ICME for Creep of Ni-Base Superalloys in Advanced Ultra-Supercritical Steam Turbines

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Aims

- Critical assessment of existing experimental data and datamining to find processing-microstructure-property (PMP) relationships.
- Assessment of predictive accuracy of current creep models.
- Development of new modeling capabilities to predict long-term creep behavior of Ni-base superalloys used in A-USC applications. This includes integration of phase-field and FFT-based crystal plasticity to develop a multi-scale, physics-based, microstructure-sensitive creep model.

Results and Discussion

A. Physics-based creep model:

- A phase field model has been developed for large scale simulation of γ'/γ two-phase microstructure evolution in the single crystal level.
- Elastic energy has been formulated using inhomogeneous phase-field micromechanics theory developed by Wang, et al. [5].
- Coupling of plastic strain energy using crystal plasticity is currently in progress.

Simulation results for γ' precipitation and coarsening:

- γ' volume fraction 60%
- Though A-USC Ni-base superalloys have lower amount of γ' but the coarsening behavior should be same.

B. Data Assessment and Datamining:

- Experimental data for creep and stress rupture is being collected from various sources.
- Dr. Chen Shen from GE Global Research has reaffirmed his commitment to share data and OSU will be receiving this coming quarter.
- Dr. Bryce Meredig, CTO Citrine Informatics, is coming to OSU in the end of this month to implement the machine learning framework and the integration of collected creep data into Citrination. The Citrination platform will be used to find PMP linkages from the collected data.

C. Assessment of Existing Creep Models:

- Existing creep models is currently being assessed including GE GRC model of Dr. Chen Shen developed under NETL support.
- Creep models which are microstructure-informed will be matched with the experimental data.
- Based on the results the best model will be chosen for the long time creep life prediction of these A-USC based superalloys.

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References