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ADVANCED AUTONOMOUS SELF-SEALING FUEL CONTAINMENT TECHNOLOGY

BACKGROUND

Fuel vulnerability can greatly affect vehicle and personnel survivability in theater. An effective self-sealing fuel containment system can provide protection against the risk of catastrophic fire due to leaking fuel as well as, preserve operational range. Currently available self-sealing technologies rely on a swelling reaction through the absorption of leaking fuel. This fuel-dependent approach is inherently limited and has not been significantly improved upon since its inception in the 1940's.

The advanced fuel containment technology provides a faster and more robust self-sealing capability than current technologies. The sealing reaction is completely self-contained and functions independent of fuel or air exposure. The technology is lightweight and can be easily integrated into current and new aircraft system designs including bladder and integral "wet wing" fuel containment systems.

This novel technology uses a composite material with redundant and complimentary mechanisms that ensure a reliable and robust seal after perforating threats. Layers of high elongation elastomer provide an immediate mechanical barricade to leaking fuel while liquid reactants contained between the elastomer layers mix and polymerize to form a solid permanent seal within 1 minute. Ballistic tests are reported which demonstrate the effectiveness of this technology against 12.7mm API threats.

BASIC SELF-SEALING DESIGN

- **Base elastomer layer:** provides initial mechanical seal from exterior
- **Internal liquid reactant layers:** react upon mixing, solidify and expand into damaged volume.
- **Final elastomer layer:** mechanical seal blocks fuel during reaction

SELF-SEALING FUNCTION

1) THREAT IMPACT

- A ballistic threat (direct or indirect fire) impacts the fuel containment system (bladder or integral).

2) THREAT PENETRATION

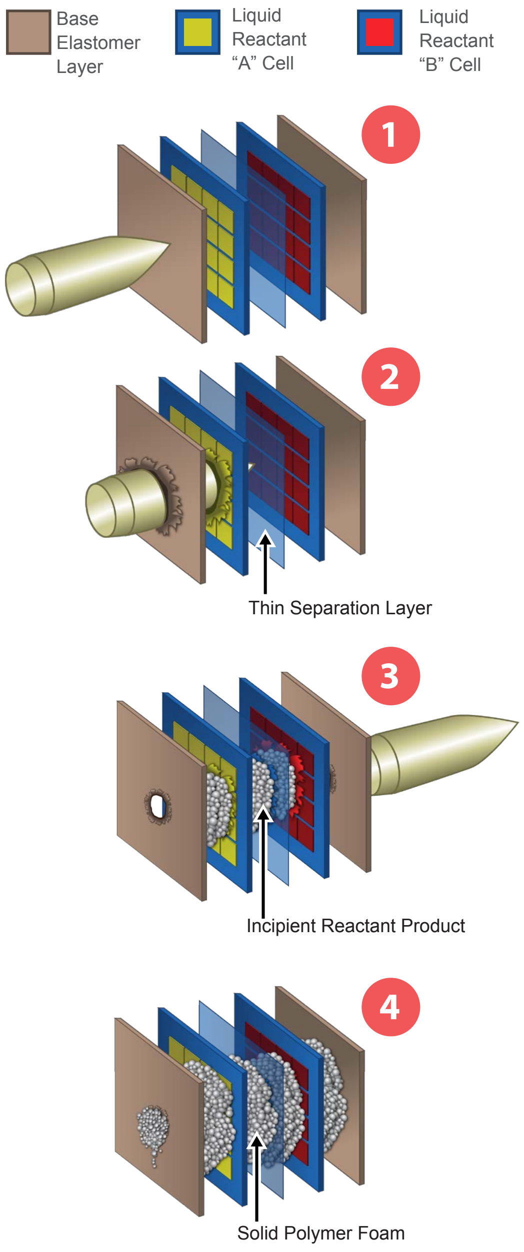
- The threat perforates the first layer which deforms elastically.
- The threat breaks the thin layer separating the "A" and "B" liquid reactants

3) REACTANT MIXING

- "A" and "B" flow together and mix, initiating the polymerization reaction.
- The threat exits and the first and last layers rebound elastically.

4) REACTION PRODUCT

- The elastomer layers recover with small residual holes.
- The "A" + "B" reaction proceeds, forming a solid polymer that expands to fill the damaged volume.



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BASIC DESIGN CONFIGURATION

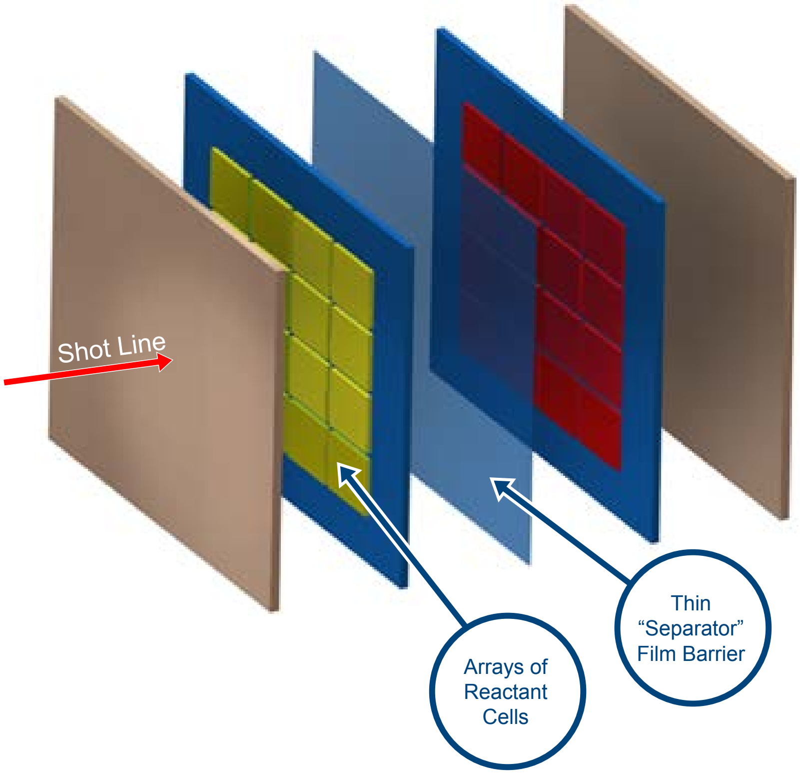
- **Reactant Mixing Cellular healing zones**
  - » Provides multi-hit capability
  - » Sized by threat damage area
  - » Seam width minimized
- **Separator film isolates reactants until activation**
  - » Frangible film facilitates mixing after threat perforation
- **Additional fibrous layers integrated to block flow and support reactants**

MATERIALS OVERVIEW

- **Elastomer materials:**
  - » High elongation materials that “rebound” after ballistic perforation
  - » Capable of spray-on application
- **Liquid reactant systems:**
  - » 2-part liquid reactant systems
  - » Rapid polymerization rate
  - » Foaming reaction
  - » Non-hazardous
- **Separation film:**
  - » Thin, frangible, very low permeability
- **Fibrous layers:**
  - » Lightweight, unwoven polymer fiber felt

PLANNED FUTURE WORK

- **Integration with fuel bladder containment**
  - » Partnered with Zodiac/Amfuel
- **Design optimization**
  - » Optimize reactant containment design
  - » Reduce thicknesses
  - » Down-select fiber layer and reactant selections
- **Bench-top long-term operation testing**
  - » Peel test with fuel exposure
- **Temperature extremes exposure analysis and/or testing**
- **Continued panel specimen ballistic testing**
  - » Additional design configurations
  - » Expanded tumbled threat testing



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