Nucleation and Growth Modes in a Monte Carlo model of Cohesive Tensile Cracks

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We analyze the nucleation and growth of cohesive tensile cracks using a free energy which is written as a functional of the crack separation (offset field). We simulate the nucleation events on a square lattice using a Metropolis Monte Carlo algorithm. Several modes of crack propagation are seen in the simulations. Our results indicate that for certain materials, crack nucleation and growth proceed through the formation and extension of a diffuse ‘‘halo’’ surrounding the classical portion of the crack. This is similar to nonclassical nucleation near the spinodal in magnetic systems. Theoretical considerations and numerical calculations strongly suggest that the diffuse halo can be identified with the fracture ‘‘process zone’’ seen in laboratory studies of advancing cracks. We are investigating scaling exponents associated with this apparent phase transition.