Stochastic Multiscale Fatigue Life Prediction Framework for Next Generation Durability and Damage Tolerance

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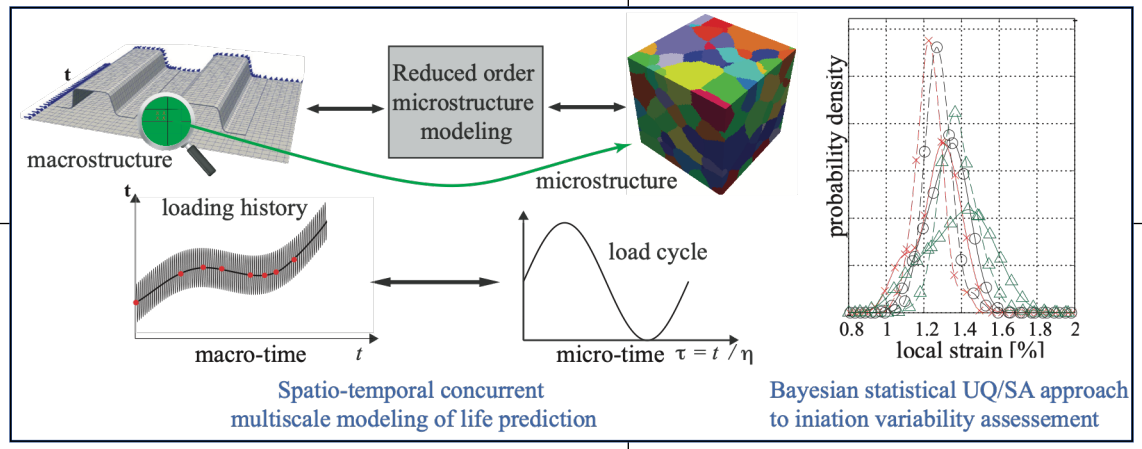
Research Objectives

- Objectives: Devise a multiscale and probabilistic computational framework for microstructure-informed prediction of fatigue crack initiation in polycrystalline structures
- Key Innovation: Directly enrich structural response with microstructure mechanisms by tightly coupling the simulations of structure and the microstructure.
- Start TRL: TRL1/TRL2. End TRL: TRL3



Spatio-temporal concurrent multiscale modeling of life prediction

Bayesian statistical UQ/SA approach to iniation variability assessement

Approach

- Concurrent multiscale modeling of fatigue life initiation prediction based on computational homogenization theory applied to space and time.
- Bayesian uncertainty quantification and sensitivity analysis to characterize variability in structural and material scale fatigue crack initiation.
- Verification and validation on near alpha and alpha-beta titanium alloy structures

Potential Impact

- Achieves the ability to predict crack initiation life with the level of fidelity similar to that of the long crack growth regime.
- Facilitates risk-informed durability and damage tolerance based design including initiation regime.
- Significant life extension of future air and space platforms and drastic reduction of weight in fatigue-critical structural components.