

DETERMINATION OF SPALL SENSITIVITY TO MATRIX MATERIAL PROPERTIES BY DIRECT NUMERICAL SIMULATION

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Abstract

The effect of material strain hardening and strain rate sensitivity on spall response is investigated through large-scale direct numerical simulations of void growth and coalescence from 3-dimensional distributions of void nucleating particles. The computational model spans multiple particle spacings in the in-plane directions, and the finite element mesh is fine enough that several elements span the initial particle diameters in the mixed-zone Arbitrary Lagrange-Eulerian (ALE) simulations. The matrix material is represented by traditional plasticity models in which material failure is not permitted. The 1000+ particles are represented by the same material model as the surrounding matrix except the particles have low tensile strength to permit fracture, which is used to simulate particle cracking or decohesion. Voids grow and coalesce naturally in the ALE framework and the simulations produce dimpled failure surfaces similar to those observed experimentally in spalled samples. The strain hardening and strain rate sensitivity of the matrix material are altered to determine their influence on the void growth and coalescence processes and the simulated free surface velocity pull-back signal. The details available from computational model permit association of spall surface evolution with features on the free surface velocity profile.

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