VORONOI CELL FEM-BASED DAMAGE MODELING IN PARTICLE REINFORCED MMC'S

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Damage initiation and progress to cause ductile failure in particle reinforced composite microstructures with varying distributions, is modeled in this paper. The damage mechanisms include particle and matrix cracking, which are modeled in a Voronoi Cell finite element model (VCFEM) framework [1]. Particles are assumed to be brittle, while the matrix is modeled as ductile with evolving porosity. Particle cracking is modeled by the Mohr's theory of maximum principal stress or the Rankine criterion. Progressive damage by ductile fracture of the metallic matrix material is represented by a pressure dependent elastic-plastic constitutive relation for porous materials. In particular a non-local form of the Tvergaard-Gurson model with void nucleation, growth and coalescence is used for modeling the matrix response and damage. Evolution of damage is monitored through growth of porosity in the microstructure. Regions of critical porosity levels are adaptively enriched to realize the localized strain fields in the evolving matrix crack. Metal matrix composites with different particle volume fractions and particle sizes subjected to different strain levels by uni-axial tension, are studied. All geometric information of each microstructural section are then recorded by an image analysis system. These sections are modeled with VCFEM for damage evolution and compared with the experimental observations. In particular, damage in the microstructure near a structural flaw is compared with experimental observations by modeling a distribution of particles ahead of the flaw in a compact tension test.

REFERENCES

[1] S. Moorthy and S. Ghosh, *Adaptivity and convergence in the Voronoi cell finite element model for analyzing heterogeneous materials*, Computer Methods in Applied Mechanics and Engineering, 185, (2000), 37-74.