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Polycrystal Modeling to Determine the Strengths of Shocked Ceramics RUQIANG FENG, DONGMEI ZHANG, University of Nebraska-Lincoln — Voronoi polycrystal (VP) modeling coupled with finite element (FE) analysis has been developed to determine the effective shock strengths of polycrystalline ceramics. First, simulations with the 3-D VP-FE model and material parameters calibrated for α-6H SiC are used to demonstrate that the mean stress behavior of a shocked ceramic is independent of heterogeneous incompressible flows at the grain level and can be accurately calculated if the crystal elasticity is accurately described and sufficient grains are used for statistical averaging. Next, a finite-strain nonlinear crystal elasticity model is worked out for (rhombohedral) α-Al_2O_3 utilizing the available 2nd- and 3rd-order adiabatic elastic constants of the material. The VP-FE and nonlinear elasticity models are then used to compute the mean stress behavior of polycrystalline α-Al_2O_3 for uniaxial compressions up to a longitudinal stress of 20 GPa. The results and the available longitudinal stress measurements give a determination of the material's effective shock strength, which is further modeled using the Drucker-Prager plasticity theory with a limiting strength cap. It is shown that the combination of strength model and mean stress calculation can well capture the key features observed for the shock response of the material: a Hugoniot elastic limit (HEL) of 9.1 GPa, a gradual post-HEL softening, and an effective strength saturation near twice the HEL. The effect of porosity and the issues related to polycrystal modeling are also discussed.

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