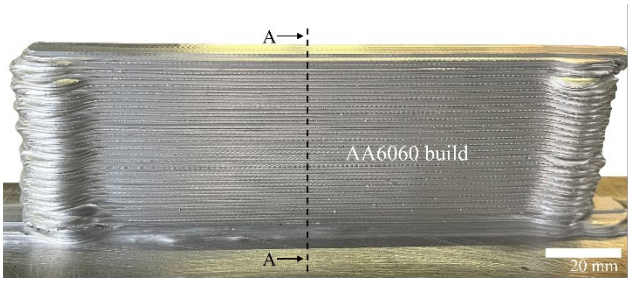
New tooling for enhanced layer-to-layer bonding with solid-state additive manufacturing (FSEAM) - MSc

Additive Manufacturing (AM) of high strength aluminium alloys by fusion based approaches is often limited by the occurrence of solidification related defects. Solid-based approaches form an attractive alternative where the temperature during deposition remains below the melting point. The in-house developed Friction Screw Extrusion Additive Manufacturing (FSEAM) process is a very promising approach to fabricate aluminium and magnesium parts with much higher resolution and part complexity and better microstructures than state-of-art solid-state approaches. First results have been obtained with a medium strength aluminium alloy (Fig. 1). The FSEAM process required relatively high process temperatures (above 500 °C) and substantial down forces (at least 9 kN) to enable defect-free deposition. Lower down forces would be beneficial to limit overloading of the build (plastic deformation, buckling) and the FSEAM setup, especially when processing high-strength aluminium alloys.



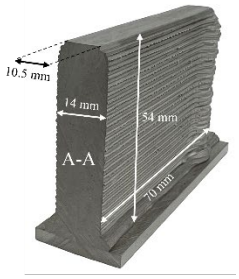


Fig. 1. Example of a FSEAM build fabricated from AA6060 (Al-Mg-Si alloy) at 500 mm/min.

Currently, the bottom of the FSEAM tool is flat (see Fig. 2a). Recently published literature employing a featured tool bottom suggested that lower down forces are needed when mixing of the deposited layer with the build surface occurs. Therefore, various alternative FSEAM tool bottom designs have been developed (see Fig. 2b – d) that could be beneficial. A thorough analysis of the behavior of these tools, and possible other designs developed during the course of the MSc assignment is highly needed to improve the performance of the FSEAM approach and to prepare it for additive manufacturing of high-strength aluminium alloys.

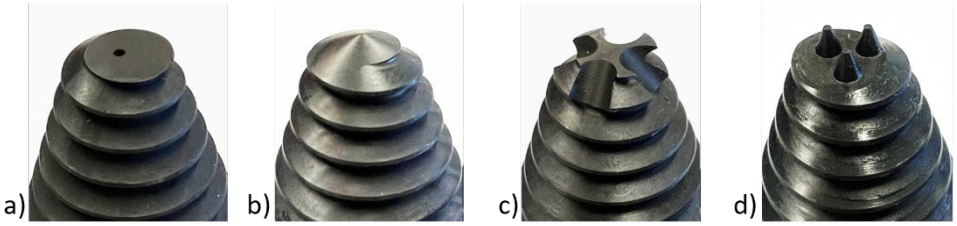


Fig. 2. Various FSEAM tool designs: a) flat bottom (current design with small hole for thermocouple), b) conical top, c) grooved, d) with pins. Designs b) – d) may be in contact with the build surface to enhance mixing and bonding.

The MSc assignment comprises:

- Literature review on tool design, transport phenomena and bonding during solid-state additive manufacturing.
- Extensive experimental work on the role of tool bottom design on the heat generation, force generation and bonding behavior during FSEAM.
- Development of basic process model to support understanding of the occurring phenomena at the layer – build surface interface.

Would you like more information on this captivating assignment? Please contact:

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