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PROCEEDINGS

Experimental and Computational Investigation on Lattice Distortion Driven Energy Release Efficiency Prediction of Multi-Component Alloys Under High-Velocity Impact

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ABSTRACT

Multi-component alloys exhibited violent combustion under high-velocity impact. However, the impact process was transient and complex, coupled with the vast composition space of multi-component alloys. It was challenging to establish a correlation between composition design and the regulation of impact energy release properties based on the intrinsic material properties. Therefore, this work explores the correlation between material properties and energy release efficiency under high-velocity impact via ballistic experiments. Firstly, among the four evaluated algorithms, the Gradient Boosting Decision Tree exhibited the best performance (R^2 = 0.78). Model analysis identified initial pressure and lattice distortion as key features. Correlation analysis indicated a strong relationship between lattice distortion and energy release efficiency (|PCC| = 0.7). Then, the mapping relationship between material properties and energy release efficiency was obtained using the cumulative fragment mass distribution function. At impact velocities of 1200–1300 m/s, the lattice distortion displayed a stable functional relationship with energy release efficiency. When the velocity decreased, the relationship became ambiguous because of the influence of the experimental factors. Then, this work developed a model (MAE = 0.029) for predicting energy release efficiency at velocities between 1000 m/s and 1500 m/s by considering the velocity and front plate. The predictability of lattice distortion for energy release efficiency could be attributed to its regulation of adiabatic shear sensitivity. The simple function models established in this work could achieve preliminary prediction of energy release efficiency without the need for complicated experiments.

KEYWORDS

Multi-component alloys; high-velocity impact; fragment; lattice distortion

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