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HYPERVELOCITY IMPACT NUMERICAL SIMULATIONS USING MATERIAL POINT METHOD COUPLED WITH EOS CALCULATED FROM MOLECULAR DYNAMICS METHOD

Abstract

The space debris hypervelocity impact is a threat to spacecrafts. Whipple shields are used to help spacecrafts survive in the debris environment. In this paper, the hypervelocity impact of space debris on the Whipple shield is simulated using the material point method(MPM) coupled with a new equation of state(EOS) calculated from the molecular dynamics(MD) method. MPM is a particle method, using Lagrangian points to carry all the physical variables and Eulerian background grids to solve equations of motion. With advantages of both Lagrangian description and Eulerian description, MPM is appropriate for simulating hypervelocity impact problems. In the hypervelocity impact MPM simulations, EOS is used to calculate the pressure of material points based on the internal energy and volume solved by MPM. The Mie-Gruneisen EOS is often used in hypervelocity impact simulations, but it is not suitable for melting. The new EOS calculated from MD method can be used to solve the pressure of material points when the phase transformation of material happens. Comparisons between numerical and experimantal results are made, and show that the MPM simulations using the new EOS are much better than the ones with the Mie-Gruneisen EOS, and agree well with experimental results.