FRACTURE ANALYSIS BASED ON A STRAIN GRADIENT PLASTICITY THEORY WITHOUT THE HIGHER-ORDER STRESS

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In a remarkable series of experiments, Elssner et al [1] observed cleavage fracture in ductile materials, a phenomenon that cannot be explained by classical plasticity theories. In this paper we present the fracture analysis using a dislocation-based strain gradient plasticity theory that does not involve the higher-order stress. It is established that, at a distance much larger than the dislocation spacing such that continuum plasticity is applicable, the stress level in the dislocation-based strain gradient plasticity is significantly higher than that in classical plasticity near the crack tip. The numerical results also show that the crack tip stress singularity is higher than the HRR field, and it exceeds or equals to the square-root singularity. This study provides a means to explain the observed cleavage fracture in ductile materials.

References

[1] G. Elssner, D. Korn, and M. Ruehle, "The influence of interface impurities on fracture energy of UHV diffusion bonded metal-ceramic bicrystals," *Scripta Metall. Mater*., v. 31, p. 1037-1042, 1994.