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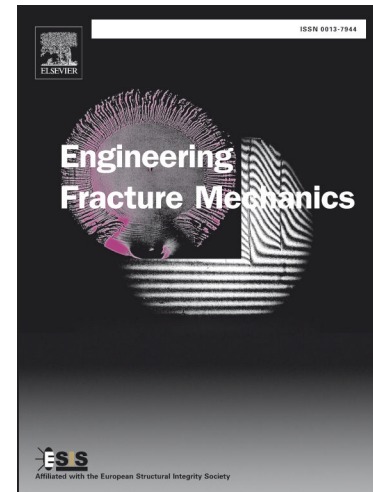
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# The fatigue crack growth in hierarchically nano-twinned materials

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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  $\lambda_1$ , the fatigue fracture toughness is enhanced first with the decreasing secondary twin spacing  $\lambda_2$ , reaching the maximum at the critical  $\lambda_2$ , and then reduced as  $\lambda_2$  becomes even smaller. It is found that the smaller the spacing  $\lambda_1$ , the smaller the critical spacing  $\lambda_2$ . 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  $\lambda_2$  when spacing  $\lambda_2$  is above the critical value, as observed in molecular dynamics simulations. The present results provide insights to optimize the microstructures for achieving high

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