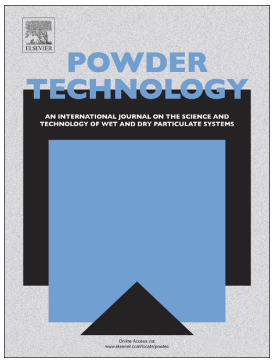

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Research on the volume and line fractal dimension of fragments from the dynamic explosion fragmentation of metal shells

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Abstract

The shape features and size distribution of fragments produced by metal shells under explosion loading have great significance for studies on weapons, industrial structures, and aircraft technology. However, it is unclear how best to describe the morphological characteristics and mass distribution of fragments, or whether a similar quantitative relationship exists between each fragment. Therefore, this paper reports the fragment characteristics and internal features of the fragmentation of metal shells under instantaneous explosion loading. An experiment was designed to measure the fragmentation and perforation of a steel cylinder shell filled with high explosives. Using fractal mathematical models, expressions for the volume and line fractal dimensions of the fragments are obtained. The volume fractal dimension, which is used to describe the mass or size distribution of the fragments, and the line fractal dimension, which is used to describe the projected contour of fragments or fragment perforations, were measured using a MATLAB mathematical model. The results reveal that the characteristic mass distribution and morphology of the fragments are statistically self-similar and can be characterized by the fractal dimension. The Gauss–Newton iterative method for the Rosin–Rammler distribution is superior to the existing fitting method, and the resulting volume and line fractal dimensions satisfy the relationship $D_3 + 2D_1 = 5$.

1. Introduction

Dynamic fragmentation is an instantaneous, irreversible, nonlinear, and nondeterministic phenomenon. Its physical mechanism can be observed at many scales, from the atomistic to the astronomic, and applied in a myriad of contexts—the impact of a meteorite on the earth's atmosphere, the drilling of a tunnel using explosives, the impact of a ceramic utensils on the floor, and so on. In the case of explosion loading, the hypervelocity interaction of two bodies initiates the violent disruption and destruction of the participating structures and materials, wherein the

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