Title:

Micromechanics of Ductile Damage

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Abstract:

The process of ductile damage during structural loading in materials or composites is enabled by availability of inelastic deformation mechanisms and generally follows a length-scale evolving path of nucleation, growth, coalescence/percolation, and failure. Nucleation is heavily influenced by structural heterogeneities based within the material and is statistically driven at small length scales where the damage field is established. In general, these manifest as discrete spatial sites whose locations are dictated by the heterogeneity of interacting stress and defect fields. The region of growth is recognized when the progression of damage is dominated by the growth of existing damage sites and there are minimal new sites created and substantial global softening takes place within the structural component. Depending upon time of stress condition, nucleation time, and growth rate of discrete damage sites, a distribution of site size will develop which will continue to bias growth rate to only a portion of nucleated sites. The processing of biasing will be driven by local mechanical conditions surrounding each site and load sharing throughout the damage field. Eventually discrete site size will increase so that the field of deformation for each overlap with neighboring sites and localized deformation will begin between sites and contribute to deformation and further softening - the coalescence/percolation phase of damage progression. At this stage the damage field is well developed and further deformation will bring failure or fragmentation as the damage field creates contiguous new surfaces in the structural component. This evolutionary process begins at the atomic length scale and continues to that of the component. This evolving length scale problem poses significant challenges computationally. Some interesting topical suggestions are:

- Computational statistical physics, rare-event methodologies to probe damage nucleation physics.
- Physically-based computational regularization methods.
- New theories representing the micromechanical physics of ductile damage and failure for specific material systems.
- Large-scale computational studies of heterogeneous material response for statistics interrogation.
- Novel computational approaches to ductile damage simulation.
- New approaches for micromechanical and thermodynamic representation of material response in large-scale simulations with heterogeneity preservation.