BLAST WAVES FROM ULTRA-HIGH-ENERGY CHARGES

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ABSTRACT

We consider the explosion environment created by the detonation of Ultra-High-Energy (UHE) charges of meta-stable cluster media. This energy can be much larger than the typical chemical bond energy (~1 ev/atom). For example, polymeric nitrogen can accumulate 4 ev/atom, while helium can accumulate 9 ev/atom in the excited triplet state. They release their energy by cluster fission. The loci of states in thermodynamic space for the detonation of such meta-stable clusters have been analyzed by Kuhl (2008). He found that UHE media possess extraordinarily large detonation pressures (3 & 16 M-bar), temperatures (12,00 K & 34,000 K) and velocities (20 km/s & 43 km/s)—as a consequence of large heats of detonation (6,600 cal/g & 50,000 cal/g) for nitrogen and helium UHE, respectively. Numerical simulations of the detonation of 1-g UHE charges in a 6.6-liter calorimeter were performed with our three-dimensional (3-D) AMR code. Results are compared with explosions from Shock-Dispersed-Fuel (SDF) charges that release 7,400 cal/g via a turbulent combustion process, and with TNT explosions that release 1,100 cal/g via a detonation wave mechanism. Such comparisons illustrate the unique effects found in UHE explosions.