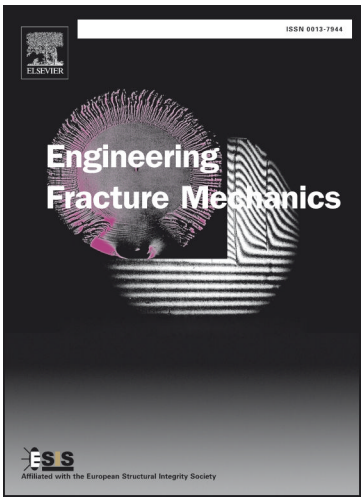

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The fatigue crack growth in hierarchically nano-twinned materials

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ABSTRACT

The dislocation emission-based model is established to reveal the fatigue crack growth in polycrystalline metals with hierarchically nano-twinned structures (HTS). The analysis illustrates that the presence of HTS can effectively prevent fatigue crack propagation along the boundaries of primary twins during plastic deformation. For the same primary twin spacing λ_1, the fatigue fracture toughness is enhanced first with the decreasing secondary twin spacing λ_2, reaching the maximum at the critical λ_2, and then reduced as λ_2 becomes even smaller. It is found that the smaller the spacing λ_1, the smaller the critical spacing λ_2. Moreover, there also exists optimal twin spacing in primary twin lamellae. In addition, the proposed theoretical model suggests that the fatigue crack growth rate reduces with decreases of secondary twin spacing λ_2 when spacing λ_2 is above the critical value, as observed in molecular dynamics simulations. The present results provide insights to optimize the microstructures for achieving high