Using Additive Manufacturing to Develop Bimetallic Strips for Rollers

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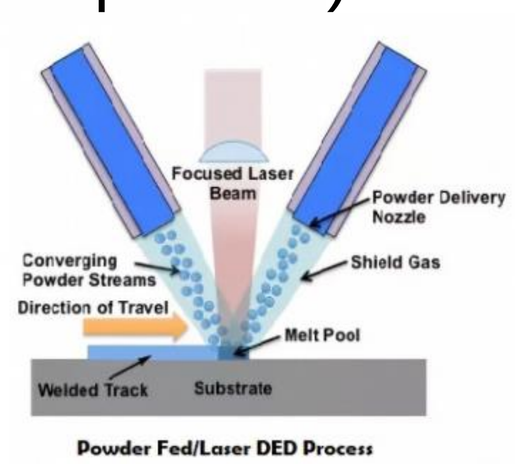
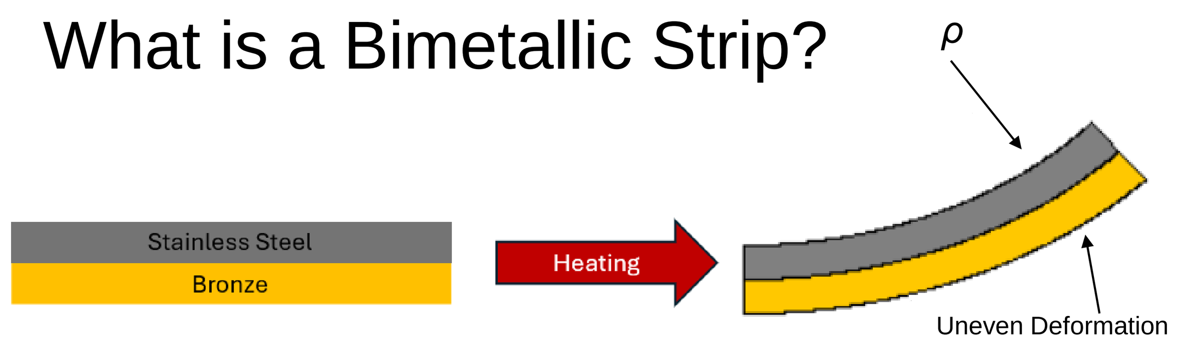
BACKGROUND

What is DED (Directed Energy Deposition)?



What is a Roller?

What is a Bimetallic Strip?



MOTIVATION

- When rollers fail inside a wind turbine, the results can be catastrophic

- Early warning systems from inside the bearing could prevent these failures
- By using heat sensitive strips in conjunction with a sensor, rollers could be replaced before they fail

OBJECTIVES

Objective: Manufacture a roller housing bimetallic strips to integrate with a sensor that can be used to determine the temperature of the roller

Specific Goal: Develop parameters for printing both bronze and stainless steel to print a functioning bimetallic strip. Then, design and print a steel roller that houses multiple bimetallic strips.

PROCEDURES

The radius of curvature ρ of a bimetallic strip is given by this equation

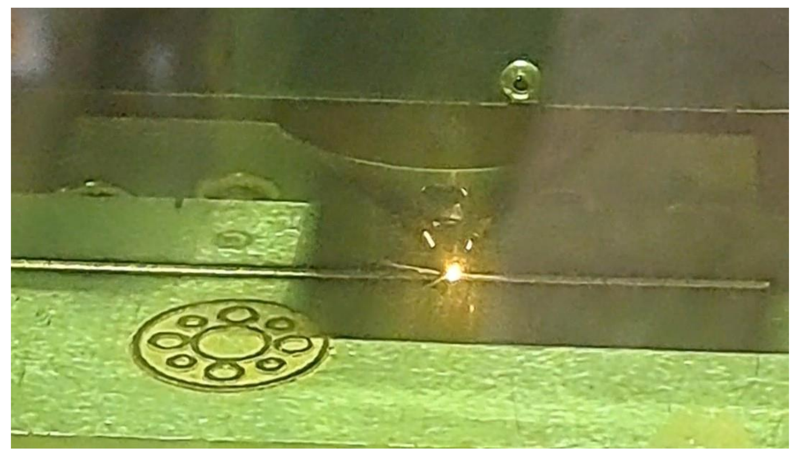
$$\rho = \frac{t \cdot \left[3 \cdot (1+m)^2 + (1 + m \cdot n) \cdot \left(m^2 + \frac{1}{m \cdot n}\right)\right]}{6 \cdot (\alpha_2 - \alpha_1) \cdot (T_h - T_c) \cdot (1+m)^2}$$

Where m is the ratio of thicknesses, n is the ratio of elastic moduli, and α is the coefficient of thermal expansion.

Then, by integrating the equation with respect to length it can be related to the deflection of the strip. After determining the correct thicknesses of bronze and steel, it was necessary to develop parameters for the printing process by printing small cylinders with varying parameters and determining what worked best.

The properties under examination were: surface finish, over/under-building, oxidation, and top surface uniformity.

Using those parameters, a bimetallic strip was successfully printed and subsequently tested using a furnace heated to 200 °C.



RESULTS

The top image shows the bimetallic strip at room temperature, about 22 °C, while the bottom image is the strip after being heated to 200 °C. The strip bent about .22” when heated.

CONCLUSIONS

The calculation predicted a deflection of .25”, and the strip ended up deflecting ~.22”, which is a small margin of error. This means that the method for printing bimetallic strips was successful, and that it will be possible to print them inside of a roller.

FUTURE WORK

From this research, methods of printing steel and bronze were determined, and additive manufacturing can be used to create viable bimetallic strips. In the future a roller will be printed that contains multiple strips and testing it to ensure that the design works in practice

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