Prince Sattam bin Abdulaziz University
College of Engineering
Mechanical Engineering Department

Additive Friction Stir Manufacturing of Metallic Parts

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Abstract:

This project explores Additive Friction Stir Manufacturing (AFSM) on a milling machine to create aluminum and stainless steel components. Two tool designs were tested, and heat-treated aluminum 6082 and stainless steel showed enhanced mechanical properties. AFSM proved effective for layer-by-layer deposition, reducing waste and costs, with promising industrial applications and scope for further research.

Objectives:

- AFSM tool design and manufacturing.
- Manufacturing of metallic parts (aluminum alloy and stainless steel).
- Microstructure and mechanical properties characterization.

Additive Friction Stir Manufacturing (AFSM):

Additive Friction Stir Manufacturing (AFSM) merges additive manufacturing and friction stir welding, offering enhanced design flexibility, material efficiency, and process effectiveness.

Experimental work:

This work applied the Additive Friction Stir Manufacturing (AFSM) technique on a milling machine to process aluminum and steel, with heat treatment applied to aluminum.

Tool design and manufacturing:

Two tool designs were successfully developed, and various rotational speeds were tested. Mechanical properties were assessed through tensile and Vickers hardness tests.

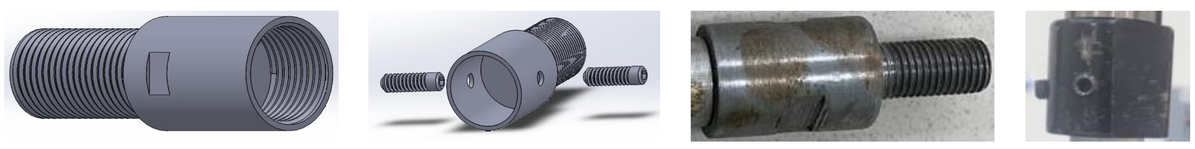


Fig.1 Tool design and Manufacturing

AFSM process:

Aluminum and stainless steel rods are tested at set speeds (850 rpm and 1660 rpm).

Fig.3 Stages of AFSM of aluminium parts

Fig.2 AFSM process

Results:

the results obtained from the characterization of the friction stir additive manufacturing of metallic parts and characterization will be presented. Which includes results of mechanical properties and microstructure.

Hardness:

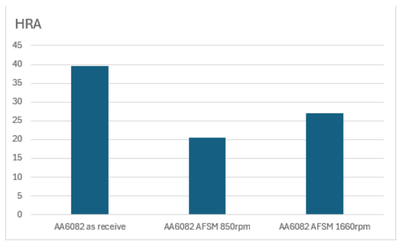


Fig.3 AA6082-T6 of as received and after FSAM

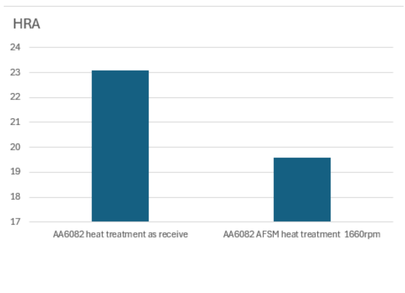


Fig.4 AA6082-O and after FSAM

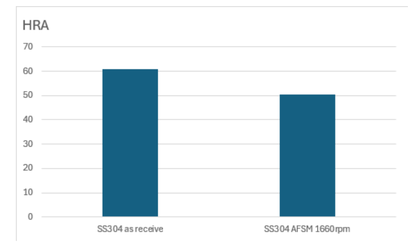


Fig.5 Stainless steel 304 and after FSAM

Macrograph and microstructure:

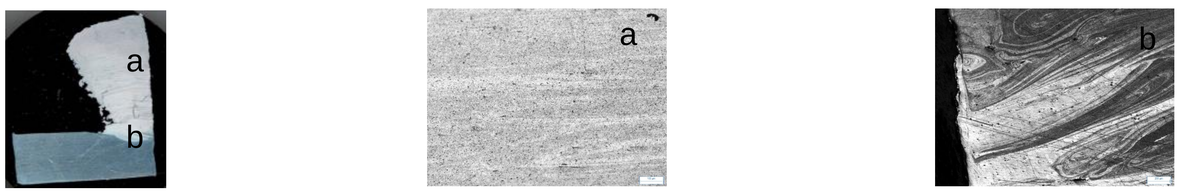
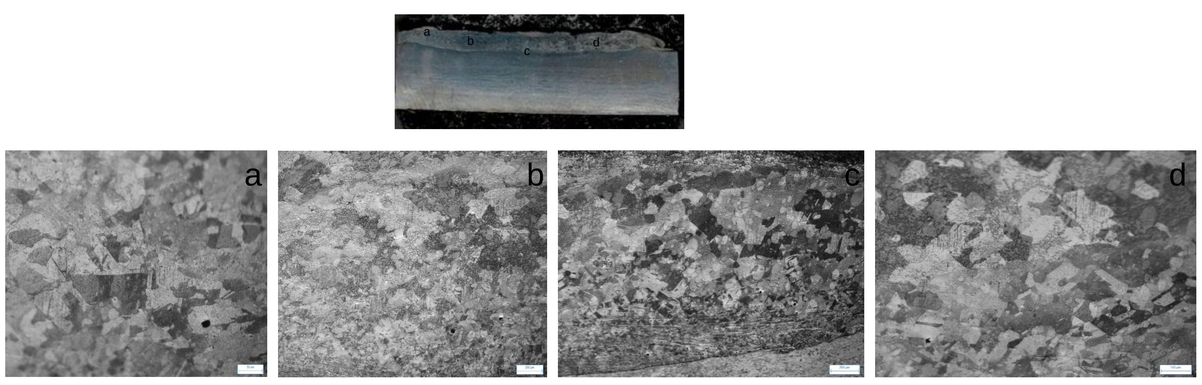


Fig. 6 macrograph and microstructure for AA6082 at 850 rpm different magnitude .



macrograph and microstructure for ss304 different magnitude .

Conclusions:

This project successfully applied the Additive Friction Stir Manufacturing (AFSM) technique to aluminum and steel using a milling machine. The results showed improved mechanical and microstructural properties, with heat treatment enhancing aluminum's characteristics. AFSM proved to be a cost-effective alternative to traditional manufacturing, with potential for broader industrial applications. Future research could focus on optimizing the process and exploring advanced materials and complex geometries.