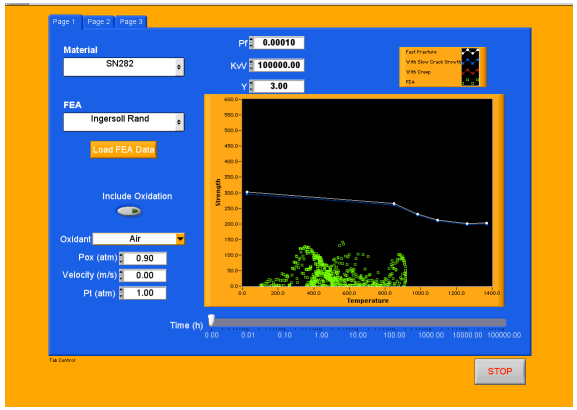
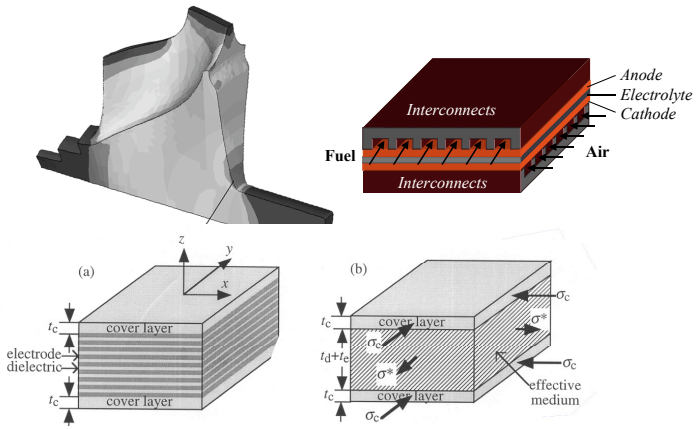
Center for Ceramic (CCR) Reliability Will Focus on Four Issues Required for Successful Design of Brittle Components

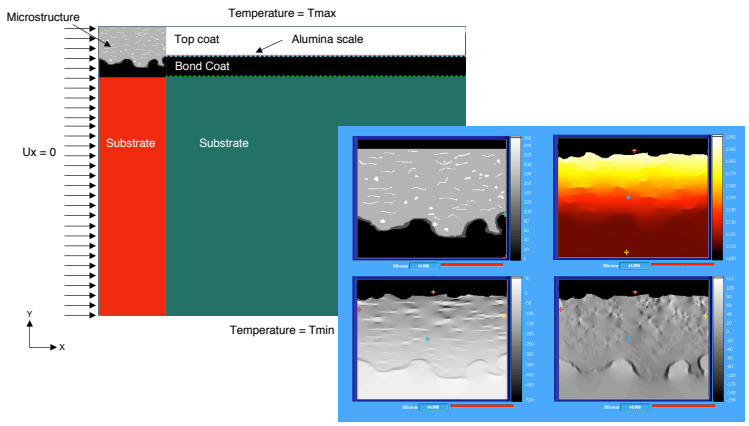
Advanced Algorithms for Predicting Reliability



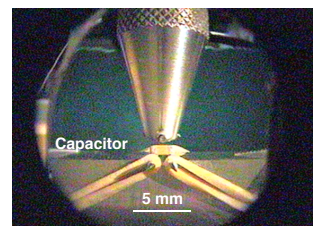
Numerical and Analytical Modeling

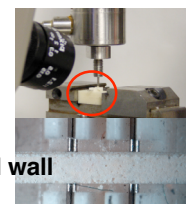


Materials Optimization

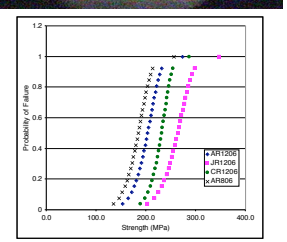


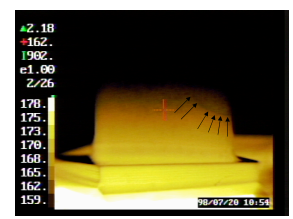
Characterization (Testing and NDE)





DPF cell wall





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Center for Ceramic Reliability Is Relevant to a Number of Material Systems

- **Structural Ceramics**
  - Airfoils, Valves, etc.
- **Electrical Ceramics**
  - Ceramic Capacitors, Substrates, Sensors
- **Ceramics for Gas Transport Applications**
  - Membranes, SOFCs
- **Bioceramics**
- **Ceramic Coatings**
  - Wear, Thermal Barrier, Environmental Barrier

Challenges

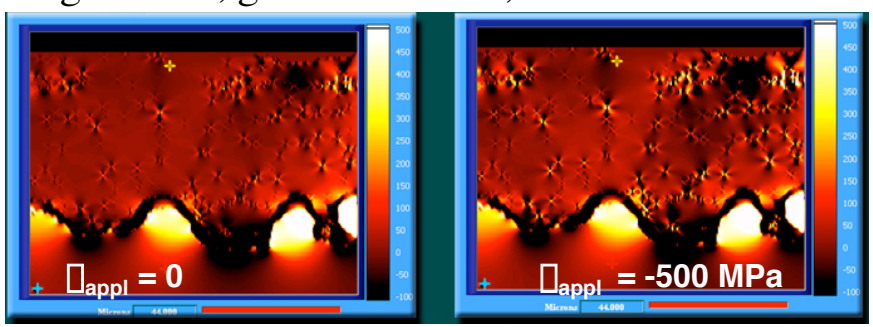
- **Assessment of Time Dependent Behavior Arising from Slow Crack Growth, Fatigue, and Creep**
  - Role of Environmental
  - Model Development
- **Development and Verification of Miniature Fixtures for Measuring Mechanical Response**
  - Required for Component Verification
- **Development of Techniques for Remaining Life Assessment**
  - NDE Based
  - Required Valid Models that Relate Measurement Parameter to Level of Damage
- **Understanding Fundamentals of Fracture for Small Volumes**
  - Weibull Theory is No Longer Valid

μ-FEA Uses Real Micro- & Macro-Structure to Predict Response to External Environments and to Tailor Materials for Improved Performance

Employs ANSYS as FEA solver thus can analyze:

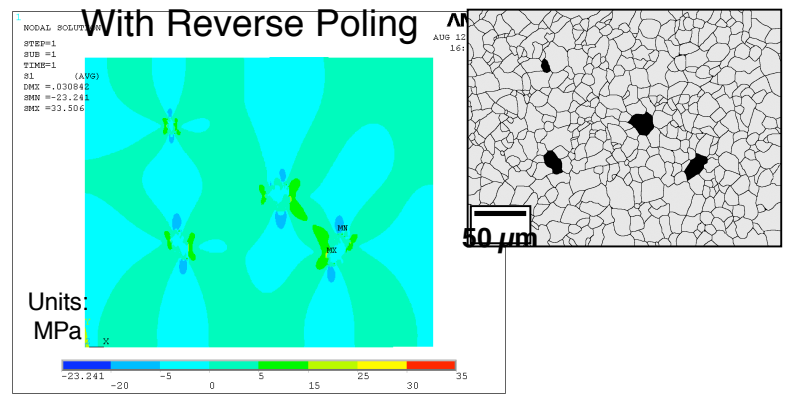
- linear and non-linear properties
- steady-state and transients (e.g., thermal shock, creep)
- piezoelectric effects
- effects of phase changes & swelling
- probabilistic behavior
- element birth & death (e.g., microcracking)

TBC Residual Stresses due to thermal gradients, growth of TGO, service stresses.

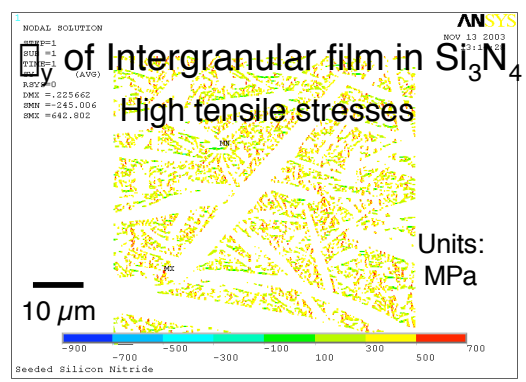


EBC: tailor Si_3N_4 surface composition to minimize tensile stresses in EBC system.

Pores Cause Stress Risers That Cycle With Reverse Poling



σ_V of Intergranular film in Si_3N_4



Predicting stresses within microstructure

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