Designs for Magnetic Pulse Welding

Michael Lee

Department of Mechanical Engineering, University of New Hampshire

Advisor: Professor Brad Kinsey

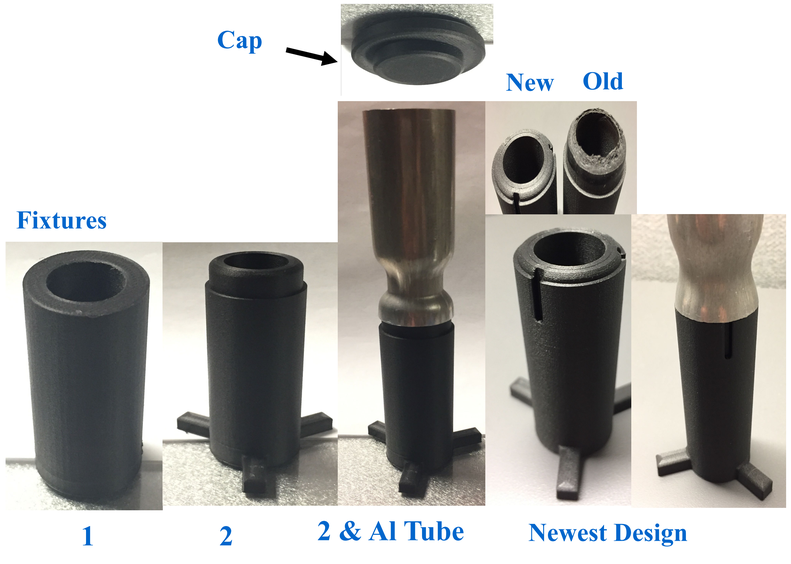
Abstract

This design project was a continuation of previous designs and a creation of new designs. It also included Magnetic Pulse Welding using tubes of aluminum & copper. The metals used are Aluminum 6061-T6 and Copper 101 and 110. The two dissimilar metals to be welded needed to be put into a field shaper in the same position each time. A new design was created to mount the metal specimen . A Photon Doppler Velocimeter (PDV) is used to detect the velocity in the tube during the deformation.

Methods

Design of Tube Fixture

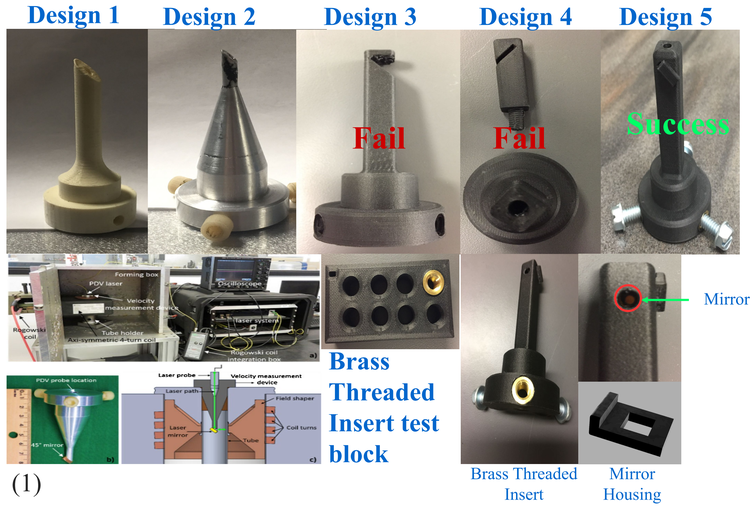
- Analyze current research and methodologies
- Redesign mount for welding specimen to better align sample to reduce deviations in results
  - Add cap with a mass to field shaper to reduce shifting of aluminum and increase weldability
- Test field shaper with an empty aluminum tube
- Use undergrad/graduate student information of LS-Dyna to establish diameters of copper
- Test weldability at four different energy levels: 45%, 50%, 55%, 60%
- Test welds using water jet cutter to cut specimen and analyze
- If weld holds, polish and examine under Electron Microscope
- Check strength of welds using peel tests



Methods Continued...

Design of Laser Fixture

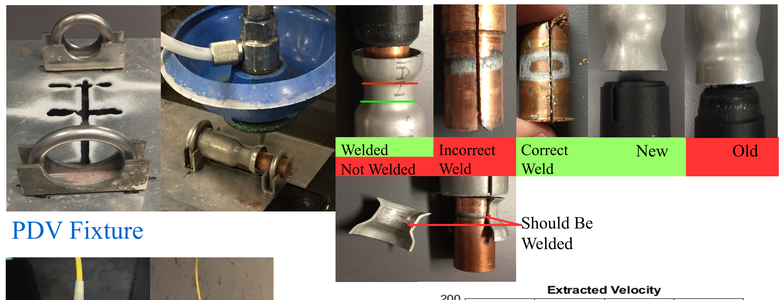
- Examine previous PDV mount
- Redesign to allow a 99% precision reflective mirror to be inserted into product at a 45 degree angle with more ease of use and reliability
- 3D print designs for testing using carbon fiber/nylon mix
- Make test piece for brass threaded inserts to hold laser



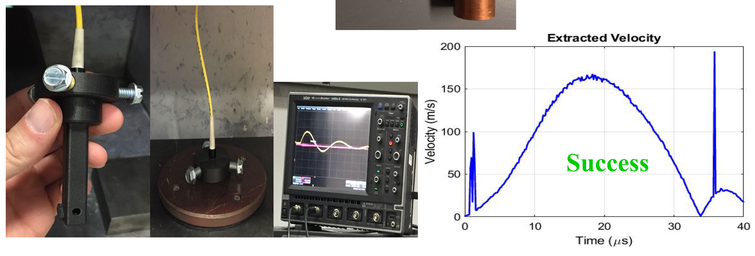
(1)

Results

Tube Fixture



PDV Fixture



Discussion

- The **PDV Laser Fixture** had two fails. The first fail (**Design 3**) was because the 3D printer did not print the support material for the 45 degree overhang. The second fail (**Design 4**) was printed with support material that got stuck inside the inner diameter of the tubes.
- **Design 5** was the successful design. It was redesigned to be printed without support. It was then tested with the laser; see results for a graph and visual of the PDV fixture.
- The graph shows the velocity of the moving metal vs time. At 15% energy (1.8kJ) the velocity of the tube is around 160m/s. The velocity matters to help the welding process. The Thresholds for the welds range from 300m/s to 1500m/s.
- After the two metals were welded they needed to be cut to acquire a good cross section of the weld. That could then be further examined using an Electron Microscope.
- However, as shown in the results section, when cutting the welded specimen the weld failed. This did not form the racetrack type weld you would usually see when doing tube to shaft welding. This lead us to believe that our **Tube Fixture** might be the cause of the failed weld. Redesigns were done to try to fix the problem and are currently being tested.

Literature Cited

Thank you to-
Advisor: Dr. Brad Kinsey
Graduate Student: Shunyi Zhang
Undergraduate Student: Wunderly Rote

Acknowledgements – This research was supported with funding from the National Science Foundation's grant #1711781

Kinsey, B., and Nassiri, A. (2017). "Analytical model and experimental investigation of electromagnetic tube compression with axi-symmetric coil and field shaper." *Analytical model and experimental investigation of electromagnetic tube compression with axi-symmetric coil and field shaper*, 66(1).