Mechanical Performance, Constitutive Response, and Fragmentation of Tailored Mesostructured Aluminum-based Compacts

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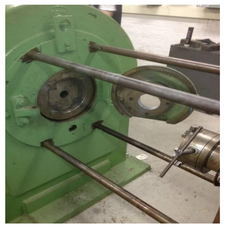
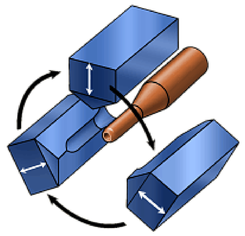
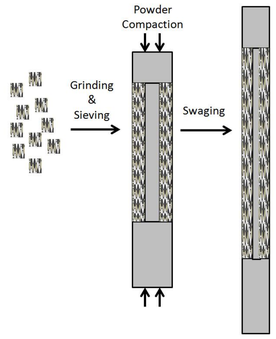
Abstract:

The mechanical performance, constitutive response, and fragmentation of tailored mesostructured aluminum-based compacts are examined under quasi-static and dynamic conditions. Elemental powders are consolidated into reactive structures through the process of swaging. The interest in these materials is due to their ability to enable both exothermic formation and subsequent combustion. Samples are fabricated for compression and explosive expanding ring tests. Aluminum powder compacts with various powder sizes were tested to assess the distribution of fragment sizes as a function of initial powder sizes. Ni/Al compacts with the layer thickness within the powders varied were tested to assess the degree of reaction following launch and following impact as a function of reactant spacing or bilayer thickness. Experimental results are analyzed with different theories on fragmentation to characterize the behavior of reactive powders based on material mesostructure.

Sample Preparation:







Fragmentation:

Swaged 400 μm Aluminum powder ring w/ 18.8mm core

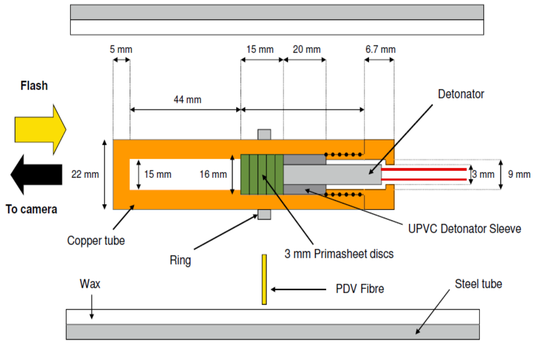
Swaged 100 μm Aluminum powder ring w/ 18.8mm core

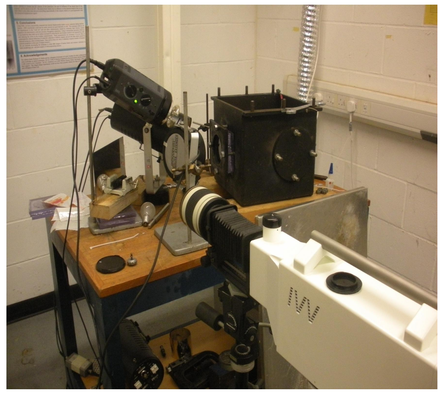
Swaged 100 μm Aluminum powder ring w/ 12.7mm core

Swaged 100 μm Aluminum powder ring w/ no core

Swaged 40 μm Aluminum powder ring w/ 18.8mm core

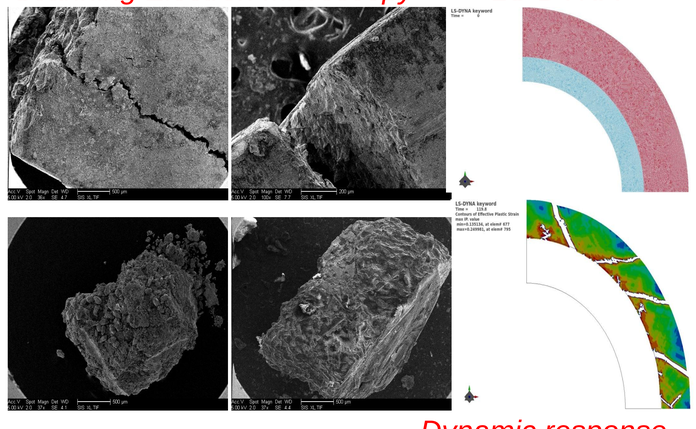
Experimental Setup:





Characterization and Simulation:

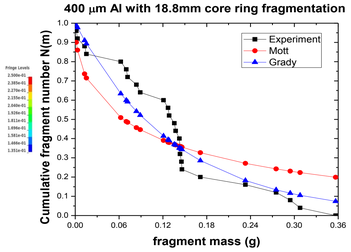
Scanning Electron Microscopy *LS-DYNA*

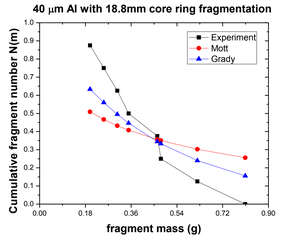


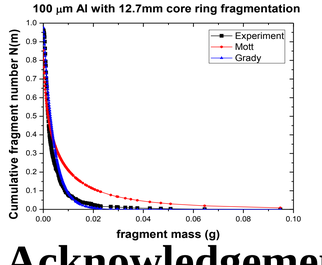
Analysis and Theory:

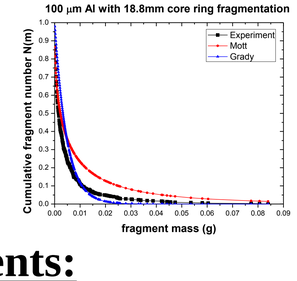
Mott distribution: $N(m) = \exp\left[-\left(\frac{m}{\mu}\right)^{\frac{1}{2}}\right]$

Grady distribution: $N(m) = \exp\left(-\frac{m}{\mu}\right)$



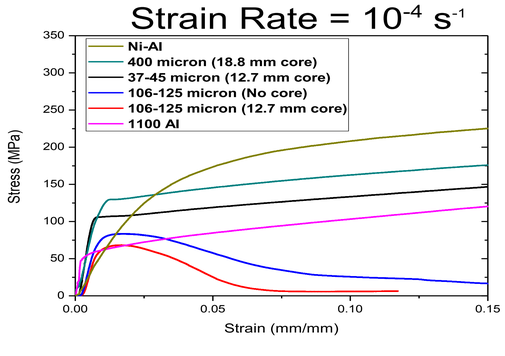


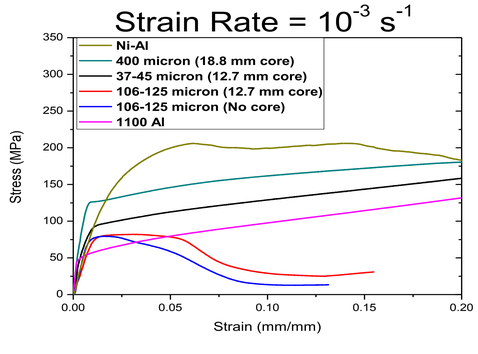




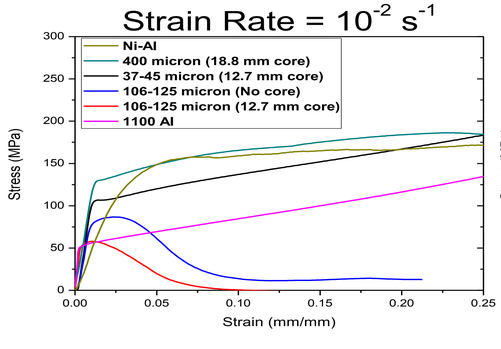
Constitutive Response:

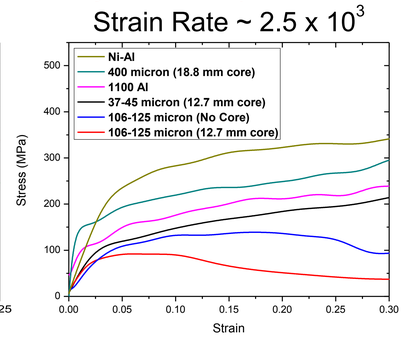
Quasi-static response





Dynamic response





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