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Abstract

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3D microstructure and heterogeneous strain response of cemented carbides during deformation

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A new method for creating three-dimensional finite element model based on real microstructures of the WC-Co cemented carbides was proposed. A series of simulations were performed to examine the heterogeneous interactions between the pre-existing thermal residual stress and the applied external stress in the cemented carbides. The deformation behavior of the as-sintered cemented carbide was demonstrated in detail for the process of uniaxial compression. The results indicate that among the heterogeneous distributions of the strain and stress in the composite microstructure, the layer-like Co distributing in the transverse cross-section with respect to the direction of compression has the most rapid strain response. The microcracks may preferentially nucleate at these regions due to the fast accumulation of plastic deformation. Assisted by 3D modeling based on both the finite element method and molecular dynamics, new strategies were proposed to achieve ultrahigh fracture strength of the composite material. Further, cemented carbide bulk materials were prepared by sintering the in-situ synthesized WC-Co nanoscale composite powders, which had coherent or semi-coherent interfaces within the cermet particles, and excellent integrated mechanical performance were obtained.