* tool for assessing influence of operating conditions on the electrochemistry of corrosion processes
• Measure material-specific parameters describing the material’s susceptibility to environmentally assisted degradation of structural materials
• Use these measurements to interpret the rate-limiting processes in the corrosion phenomena and as input data for lifetime analysis.
• Obtain information on crack nucleation and growth via analysis of conjugate fracture surfaces
• Identify candidate remedial actions by which the susceptibility to stress corrosion cracking can be decreased.
Approach

• Assumption: the rate of transport of ionic defects through the oxide film on the crack walls is a factor that affects crack growth rate,

• A correlation should exist between the crack growth rate and the oxide film properties. Generally, the faster the transport of ionic species through the film, the more defective and thus the less stable the film is.

• Characterize the influence of different ionic impurity contents in the coolant on the transport rate of ionic defects in oxide films forming on candidate structural materials

• Correlate these results with crack growth data obtained in separate experiments.
Techniques

• Controlled Distance Electrochemistry (CDE)
  – determine in relatively short experiments a measurable material parameter that describes the transport of ions or ionic defects in the oxide films

• Fracture Surface Analysis
  – reconstruct evolution of crack initiation and growth.
Controlled Distance Electrochemistry

![Controlled Distance Electrochemistry Diagram]
Application of CDE

Parameter(s) of surface film

Degradation

(Environment, Materials)
Fracture Surface Topography Analysis
Application of FRASTA

Pure water

(a) 0 hours
(b) 90 hours
(c) 110 hours
(d) 130 hours
(e) 150 hours

Water with lowered pH

(a) 45 hours
(b) 63 hours
(c) 80 hours
(d) 98 hours
(e) 115 hours
First Results

Forced Open Area