Stopping km/s Blunt Fragments and Limiting Shock Lensing with a New Advanced Energy Absorbing Composite

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Overview

• Munition initiation usually occurs through hot spot formation during compression

• Currently two broad approaches to reduce hotspot initiation
  • Alter the chemical behavior of the explosive to reduce its sensitivity
  • Alter microstructure of the binder to reduce hotspot intensity

• We are presenting a new process to avoid hotspot formation
What is the process?

• Shock waves propagate very high transient pressures and temperatures very quickly.

• We need an equally fast energy dissipation mechanism to prevent the initial shock reaching the energetic material.
  • Plastic deformation and fracture aren’t fast enough

• A new transient release phenomena has been proposed which allows the material to partially release at the shock front.
Typical Shock – Rarefaction Profile
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Including Transient Shock Release Phenomena
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Plate impact experiments
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Target Chamber

- Light gates measure velocity
- 3” ThorLabs optical mount used to align targets
- Polycarbonate/aluminium sabot stripper used for fragment experiments
Experimental Evidence

- 195 m/s impactor
- 185 m/s rear surface velocity
- No transient release
Experimental Evidence

- 195 m/s impactor
- 175 m/s rear surface velocity spike, 160 m/s average
- Unoptimised transient release as evidenced by residual shock peak.
• Same residual velocity – momentum conserved
• Reduced initial shock by 20 m/s
• Average reduction in velocity of 15 m/s for 35 microseconds
• Equivalent energy absorption to a material toughness of 1MJ/m³
Experimental Evidence – Fragment Test

• 430 m/s steel STANAG fragment.
• Increasing velocity to work towards km/s protection
Next Steps

• Methodically increase fragment velocity to find maximum
• Investigate other materials
• Investigate 3D geometries
  • We can engineer the shape of the release phenomena
  • Converging shocks can be mitigated using a divergent release geometry
Conclusions

• Currently able to attenuate the shock front in plate impact experiments by 20 m/s
• Able to stop 430 m/s fragments
  • Need to optimize the transient release to get further improvement
  • Theoretical maximum is 7km/s

• Presented is a technology for a family of materials – we are investigating more suitable raw materials for km/s impacts.