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Study of Alloy 690 Resistance to SCC Initiation in Subcritical and Supercritical Waters

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NRC/Industry Alloys 690/52/152 PWSCC Research Collaboration Meeting

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Objective

- To quantatively compare the performance of Alloy 690 vs. Alloy 600, in resisting PWSCC initiation

Background

- PWSCC FOI for Alloys 690/52/152 is a high MRP knowledge gap
- No PWSCC has been reported in plant operations
- It is difficult to initiate SCC in Alloy 690 in PWR environment
- Crack initiation is difficult to quantify and to define
- Few effective methodologies in studying SCC initiation for Alloy 690

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Approaches

1. Increase test temperature to accelerate the cracking. The kinetics of cracking in supercritical water (SCW) regime is expected to increase significantly
    - Crossing this phase boundary brings with the question of whether the degradation mechanisms will be altered, given that SCW has some very different characteristics.

2. Use interrupted CERT test to assess severity of cracking and to quantify crack initiation
    - To observe cracking in the “early” stages (<10um)
    - To assess extent of cracking at a set value of strain
    - To compare cracking severity among different material conditions

3. Additional tests of U-bend/O-ring samples to assure statistic confidence

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Main Rationale of Testing at Higher Temperatures

- Assume no disconnect of cracking behavior across the subcritical-supercrticial regime:
  - Confirmed by the limited amount of data in the crack depth as determined from CERT tests [Teysseyre 2006, Jacko 2007]
  - Characterization of the oxide films also shows similarity in the oxide phase structure and morphology [Was 2006, Was 2007]
- To establish a correlation between crack initiation and temperature
- To extrapolate the result to realistic operating conditions through the established temperature dependence

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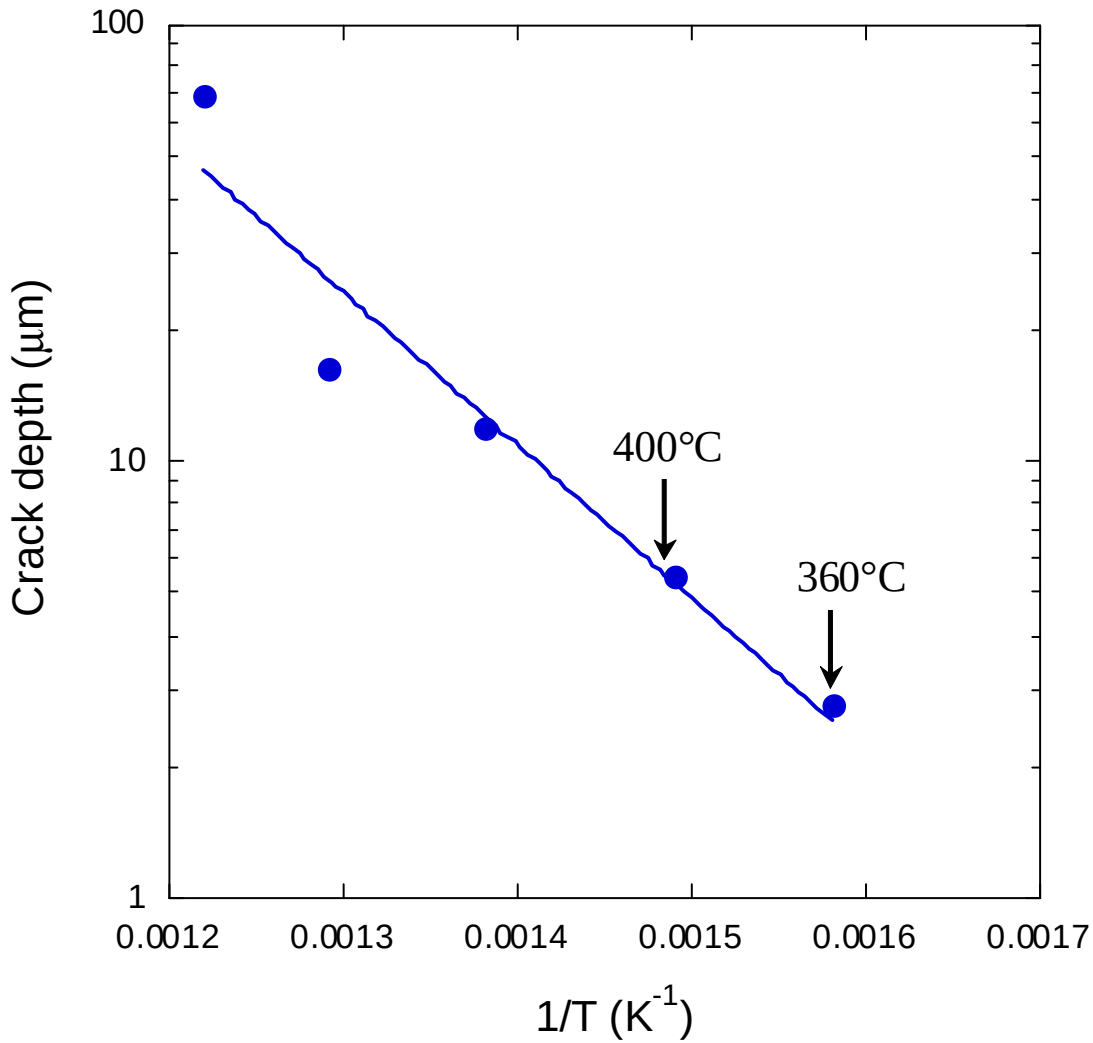
Previous Data: Crack depth as a Function of Temperature for Alloy 690



Teysseyre & Was, 2006

- Alloy 690 tested in CERT
- Pure water containing < 10 ppb O_2
- Extension rate of 3×10^{-7} s^{-1}
- Activation energy 90 kJ/mol

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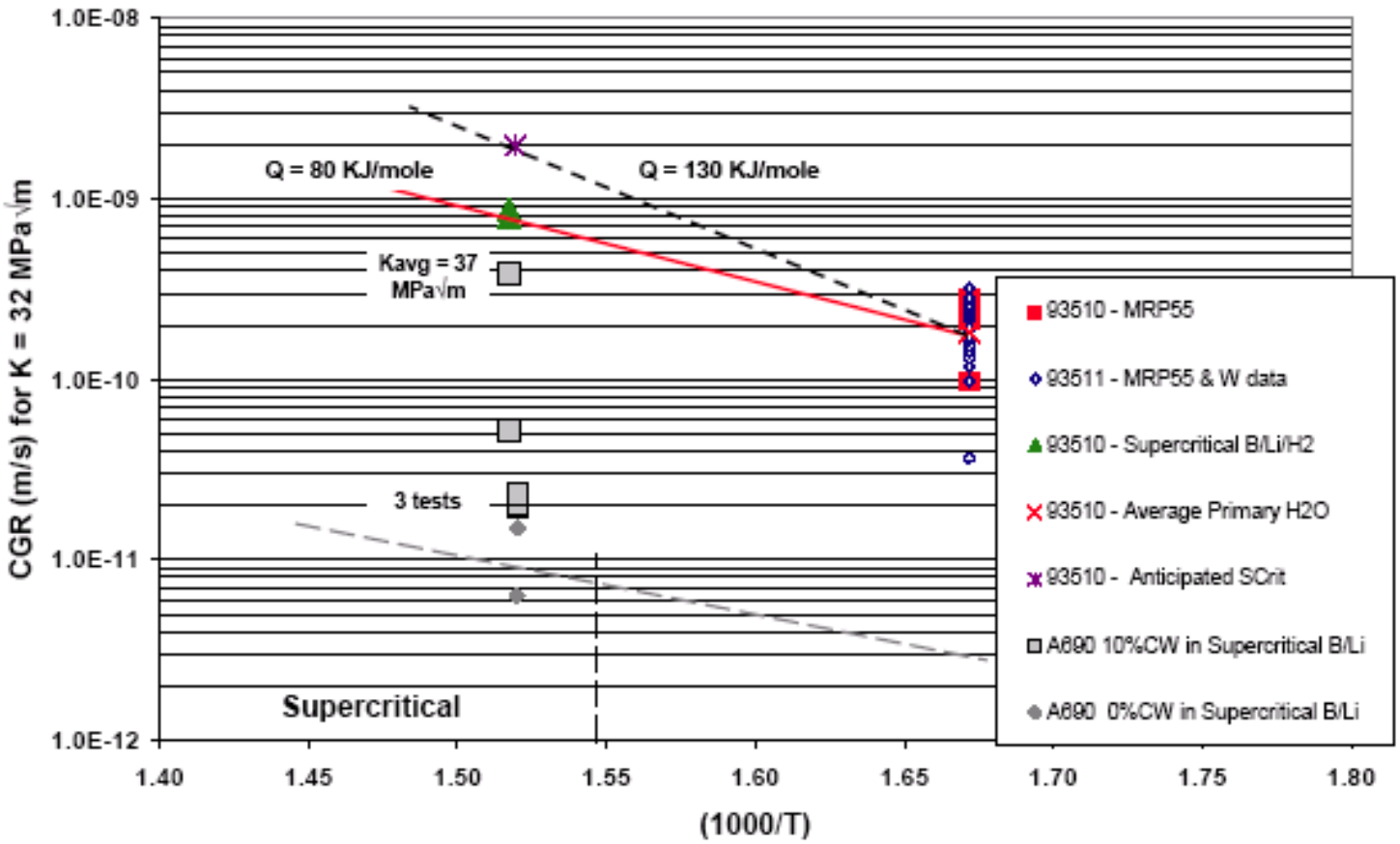
MRP 225 ---- Comparison of Crack Growth in Alloys 600 and 690 in Subcritical and Supercritical Waters

Jacko 2007, SCW environment had introduced no extraneous effects



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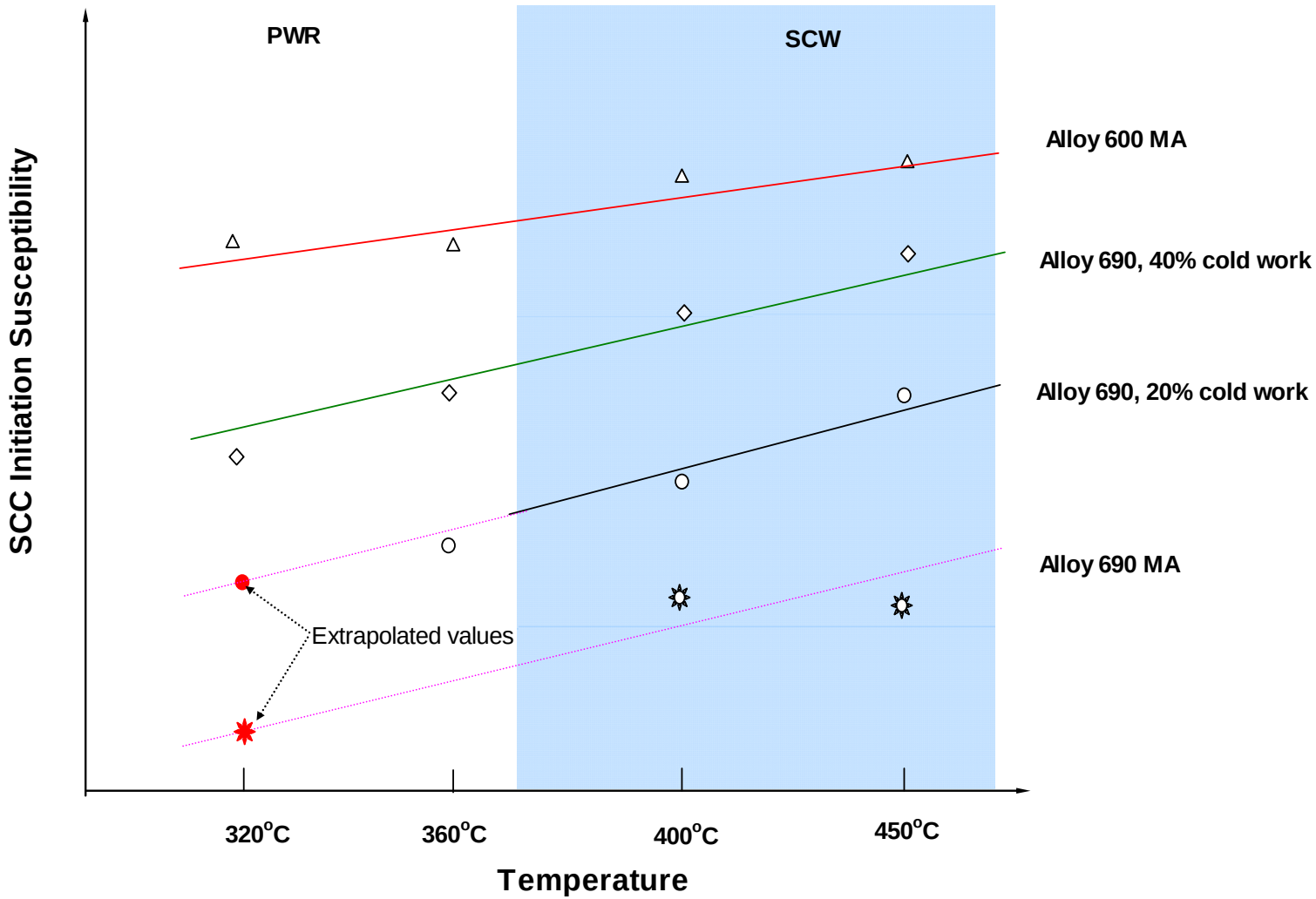
Proposed: To Establish Temperature Dependence for Predicting Alloy 690 PWSCC Susceptibility



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