GAS DYNAMIC COLD SPRAY PROCESSING FOR JOINING OF SHAPE MEMORY ALLOYS (SMAs)

PI: Danielle L. Cote

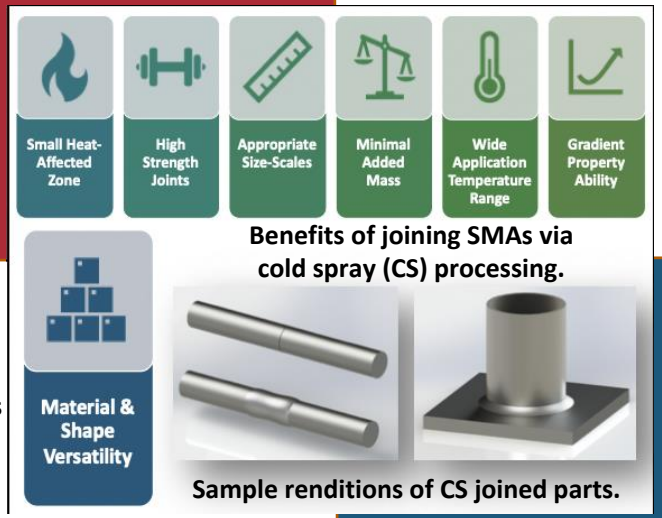
Worcester Polytechnic Institute

RESEARCH OBJECTIVES

GOAL: To use *cold spray processing* to join SMAs to SMAs and to other structural materials while maintaining mechanical and material property requirements

INNOVATIONS: Retained SMA memory, reduced HAZs, application-specific processing parameter flexibility.

Unlike the **current SOA**, cold spray processing *does not* produce oxidation, element volatilization or evaporation, discontinuous joining, decreased joint strength, filler material dependence, brittle intermetallic, added weight, or complex processing techniques.



Benefits of joining SMAs via cold spray (CS) processing.

Sample renditions of CS joined parts.

Start TRL: (1-2). Foundational research demonstrating the ability of cold spray to be used on SMAs has been successfully performed. Separately, cold spray as a joining processing has been successful.

End TRL: (3). Tasks 1-4 should fulfill the exit criteria for TRL 2, while Task 5 will take place in TRL 3.

APPROACH

To determine feedstock powder (joint material) and cold spray process parameters:

Task 1: Classification of SMAs and structural metals to-be-joined into three hardness classes*

Task 2: Model-guided Metal Joining

- Mechanics simulations of supersonic particle impact phenomena (cold spray processing) to screen feedstock candidates.
- Various combinations of SMAs to SMAs and structural metals will be produced, mechanically tested and microstructurally characterized.

Task 3: Joining Other Geometries

- Using joint materials determined in Task 2, vary joint geometry to include plate-plate, plate-cylinder combinations (others may be added upon request).

Task 4: Metal to Non-Metal Joining

- Join binary and ternary SMAs to specified space grade ceramics and polymers.

Task 5: Application-Driven Joining

- Input from NASA will provide specific chemistries and geometries (including complex) of parts to-be-joined. Results from Tasks 2-5 will be considered.

*note about hardness or strength significance: cold spray for joining depends on the to-be-joined material's hardness value more than chemical composition.

POTENTIAL IMPACT

Joining most material combinations (similar and dissimilar) of SMAs and other structural materials are possible with cold spray processing, including gradient joints and complex component geometries. Therefore, this:

BENEFITS

→ **Reduces material selection limitations**

→ **Reduces component geometry restrictions**

This research should **enable impactful advancements**, with long-term potential and promise, in real-time repair and component reclamation and recovery during exploratory missions.

Other benefits and outcomes of proposed research:

Cold spray is currently used for building, reclaiming, and repairing Apache helicopter housing and driveshaft components, Boeing 747's integrated drive generators, Cu flanges, and certain types of propeller blade repair. Also, EMI shielding, corrosion-resistant coatings, antimicrobial coatings, and DNA-based biosensors. NASA applications are expected.