Welding Process Comparison for Thin-Sheet Aluminum: Distortion, Heat Input, and Gap Tolerance

Kassidy Shimek

Paul Blackhurst, Dr. Panton

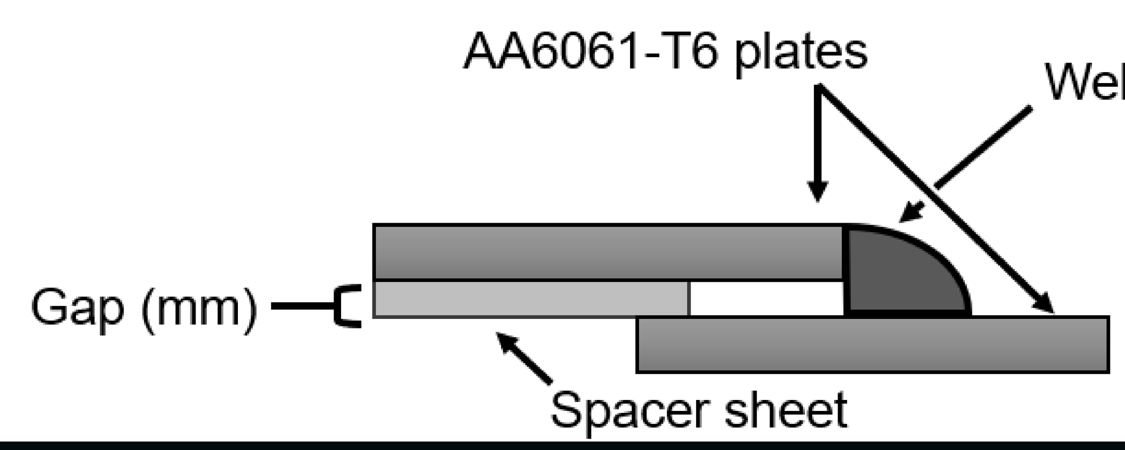
Background & Objectives

There are many instances in which thin sheets of aluminum need to be welded, such as for electric vehicle battery assemblies. There are, however, several challenges to welding thin sheet aluminum, including solidification cracking, heavy surface oxides, burn through, and distortion. Hot wire laser welding (HWLW) is a novel process that has been recently developed and can effectively join thin sheet aluminum while avoiding the common heat input problems associated with arc processes.

The goal of this project is to compare four different welding processes when welding on thin sheet aluminum. The four processes are autogenous laser beam welding (LBW), conduction mode HWLW, keyhole mode HWLW, and gas metal arc welding (GMAW). The following work compares the heat input, distortion propensity, and gap bridging ability of each process. Results indicate that these HWLW processes are capable of replacing GMAW in industry when needing to join thin sheet aluminum.

Points of comparison:

1. What gap tolerance can each process handle?
2. How does the heat input differ for each process?
   a) How is the heat affected zone (HAZ) impacted by each process?
   b) How does the distortion vary with each process?



Results & Discussion

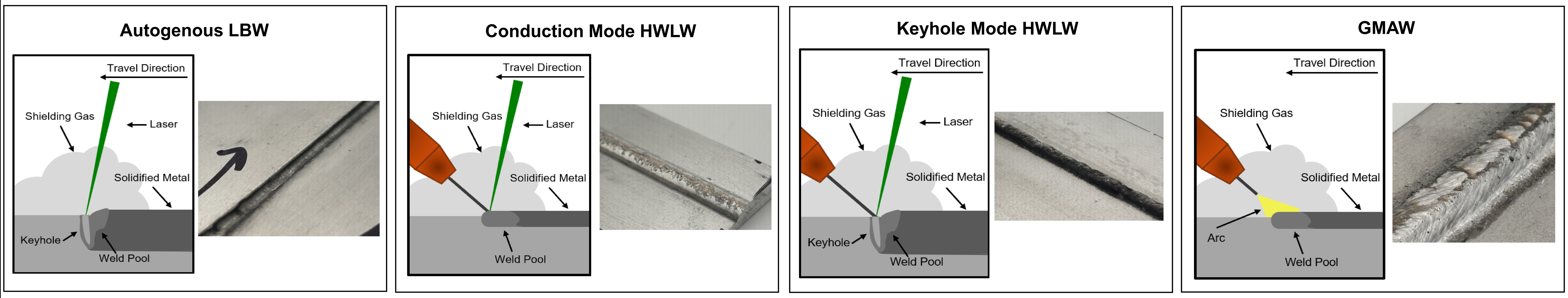


Figure 1: The four welding processes being compared are illustrated above. The diagrams show the differences in the process for each, and the picture to the right of the diagrams show what the weld looks like for each process.

Gap (mm)	Autogenous LBW	Conduction Mode HWLW	Keyhole Mode HWLW	GMAW
0.0				
0.5				
1.0				
1.5	N/A			
2.0	N/A	N/A	N/A	

Figure 2: Results of the gap study. The different processes were able to handle varying gap sizes.

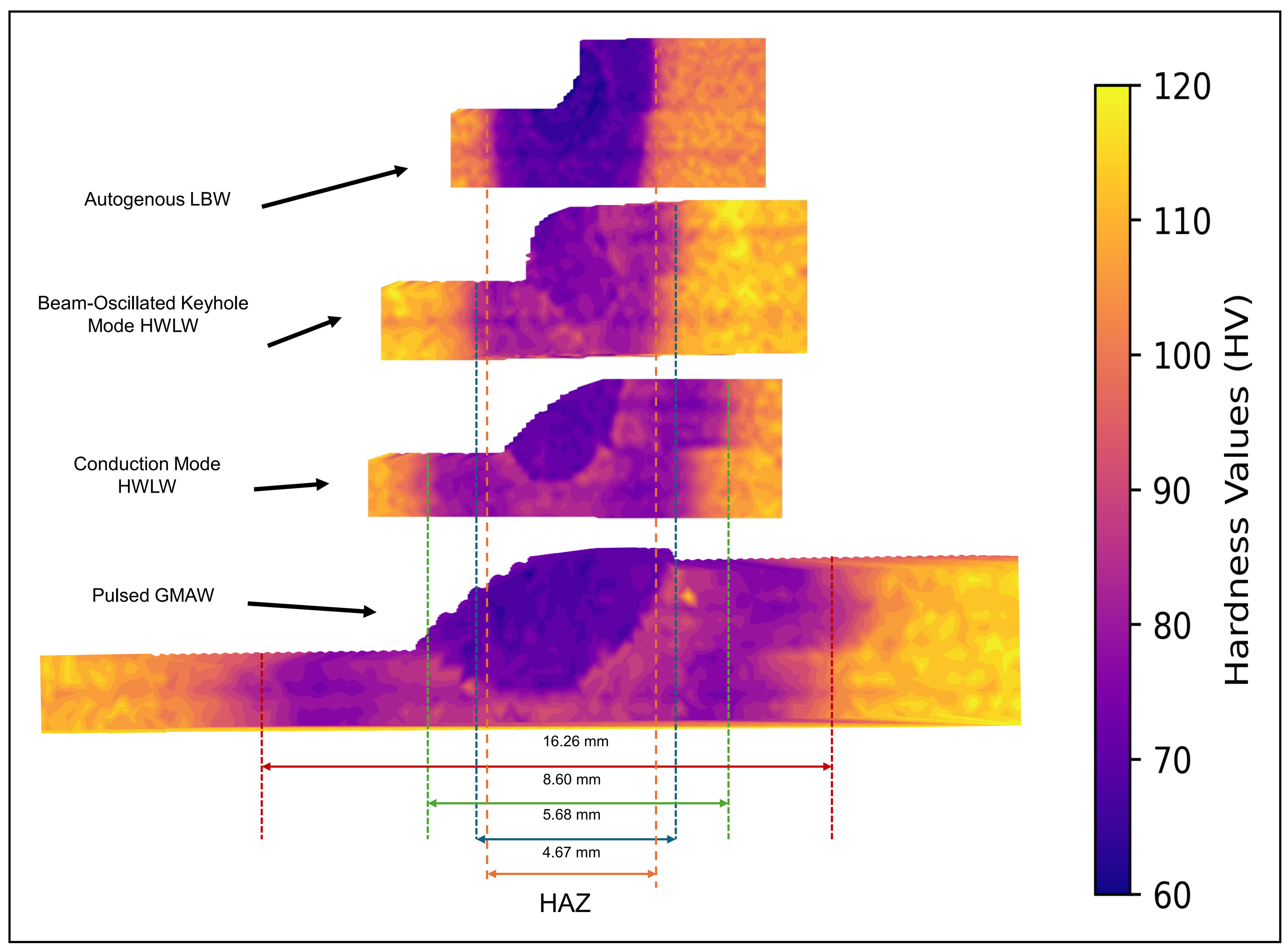


Figure 3: Microhardness testing results reveal the heat affected zone.

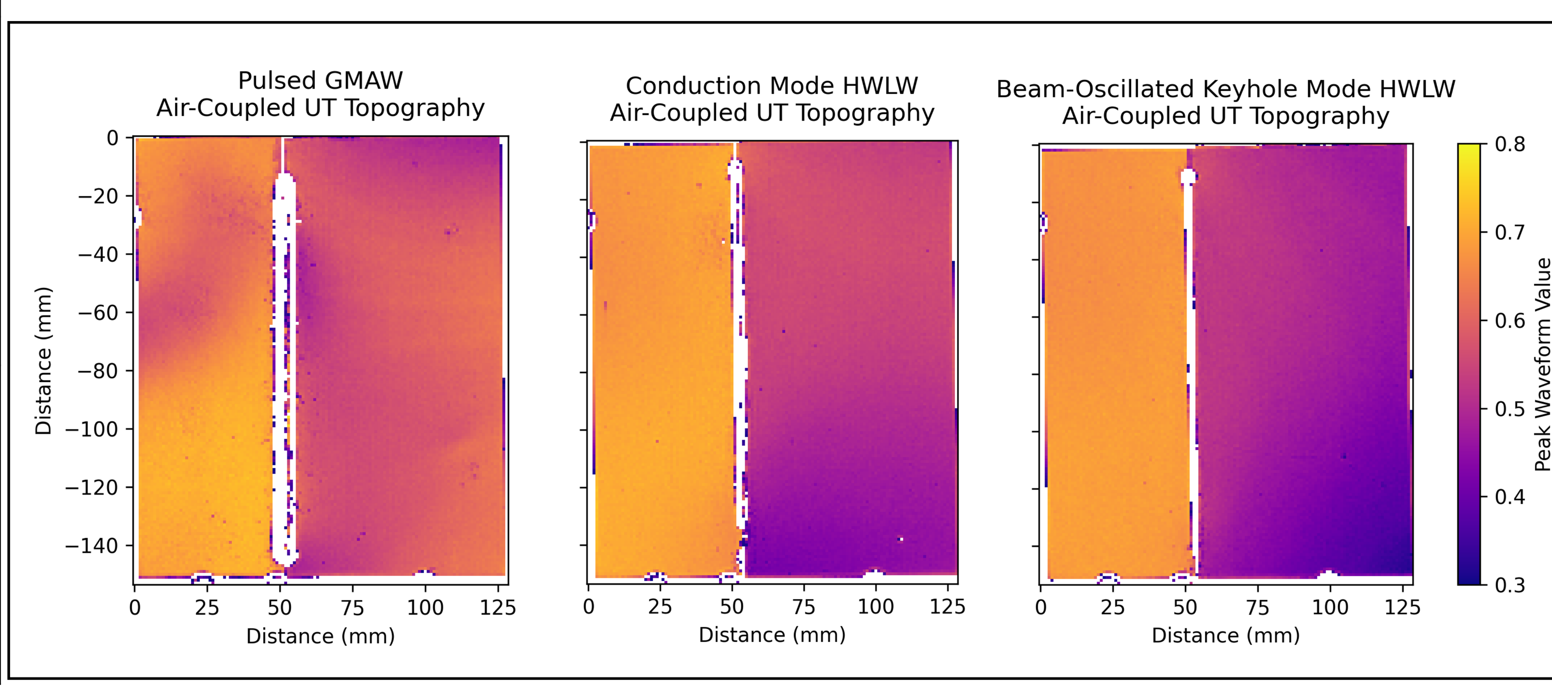


Figure 4: Air-Coupled Ultrasound Testing.

Conclusions

- GMAW was able to withstand the largest gap, 2mm, while autogenous LBW withstood the smallest, 0.5mm.
- The HWLW processes adequately withstood poor gap tolerances.
- Microhardness testing revealed smaller HAZ's for the HWLW processes.
- The distortion from each process–excluding autogenous LBW–was significantly different. The HWLW were similar to each other, but GMAW had much more distortion than either of them.

Future Work

- Fatigue testing to further compare the effect of the joint size and shape on the mechanical performance for each process.
- Further development of the conduction mode HWLW process with higher power lasers and different spot shapes.
- Development of these processes on full-scale battery assemblies to further validate reduction in distortion over arc processes.

"Center Proprietary"

The Ohio State University

This program is proudly sponsored by the American Welding Society Foundation.

AWS + Ma2JIC

HIGH SCHOOL INTERNSHIP PROGRAM