Cost Reducing Material For 40mm Practices Cartridges

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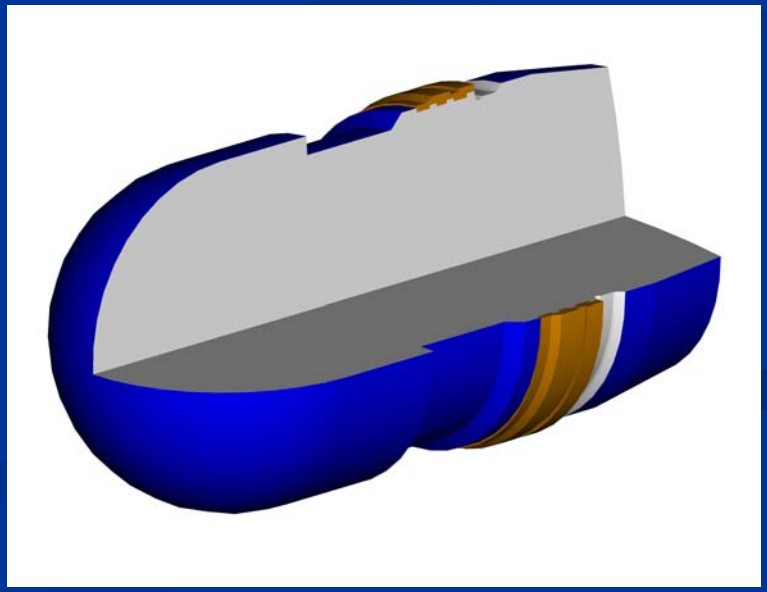
Cost-Reducing Material Substitution

- What is the 40mm M385A1 Practice Cartridge?
  - Check-out round for the Mk19 GMG Mod 3
  - Fired from a linked configuration
  - Muzzle Velocity = 240 m/s
  - Peak Chamber Pressure = 95 MPa
  - Aluminum projectile body with swaged copper rotating band
  - Approximately $6.00 per projectile

Cost-Reducing Material Substitution

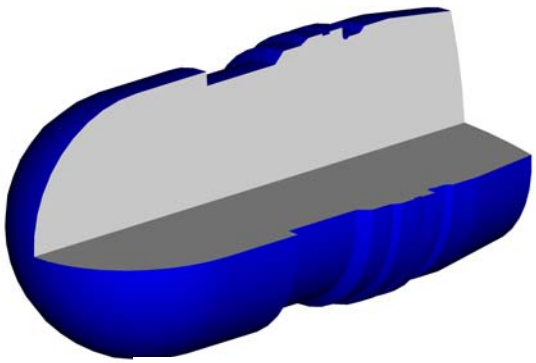
- How the one-piece projectile was born?
  - Current fabrication
    - Machine profile from aluminum bar stock
    - Swage copper rotating band to projectile body
    - Final machine band to size
    - Anodize projectile



Cost-Reducing Material Substitution

- How one-piece projectile was born?
  - Desire for an integral rotating band
    - Aluminum projectile with integral rotating band
      - Concern that hard anodized band will erode bore
    - Thermoplastic projectile with integral rotating band
      - Current projectile mass is 245 grams
      - Specific gravity of commercial thermoplastic polymers too low to machine solid projectile (polymer ~ 1.0 g/cc ; Al = 2.78 g/cc)
      - Cannot obtain ballistic match

PVC Plastic - 121 grams



Aluminum Projectile

Cost-Reducing Material Substitution

- How one-piece projectile was born?
  - Desire for an integral rotating band
    - Composite projectile with integral rotating band
      - Polymer-metal powder composite material
      - Machinable & Injection moldable
      - Can use almost any commercial grade thermoplastic
      - Colorable
      - Tunable specific gravity

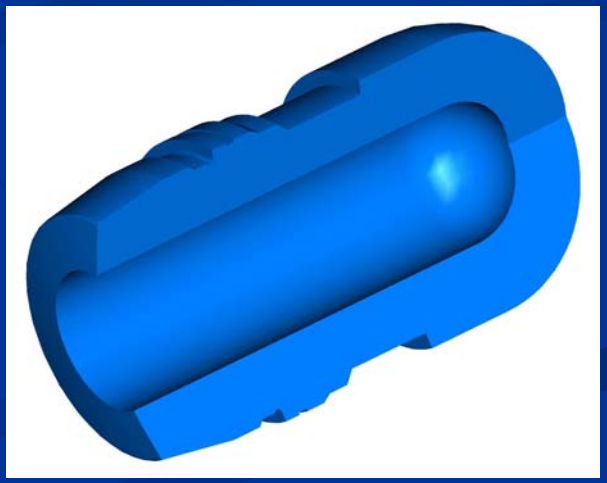
Injection Molded Sample – Copper-Nylon

Cost-Reducing Material Substitution

- M385A1 One-Piece Projectile Feasibility Study
  - Objectives
    - Reduce unit cost
    - Integrate rotating band to the projectile body
    - Ballistically match to M385A1
  - Requirements
    - Color – Blue #35109, FED-STD-595
    - Maintain Bore Life – 30,000 rounds
    - Survive Linking/De-linking
    - Accept Ink Stenciling
    - Fire from Mk19 GMG
    - Preserve Physical Properties
      - Profile, Mass, CG, Moments of Inertia

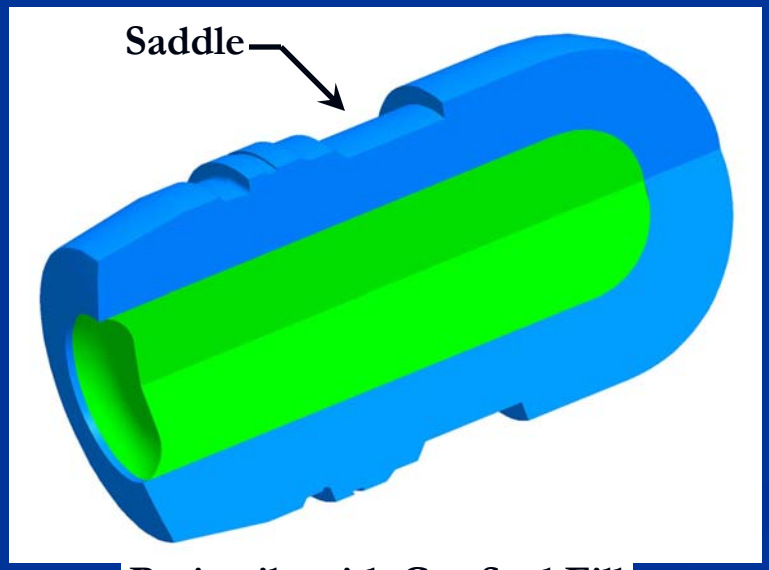
Cost-Reducing Material Substitution

- M385A1 One-Piece Projectile Feasibility Study
  - Material Selection
    - Aluminum – powder can be energetic during blending
    - Tungsten – high hardness may be erosive to the bore
    - Stainless Steel – may be erosive to the bore, but a possibility
    - Copper – high specific gravity, low hardness, but may tarnish
  - Prototype Mold
    - Single-cavity with parting line along axis
    - Core placed on aft side of projectile
  - Testing
    - Full dimensional inspection
    - Fire belts of 10 from Mk19 GMG at hot, cold and ambient
    - Subject projectiles to moisture and humidity for discoloration and growth

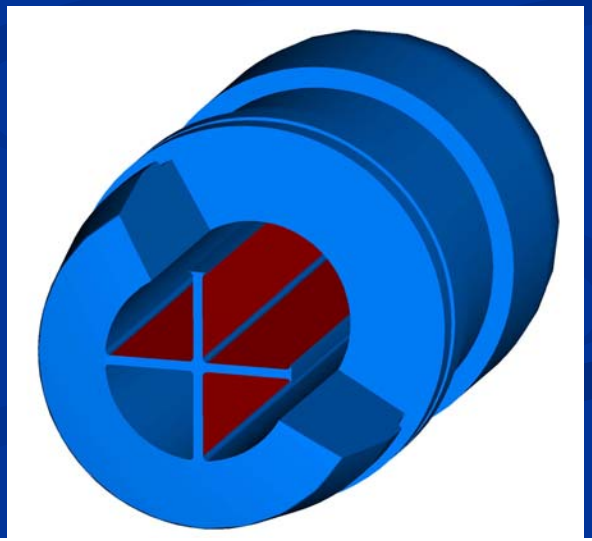


Cost-Reducing Material Substitution

- M385A1 One-Piece Projectile Feasibility Study
  - Challenges
    - Core volume increases chamber volume which may reduce MV
      - Could apply gas seal, but reduces cost savings
      - Adjust propellant load to obtain muzzle velocity
    - Preliminary/Static FEA shows minor ballooning in saddle area
      - Design in structural ribbing if proves to be a concern



Projectile with Gas Seal Fill



Projectile with Structural Ribbing

Cost-Reducing Material Substitution

- Post-Feasibility Study
  - If material substitution proves feasible…
    - Material Characterization at high strain rates
    - Pre-Qualification Testing
      - Larger firing samples
      - Full environmental testing
      - Rough handling
  - Production Mold & Qualification Testing
    - Cost savings estimate based on:
      - 300K to 400K rounds per year
      - 5 years production contract
      - 4-cavity mold with slides to eliminate parting line along axis

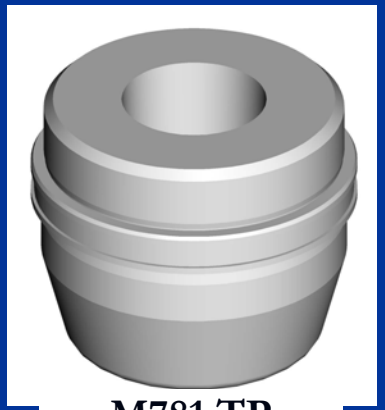
Cost-Reducing Material Substitution

- Follow On Work
  - Ballistics Mismatch – M385A1, M918 & M430A1
    - Modify M385A1 One-Piece projectile to match profile and physical properties of M918 and M430A1

M385A1 TP M918 TP M430A1 HEDP

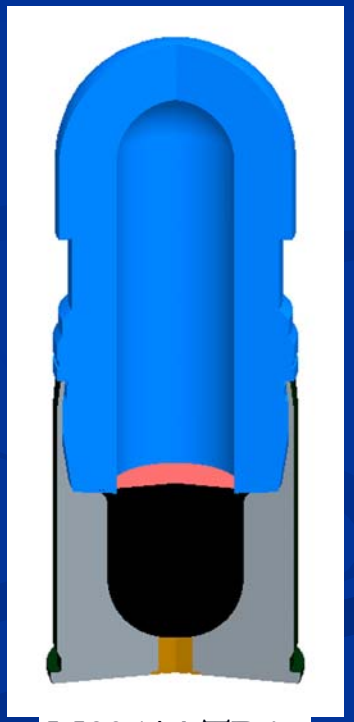
Cost-Reducing Material Substitution

- Follow On Work
  - Mate M385A1 One-Piece projectile with Single Chamber Cartridge Case (SCCC)
  - M918 Body Insert
  - M781 Projectile Body



M781 TP Projectile Body

M918 TP Body Insert



M385A1 TP in SCCC

Cost-Reducing Material Substitution

- Advantages of Polymer-Metal Powder Composite
  - Can composite almost any injection moldable polymer with metal powder
  - Machinable & Injection moldable
  - Tunable material density
  - Colorable
  - Emboss/Engrave instead of Stencil Marking
- Functional Advantages
  - Reduce cost with injection molding and insert molding
  - Less effort to design in Ballistic Match
  - Combine components/features to reduce number of parts
- ARDEC Value Engineering submission #20052007