A new method for fabricating copper rotating bands on munitions

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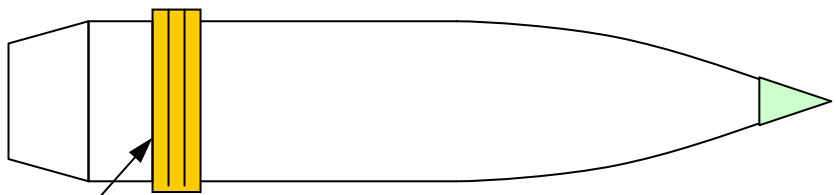
Two Types of Bands

1. Slipband (two-piece band)
2. Rotating Band
   - Usually copper based alloy
   - Provide obturation
   - Provide torque transfer from rifling to projectile



Rotating Band

Fabrication Methods

Traditional Fabrication Methods

1. **Weld overlay or other thermal spray process**
2. **Swage**

Non-Traditional Fabrication Methods

1. **Explosively Formed**
2. **Cold-Spray**

Motivation for Current Work

A projectile program needed a copper rotating band on an aluminum projectile component

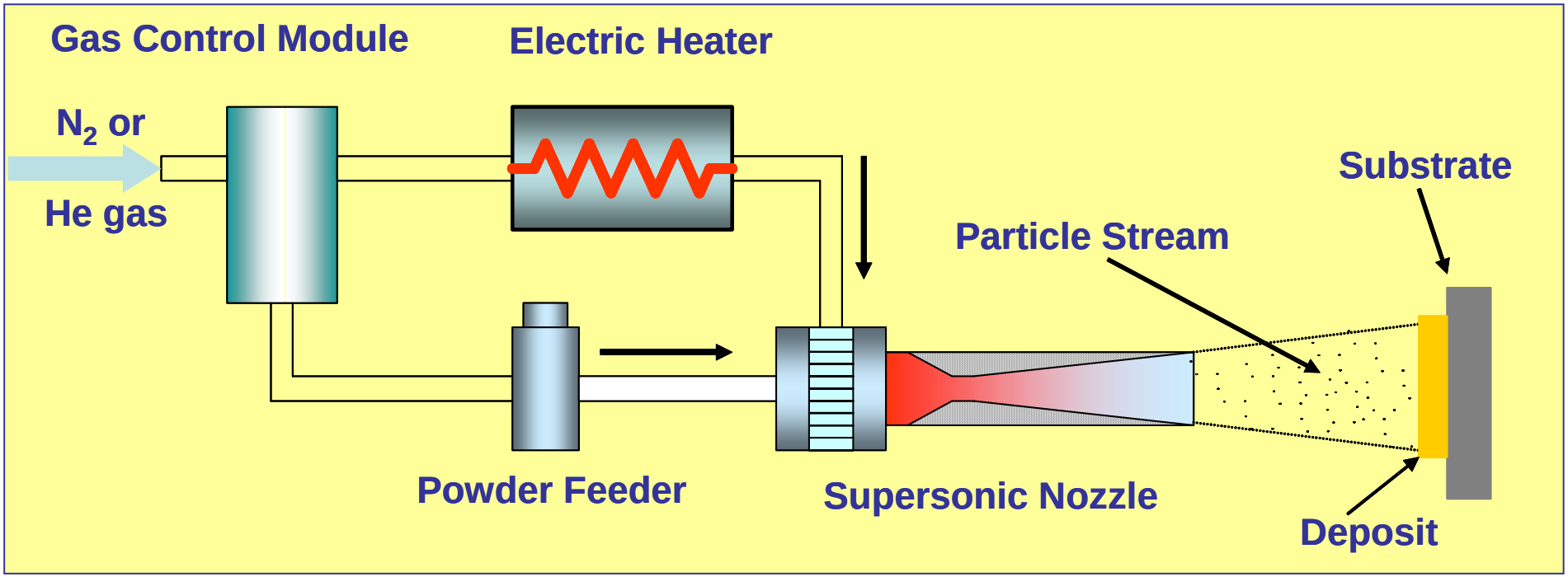
Weld Overlay – not possible

Swage – not cost efficient for R&D low volumes

Explosively Formed – not practical

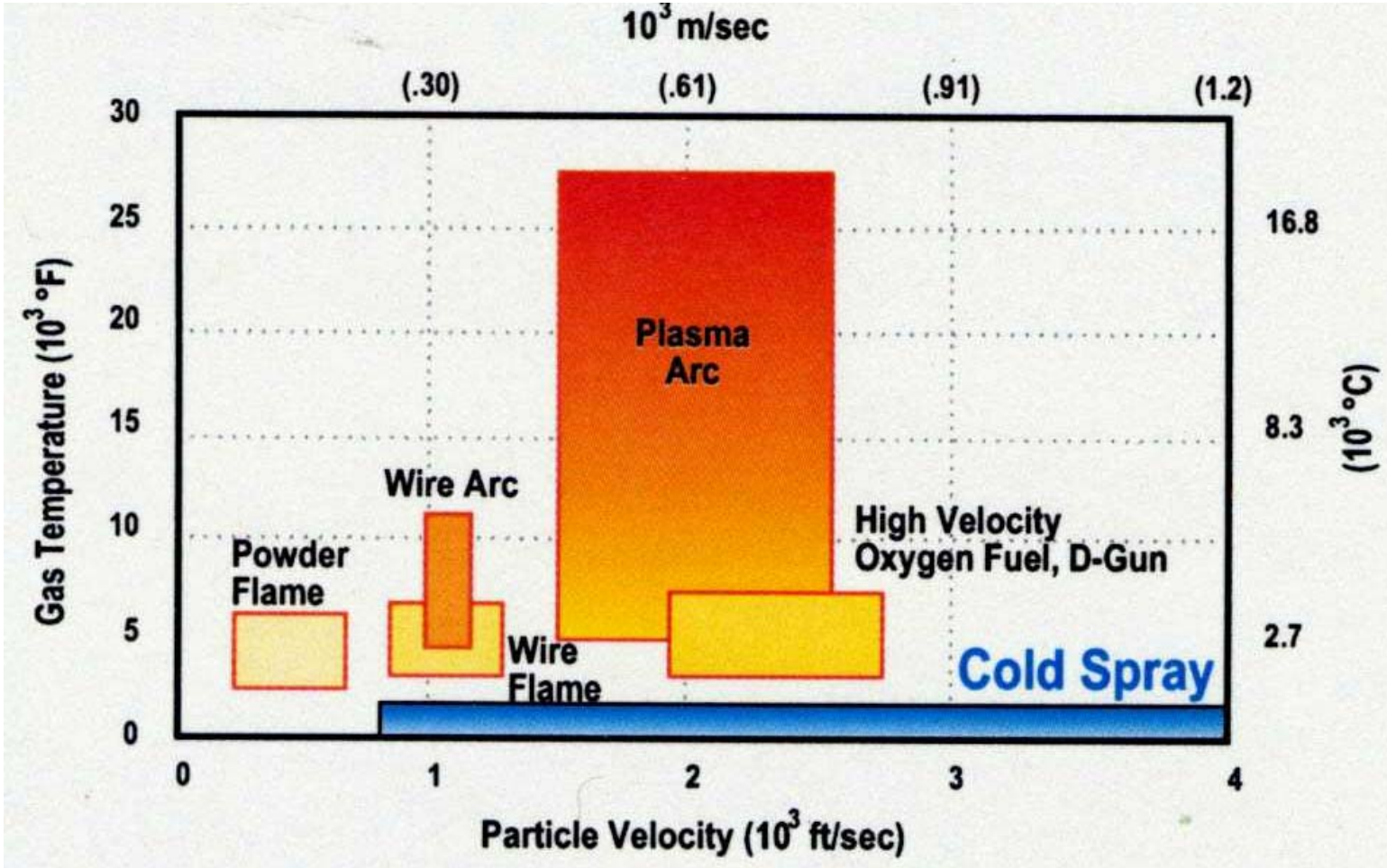
Cold Spray – quick and easy to fabricate

The cold spray process



Cold spray is a process where particulates are deposited by ballistic impingement upon a substrate at super sonic velocities to form a coating or a free-standing structure.

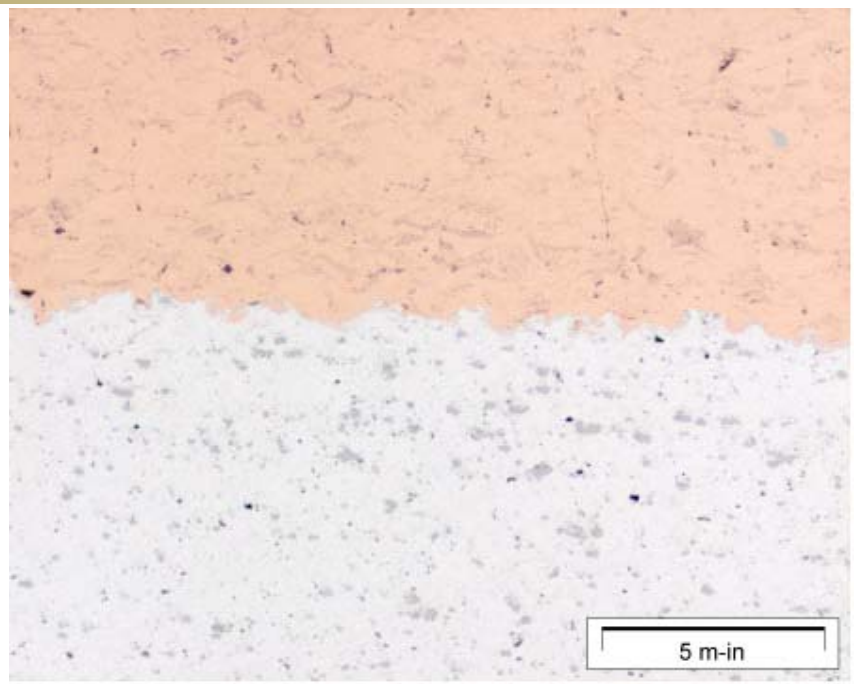
Cold Spray vs. Thermal Spray

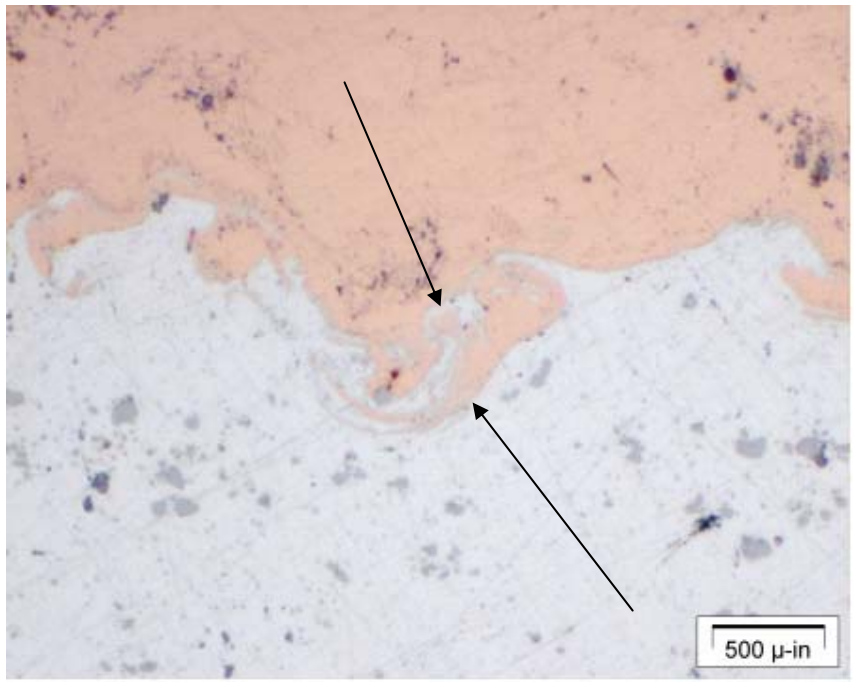


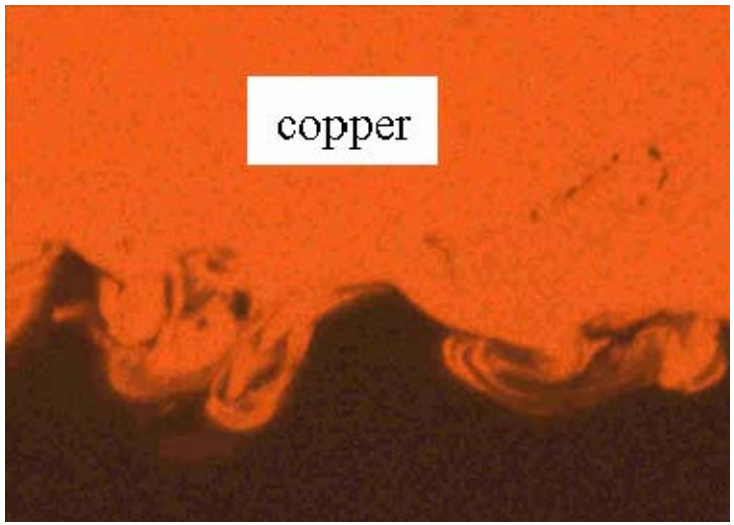
ARL Stationary Cold Spray System

Robot-Controlled, High Pressure, He and N Gas

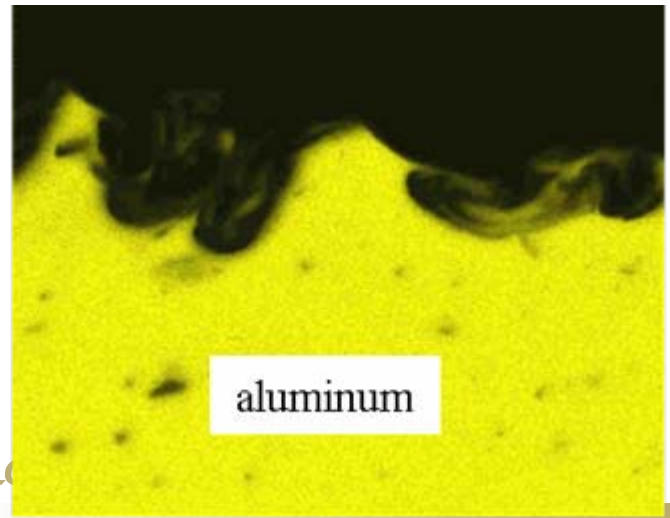
Mechanical Mixing at Interface







EDS X-ray Mapping showing mechanical mixing between coating material and substrate



Cold Spray Band Fabrication

Before application of cold sprayed copper band

After application of cold sprayed copper band

Bulk deposited material

Rotating Band and Test Projectile

The rotating band profile is machined from the bulk deposited material

Rotating Band

Test Projectile

1st Demonstration

Recovered Test Projectile

One of four test projectiles fired for 1st Demonstration

Test projectiles fired at M4A2-Zone 3(x2), 4, and 6

Engraved Cold Sprayed Copper Band

Spall Failure

Issues

The only identified issue is the spall of the copper rotating band at muzzle exit (2 instances)

Issue can be overcome by changing the cold spray process parameters to improve spall strength

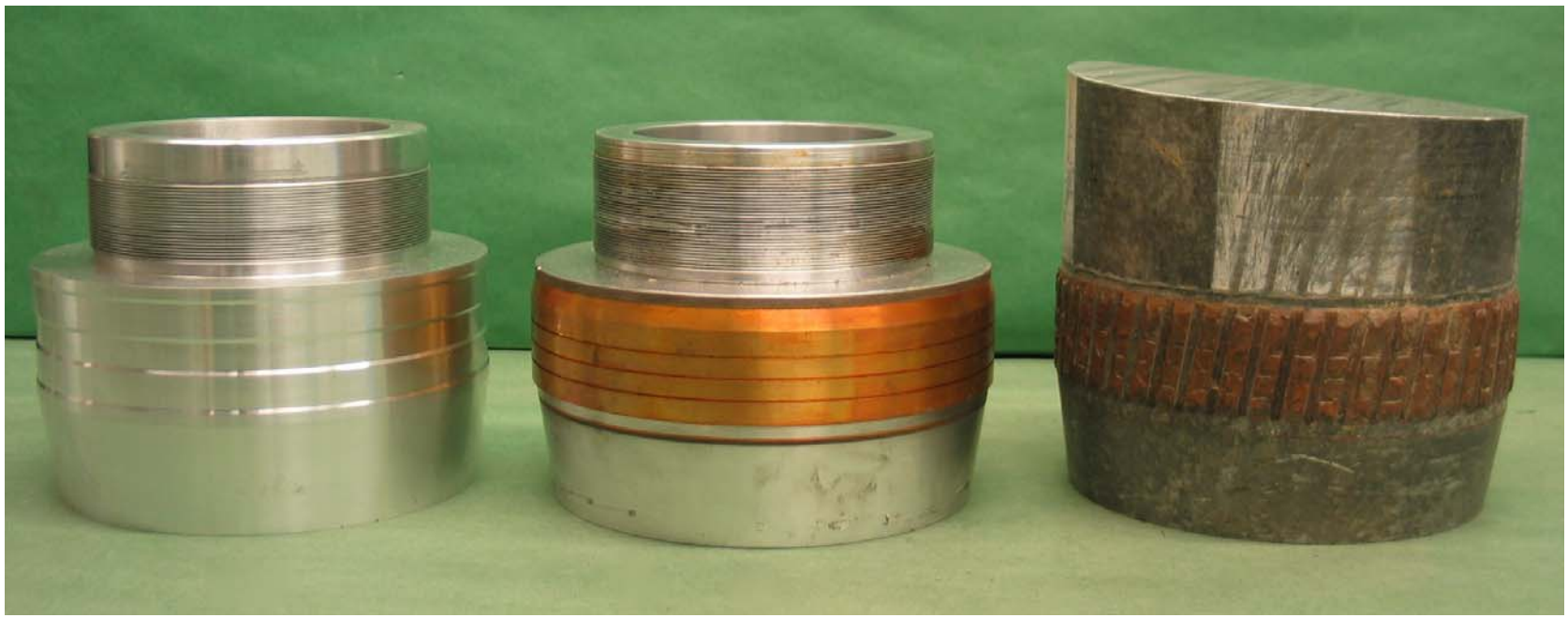
- **Particle material (single vs. multi-material powders)**
- **Gas temperature**
- **Particle velocity**
- **Particle size**

Advantages of Cold Spray

- High deposition rates
- Deposition efficiency greater than 70%
- Low residual stress
- Porosity less than 1%
- Low temperature deposition
- Solid state bonding
- High density, low oxide content
- Young’s modulus 85% of bulk material
- Compressive residual stress
- Produces free-standing structures

Summary

Cold sprayed copper rotating bands have been successfully demonstrated on four aluminum 155 mm projectiles



Questions