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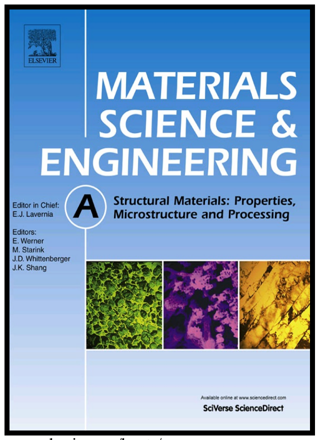

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Fragmentation and mechanical performance of tailored nickel-aluminum laminate compacts

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The fragmentation of materials is a complex sequence of physical processes in which the kinetic energy is converted into deformation and fracture energy. The addition of reactive mixtures adds a third form of energy, chemical energy. The fragmentation and mechanical performance of nickel-aluminum compacts was examined under dynamic conditions using mesostructured powder compacts in which the interfaces between the powders (having initial sizes between 355 and 500 μm) were tailored during the swaging fabrication process. Fragmentation was created in ring samples of this material through explosively driven expansion (generating velocities around 100 m/s) and analyzed through high-speed photography, laser interferometry and soft capture of fragments. Quasi-static and dynamic mechanical testing was conducted to examine the mechanical performance and to provide parameters for the constitutive description. Experimental results are compared with fragmentation theories to characterize the behavior of reactive powders based on the material's mesostructure by introducing the fracture toughness of the compacts, following the principal elements of the earlier work on tailored aluminum compacts. The fracture toughnesses, which ranged from 0.17 to 0.67 MPa*m$^{1/2}$, are related to the interfacial cohesion between particles and the fragmentation is a direct consequence of these parameters. The mean fragment size is calculated using a modified form of Mott's theory and successfully compared with experimental results; it ranges from 10 μm to 40 μm. The methodology developed here can be applied for tailoring the fragmentation of reactive munitions.

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