

Breakdown of Fracture Mechanics in Nanoscale Components

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The applicability of fracture mechanics criterion in the nanoscale components with a crack is investigated using the molecular dynamics simulations in conjunction with finite element method. We perform fracture experiments *in silico* for pre-cracked nanoscale specimens of a brittle material of silicon. In the specimen with the size of 100nm or larger, the crack propagates just when the stress intensity factor reaches the fracture toughness, i.e., the fracture mechanics criterion is still valid in the nanoscale. However, as the specimen size decreases down to several tens of nanometers or smaller, the fracture takes place before the stress intensity factor reaches the fracture toughness. This indicates that the fracture mechanics criterion is no longer applicable in these nanoscale specimen, i.e., the breakdown of fracture mechanics. This also suggests that there exists the lower applicable limit for fracture mechanics criterion.