NEWSLETTER 4

HORIZON-CL4-2023-TWIN-TRANSITION-01-02.

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Experimental laser process development

The FLASH laser system integrates three laser sources and three beam delivery methods into a single machine platform. Potentially offering exceptional flexibility and cost reductions in accomplishing laser machining, joining, and surfacing processes. During the initial experimental laser process development phase of the FLASH project, the Manufacturing Technology Centre (MTC), UK, have collaborated with the project end-users to develop the fundamentals of numerous discrete laser manufacturing processes necessary to demonstrate and validate the FLASH system against ambitious end-user's targets in the latter stages of the project.

Motor hairpin joint preparation and joining

IMA Automation ATOP, Italy, who have a long history of using lasers in its assembly systems, aims to deploy laser cutting, cleaning and joining processes for the preparation and manufacture of copper hairpins for motor assemblies. The FLASH project team have developed discrete laser processes that embody the multi-laser, multi-delivery capability of the intended FLASH system in cutting, stripping, cleaning and joining copper hairpin joints. The processes developed enable the rapid galvoscanner-based removal of the outer insulating layer of the copper wires and followed by the high-quality nozzle-based cutting/trimming of the copper wires. The wire ends can then be cleaned with short-pulsed lasers to remove any residual insulating material and contaminants before welding. The addition of dynamic laser beam shaping in the final FLASH system will offer significant improvements in achieving the highest quality welded joints, as preliminary welding trials at the MTC have indicated a sizable reduction in joint porosity when beam shaping is implemented.

(a) (b)

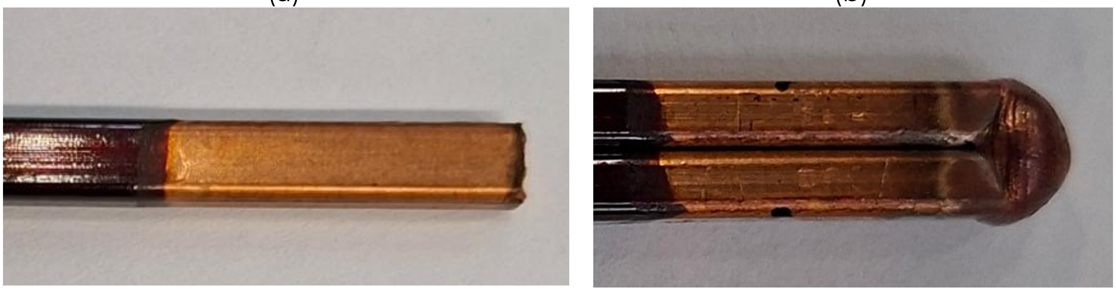
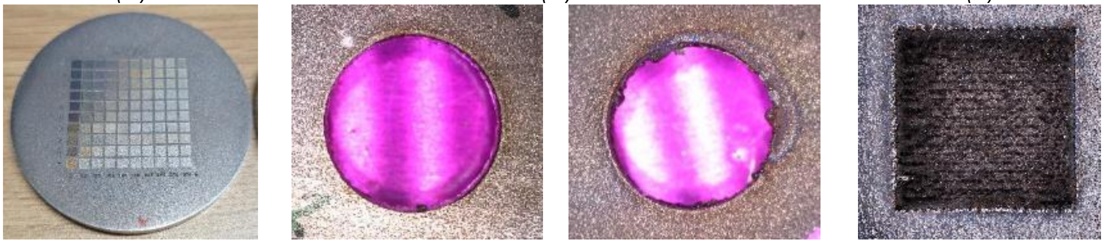


Figure 1: Outputs from various laser processes used to prepare and manufacture copper hairpin joints, (a) example of copper wire that was stripped, cut and clean, and (d) laser welded copper hairpin with beam-shaping

Furthering lasers in the manufacture of medical devices

Depuy Syntheses, Ireland, are working with the project team to develop several laser-based subtractive processes, such as texturing, drilling, cutting, and water jet guided laser (WJGL) milling, which will ideally play a crucial role in the future production of titanium acetabular hip cup components. Laser texturing and polishing are used to create controlled micro- and nano-scale surface roughness that promotes the long-term stability of the implant. Laser drilling and cutting enable the rapid removal of material to create defined complex features that are used to secure the implant in position. The sequential dual-laser process of WJGL milling and short pulse laser machining is used to create pocket-like features necessary for the implant assembly. Meanwhile, laser marking provides permanent, high-contrast identification and traceability features without compromising the biocompatibility of the implant. Together, these laser processes provide the fundamental strategies for an alternative production method to standard mechanical manufacturing, whilst still ensuring that acetabular hip cups meet stringent medical standards.

(a) (b) (c)



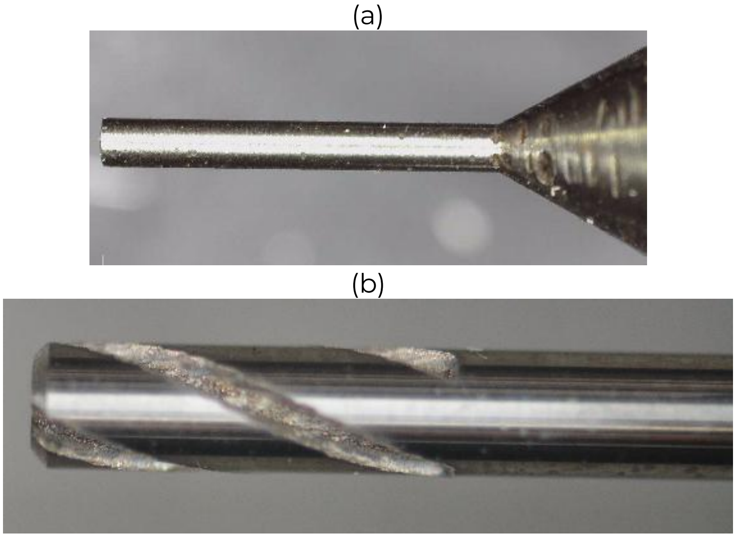
Entrance Exit

Figure 2: Demonstration of (a) short pulse parameter optimisation to create desired surface roughness and marking features in the titanium-alloy, (b) multi-step laser drilling of angled-stepped fixturing holes in 4 mm thick titanium-alloy, and (c) water jet guided laser milling of blind pockets

Laser machining for high-strength micro-drills

Diamoutils, France, is aiming to take advantage of the precision and low-stress removal of high-strength materials provided by WJGL turning and short pulse laser micro-machining to manufacture 1.5 mm diameter polycrystalline diamond (PCD) tipped tungsten carbide drill bits. These tools are vital for the manufacture of printed circuit board assemblies. In this work, the project team have developed a two-step WJGL turning process, where multiple facets are created around the diameter to remove the bulk of the material. A finishing pass follows to turn the rod to the required diameter. The MTC have demonstrated the ability to WJGL turn parts from 5 mm to 0.7 mm in diameter and to a surface roughness below 1 μm. The spiral flute geometries and cutting edges of the drills can then be machined into the WJGL turned blanks using short-pulsed laser ablation. By combining these two laser processes, manufacturers can produce small-diameter, high-strength drill bits with exceptional precision, minimal thermal damage, burr-free edges, and superior durability.

(a)



(b)

Figure 3: Outputs of (a) water jet guided laser turning of drill shanks and (b) short-pulsed laser machining of flute geometries on drill shanks

Laser manufacturing for automotive assemblies

In the attempts to continue developing towards lightweight automotive structures and enhanced sustainable manufacturing processes, TOFAS is working with the FLASH project team to investigate the laser cutting, surfacing and joining techniques. Using a laser for preparing and joining aluminium to steel sheets is a particular challenge that is being addressed in the project. The MTC team have carried out experimental trials to investigate the dynamics of creating this complex joint system. Results have been mixed as precise optimisation of the laser parameters and processing strategies is required to minimise intermetallic formations and to maximise joint integrity. Further analytical and experimental investigations will be carried out on the project to continue towards overcoming this complex challenge.

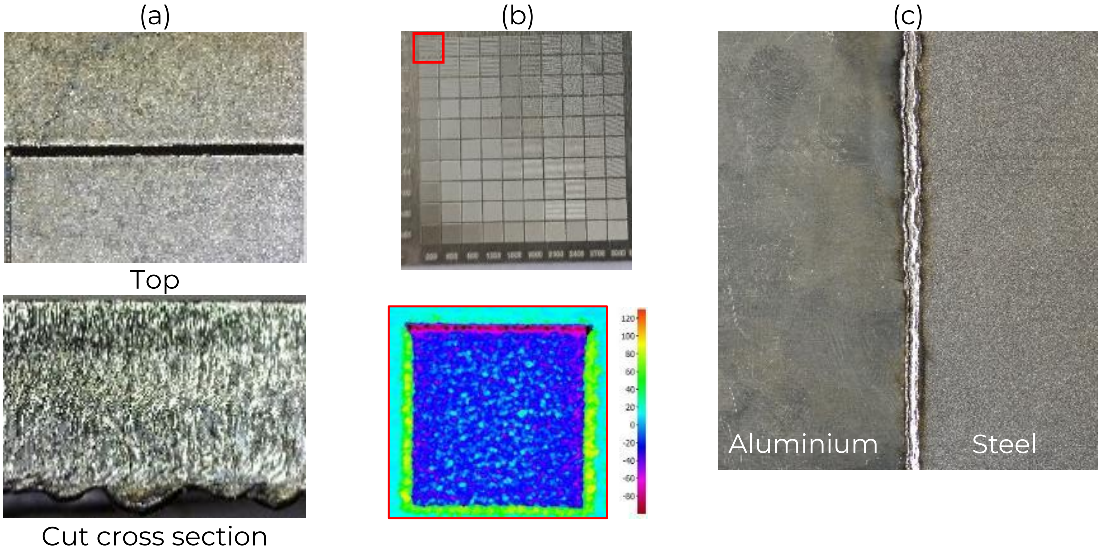


Figure 4: Multi-step laser manufacturing to producing initial dissimilar metal automative joints, (a) laser cutting of 2.5 mm thick steel, (b) laser surfacing parameter optimisation on aluminium, (c) butt weld of aluminium to steel