SMOOTHED PARTICLE HYDRODYNAMICS STUDY ON EJECTA BREAKUP AND SIZE DISTRIBUTIONS

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Under intense shock, metal interface disturbances grow under the Richtmyer–Meshkov instability mechanism and further fragment into numerous small particles. Understanding the dynamics of fragmentation and predicting the size distribution of the resulting particles is a crucial scientific issue in engineering. In this work, we developed a three-dimensional, large-scale parallel smoothed particle hydrodynamics code capable of efficiently and accurately simulating physical models such as elastic-plastic deformation for solid and surface tension for liquid, with numerical stability over long-term evolution. We performed direct numerical simulations of the formation and fragmentation of ejected sheet from a triangular groove on tin surface, involving a total of 130 million particles and a simulation time of ~11 microseconds (with a time step of ~0.03 nanoseconds). The simulation results for the first time revealed the fundamental dynamics of metallic sheet fragmentation on a macroscopic scale. The fragmentation can be divided into the following stages: void nucleation, growth, network formation, breakup of the network into filaments, then breakup into discrete droplets, followed by spontaneous instability and collision breakup of large particles. The size distribution of the particles decreases with increasing velocity of the micro-ejecta and exhibits significant spatial distribution characteristics. Overall, the particles follow a log-normal distribution, and the quantified results are close to experimental ones.