

EPSRC Centre for Innovative Manufacturing in Add, Remove, Measure or Repair 2(AR)MoR Parallel Robot Platform for 3D Freeform Laser Manufacturing

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Project overview

- Development of novel 3D freeform laser- \bullet based manufacturing platform.
- Concurrent engineering by combining the abilities of metrology and both additive and subtractive laser manufacturing.
- Single workstation enables adding and removing material to and from freeform shapes in combination with process control and measurement.



Objectives

- Demonstration of viability of parallel robot for laser based 3D freeform fabrication.
- Integration of fibre delivered CW laser source for additive blown powder process.
- Demonstration of novel hollow core fibres for high power ns and ps subtractive laser processing.
- Investigation of process feedback and control.



Fibre delivered laser processing.



Potential applications: Repair of damaged high value components (e.g. turbine blades) or novel customised parts (e.g. medical prostheses).

Project partner:

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Add: Blown powder laser metal deposition <u>Custom designed lightweight powder nozzle</u>

- Coaxial powder nozzle
- Weight: 260 g (~200 g feasible) \bullet
- Adjustable thickness and confinement of powder channel
- Powder: Stainless steel 316 (average \bullet particle diameter $\sim 30 \,\mu m$)
- Argon as carrier and assist gas \bullet
- Laser source: 400 W CW fibre laser



Additive processing head





Developed and fabricated nozzle

Powder distribution of nozzle:



Remove: Fibre delivered ns laser machining with parallel robot

Hollow Core Negative Curvature Fibres (NCF)

- 42/21 µm diameter hollow core
- Anti-Resonant Reflecting Optical Waveguiding Mechanism (ARROW)



NCF based laser micro-machining with parallel robot

- Laser source: 60 ns pulses with 1064 nm wavelength
- Fibre couple efficiency: 90.9% @: 17.6W (pulse energy 1.17 mJ)
- Parallel robot(Equator 300) arm translation speed: up to 100 mm/s







Controllable powder confinement by means of adjustable nozzle.

Additively manufactured sample: Micro laser cladding

SS 316 powder on SS 116 substrate



2(AR)MoR: 2(Add-Remove) with Measure or Repair Next step



Marking (SS)

Material removal (SS)



Cutting(AL 0.3mm)

Remove:

Add: Laser mirco wire metal deposition

- Development of customised micro wire feeding system.
- Process optimisation for blown powder and wire metal deposition.
- Miniaturisation of additive laser processing heads.



Alabama laser micro-wire feeder (minimal wire diameter 125 µm)

- Process optimisation.
- Synchronisation of laser and robot movement for complex freeform \bullet surfaces.

Measure:

- Process monitoring and control systems for additive and subtractive processes.
- Laser triangulation, quality inspection camera, power control etc. \bullet







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