FRACTURE ANALYSIS IN THE CONVENTIONAL THEORY OF MECHANISM-BASED STRAIN GRADIENT PLASTICITY

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In a remarkable series of experiments, Elssner et al. (1994) and Korn et al. (2002) observed cleavage cracking along a bimaterial interface between Nb and sapphire. The stress required for cleavage cracking is around the theoretical strength of the material. Classical plasticity models fall short to reach such a high stress level. We use the conventional theory of mechanism-based strain gradient plasticity (Huang et al., 2004) to investigate the stress field around the tip of an interface crack between Nb and sapphire. The tensile stress at a distance of $0.1mm$ to the interface crack tip reaches $13.3\sigma_Y$, where σ_Y is the yield stress of Nb. This stress is nearly 4 times of that predicted by classical plasticity theory ($3.6\sigma_Y$) at the same distance to the crack tip, and is high enough to trigger cleavage cracking in materials and interfaces. This is consistent with Elssner et al.'s (1994) and Korn et al.'s (2002) experimental observations.

References

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