# Microstructure and defect informed predictions of damage tolerance and durability of materials and structures, including verification and uncertainty quantification


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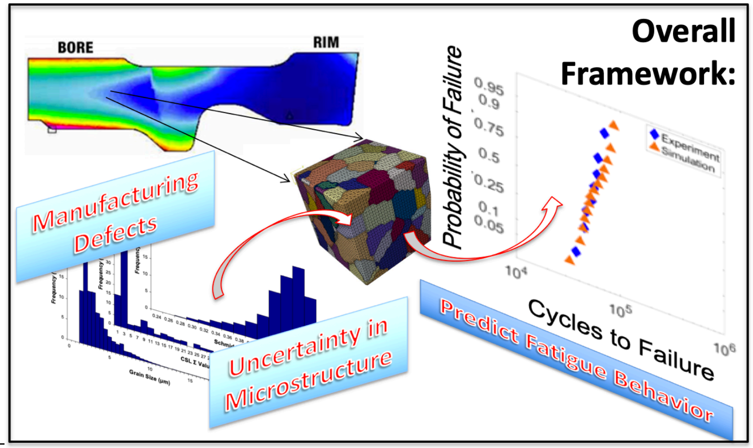
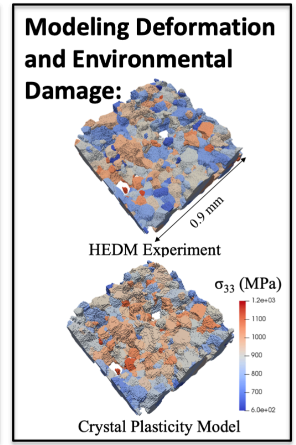
## Research Objective

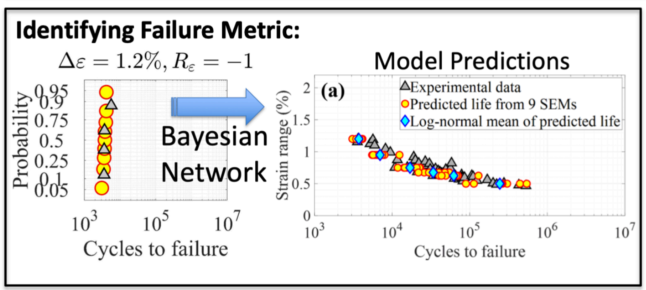
- Automates creation of crystal plasticity model for deformation, through identifying appropriate constitutive relationships, calibrating the model parameters, and performing uncertainty quantification
- Identifies failure metric (including threshold value and uncertainty) through Bayesian network, using minimal test data
- In situ HEDM experiments provides abundance of validation data at the appropriate length scale for each test

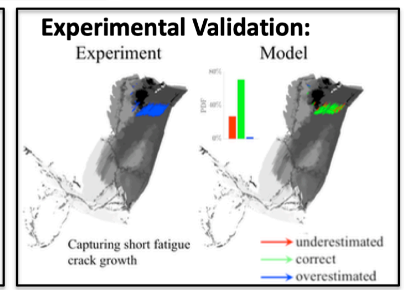



## Approach

- Holistic framework to predict microstructurally sensitive fatigue crack initiation & propagation
- Applicable to a general class of structural polycrystals, loading scenarios, and environments
- (i) Develops statistically equivalent microstructures with manufacturing defects, (ii) Employs crystal plasticity for combined mechanical and environmental loading, (iii) Identifies fatigue failure through a Bayesian network, (iv) Validates the model via in situ high energy x-ray diffraction microscopy (HEDM) experiments, and (v) Scales to component analysis through hierarchical modeling




## Potential Impact

- Next generation fatigue methods reduce the reliance on large-scale coupon testing, saving time and cost
- Compared to classical approaches, proposed models account for: (i) manufacturing defects, (ii) microstructure variability, (iii) environmentally damage, and (iv) component features of similar length-scale as the material's microstructure
- High fidelity and precise models will reduce level of mission risk and reliably assess the safety of NASA spacecraft vehicles
- Project starts at TRL 1 and will finish at TRL 3