**Introduction: NiAl-Strengthened Ferritic Alloys**

A comparison of Larson-Miller parameter plots between FBB8 and other Fe-based materials candidates for steam turbine applications. TEM dark field image of FBB8 alloy with superlattice reflection.

**Objective**

- Introduction of new types of precipitates, (single Ni$_3$TiAl) precipitate-strengthened ferritic alloy [HPSFA].
- Understanding of the effect of precipitate structures on the creep behavior.

**Schematic Illustration of Current Study**

- First-Principles Calculations
- Experimental Validation

**Optimization of creep properties of novel ferritic superalloys with a hierarchical structure**

**First-Principles Calculations**

- Harmonic Transition-State Theory Assuming Vacancy Mechanism

**Experimental Results**

- In-Situ Neutron-Diffraction Creep Results

**Future Works**

1. Effects of aging temperatures and time on the hierarchical-precipitate structure and creep behavior of the 2% Ti alloy (coarsening behavior and optimization of Nb).
2. Systematic study of hierarchical-precipitate-strengthened ferritic alloys by substituting Ti with Hf, Ta, and Zr (introducing a new two-phase microstructure structure and its effect on the creep mechanical properties).
3. Systematic creep experiments of various temperatures and stresses on the new hierarchical-precipitate-strengthened ferritic alloys study of creep behavior and mechanisms.
4. Calculations of single-crystal elastic constants (C44 for L2$_1$-Ni$_3$Al, L2$_1$-Ni$_3$Al(N), and L2$_1$-Ni$_3$Al(N) from first principles morphology of precipitates and load partitioning condition in creep.
5. Calculations of interfacial energies for Fe-Cu-Al, Cu-Ni-Al, and Cu-Ni-Al from first principles investigation of the interface energy for various microstructural models to optimize the creep resistance.

**Creep Properties**

- In-Situ Neutron Diffraction Experiment Results
- Crystal-Plasticity Finite-Element Modeling Results

**Experimental Results**

- Fe-6.5Al-10Cr-10Ni-3.4Mo-2.0Ti-0.25Zr-0.15Nb (wt. %), HPSFA

**4.** From the in-situ neutron-diffraction experiments, a clear load transfer from the matrix to precipitate during loading and creep at 973 K.

**Publication**


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