**Introduction**

“Cold Spray” is an additive manufacturing process traditionally used as a tool to repair metal structures/parts. Often used to repair aircraft structures that receive extensive wear and would otherwise require often and expensive replacement. Spee3D, an Australian research and development company, developed the world's first commercially available additive manufacturing machine which uses cold spray to build 3D objects.

**MATERIAL CHARACTERIZATION OF COLD SPRAYED 3D PRINTED COPPER PARTS**

**Objectives**
- Characterize cold sprayed parts for future applications.
- Explore printing parameters to maximize conductivity, ductility, and strength.
- Experiment with different annealing times and temperatures to determine ideal post-processing procedures.
- Compare specimen conductivity, strength, and ductility to that of “pure” copper.

**Procedure**
- Rectangular test samples printed onto aluminum substrates.
- Specimens machined to achieve uniform cross-sectional area.
- Using a Fischer SigmaScope, eddy current testing on samples from each category was performed to determine conductivity.
- Compared conductivity data to flexural test data previously done on similar specimens printed on the same machine.

**Results**
- Higher sprayed-at temperatures are generally slightly higher in conductivity.
- Strong correlation between conductivity and ductility at all parameters.
- Annealing at 500°C for 4 hours appears to be best post-processing treatment for obtaining max conductivity and ductility.
- Increased length spent annealing positively impacts both strength, ductility, and conductivity.
- Dissipation of oxidation between layers observed in all specimens.
- Imperfections become magnified when annealed at 600°C.

**Path Forward**
- Replicate previous four-point flexural test results with current specimens.
- Apply strain gauges to each sample.
- Follow procedures outlined in ASTM D790.
- All samples to be tested in Instron 5567 Universal Testing Machine with 5 kN load cell and strain rate of 0.5 inches per minute.
- Flexural stress ($\sigma_f$) calculated by

$$\sigma_f = \frac{3FL}{4bd^2},$$

where
- $F$ is load
- $L$ is length of support span
- $b$ is the width of the specimen
- $d$ is the thickness of the specimen.

**Future Work**
- Apply data to future projects.
- Replicate results.
- Investigate coating applications and various substrates.

**Acknowledgements**

This work is supported by the Center of Composite Materials and the Applications Technology Transfer Laboratory.

Specimens printed via cold spray in the Spee3D are printed in environmental conditions. Although heat is not used to bond particles together, there is heat produced in the process. This heat leads to oxidation between layers. The cold spray process also produces brittle parts making annealing a necessary post processing procedure.