Laser Beam Welding Capability

Process Summary

Laser beam welding (LBW) is becoming an established welding process across many industrial sectors and is characterised by high process speeds, a highly controllable heat input and limited distortion. LBW is exploited across a diverse range of both metallic and polymer substrates for making high integrity, hermetic joints, from sub-millimetre, discrete weld spots in reactive foils, up to 20mm deep, single pass welds in structural steels.

Welds made with a focussed laser spot less than 100µm diameter (as typically applied within the electronics and medical devises sector) are considered by the MTC to represent 'micro-welding' applications, with welds utilising a larger spot considered to be 'macro-welding'. The MTC specialises in macro-welding applications for metallic materials. The core capabilities of the Nuclear AMRC are large scale cladding and welding.

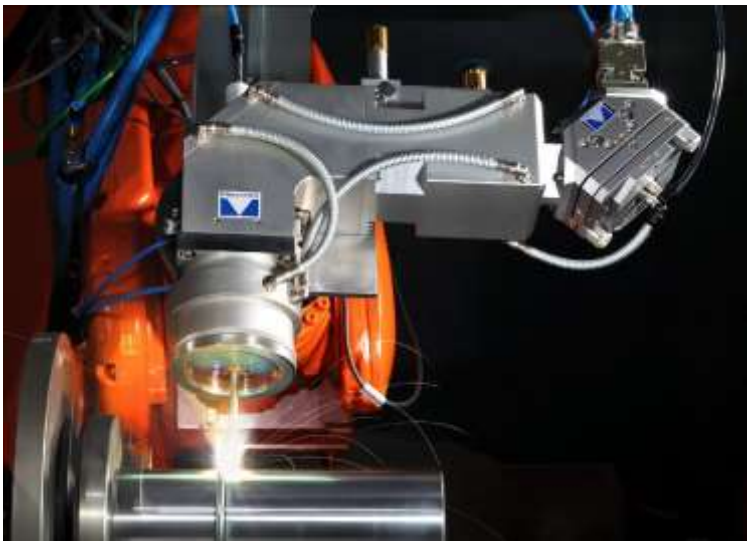
a)

b)

Set up at the MTC (a) and at the Nuclear AMRC (b)

By equipping the process tool with an appropriate material feed system (either powder or wire), additional material may be added to the weld pool. This can be used for adding reinforcement in fillet joints (welding or brazing), mitigating compositional change in alloyed metals, or adding material to the workpiece surface. If the additional material forms a conformal coating of the workpiece surface (regardless of the number of deposited layers), this is widely considered to be 'laser cladding', but if

the added material forms a discrete shape (again, regardless of the number of layers), this can be considered ‘additive manufacture’.



Process Advantages

- Increased process speeds compared to ‘conventional’ fusion processes.
- Reduced overall heat input compared to ‘conventional’ fusion processes.
- Highly controllable heat input.
- Highly controllable weld penetration.
- Reduced HAZ width / depth.
- High aspect-ration welds possible (keyhole mode).
- Low aspect ratio welds possible (conduction mode)
- No weld-prep required for butt welds (square butt ideal)
- Reduced distortion.
- Welds can be autogenous, or use filler wire.
- Highly controlled dilution for deposition applications.
- Ability to deposit macro-scale metal-matrix composites with high carbide content without loss of carbide content.

Typical Applications: Macro Welding

- Remote laser welding of automotive body parts including Tailor Welded Blanks (TWBs) and pressed assemblies.
- Seam welding of roll formed tubes for hydroforming applications, spacer bar etc.
- Seam welding of pressurized vessels for CHP (domestic / industrial heating / power)
- Welding of automotive drive-line components (gear clusters, driveshafts, differentials, clutch packs etc.).
- Welding of pressurised vessels for fluid sensing and power transfer applications (automotive, yellow goods, power generation).
- High speed welding of tube to header joints for heat exchanger applications

- Fabrication of structural cases and houses (aerospace)

Typical Applications: Deposition

- Brazing of roof-to bodyside seams, tailgate seams (automotive)
- Hard facing of crusher hammers (mineral processing, mining).
- Wear / corrosion resistant coatings for continuous casting mold foot rolls (foundry)
- Repair of mill rolls.
- Repair of teeth for earth moving machinery.
- Repair of fan blade leading edges (aerospace, power engineering)
- Hard facing for down-hole drilling tools (oil and gas, construction)
- Hard facing of augers and material conveyance screws (oil and gas, mining, material processing, construction)
- Repair of rotative shafts (foundry, marine, heavy engineering)
- Corrosion protection of valves and vessels (power generation, oil and gas, chemical processing)

	IPG Fibre	**Trumpf Disk**		**Laserline Diode Laser**
Power (kW)	20	3	16	15
Wavelength (nm)	1070	1060	1030	900 - 1100
Primary motion system	6 axis robot (3.5m reach, 140kg payload)	6 axis robot (2.0m reach 30kg payload)	6 axis gantry (7m x 4m x 3m reach, 20 kg payload)	6 axis gantry mounted robot (up to 6 m reach, 60 kg payload)
Secondary motion system	Twin axis tilt / turn (1500kg, 2.0m dia.) Single axis lathe (4000kg, 2.9m dia.)	Twin axis tilt / turn (400kg, 1.5m dia.)	Turn/tilt table (15000 kg)	Roller bank (3000 kg, 4.0 m dia) Turn table (3000 kg, 3.0 m dia.) Turn/tilt table (350 kg, 0.2 m dia.)
Delivery fibre Dia. (µm)	200, 300, 600	400	200, 400	1000, 1500, 2000
Focussed spot Dia. (µm)	500, 600, 1000		400	1.2 to 45x5 mm
Additional processes	Laser welding with wire (off-axis and co-axial) Off-axis cladding (powder) Off-axis cladding/brazing (wire) Co-axial cladding/brazing (wire) Hybrid welding (GMAW – 550A)	Off-axis cladding (powder)	Off-axis welding (wire) Hybrid welding (GMAW – 550A)	In-axis cladding (powder) Off-axis cladding (powder) Inner bore cladding

Applications Undertaken

- Single pass, full penetration butt welding in Ti alloys up to 10mm thick (aerospace).
- Single pass, full penetration butt welding in heat-resistant Nickel Alloys, up to 8mm thick (aerospace and power generation).
- Single pass, full penetration butt welds in S355 structural steel, up to 20mm thick (transport and yellow-goods).
- Single pass, through-thickness, T-fillet welds in S355, 10mm thick, Hybrid welding (yellow goods).
- Overlap welds in stainless steel sheet pressings (1.0mm-1.0mm) (aerospace).
- Overlap welds in Ti alloy sheet pressings (~1.0-1.0mm) (aerospace).
- Repair of Ti alloy fabrications (aerospace).
- Deposition of Ti alloys.
- Hardfacing of forging dies (general engineering).
- Repair of critical wear surfaces (power generation).
- Wear resistant coating application (power generation and mining).
- Corrosion resistant coating application (power generation).