

Laser welding of Ti-6Al-4V parts produced by AM

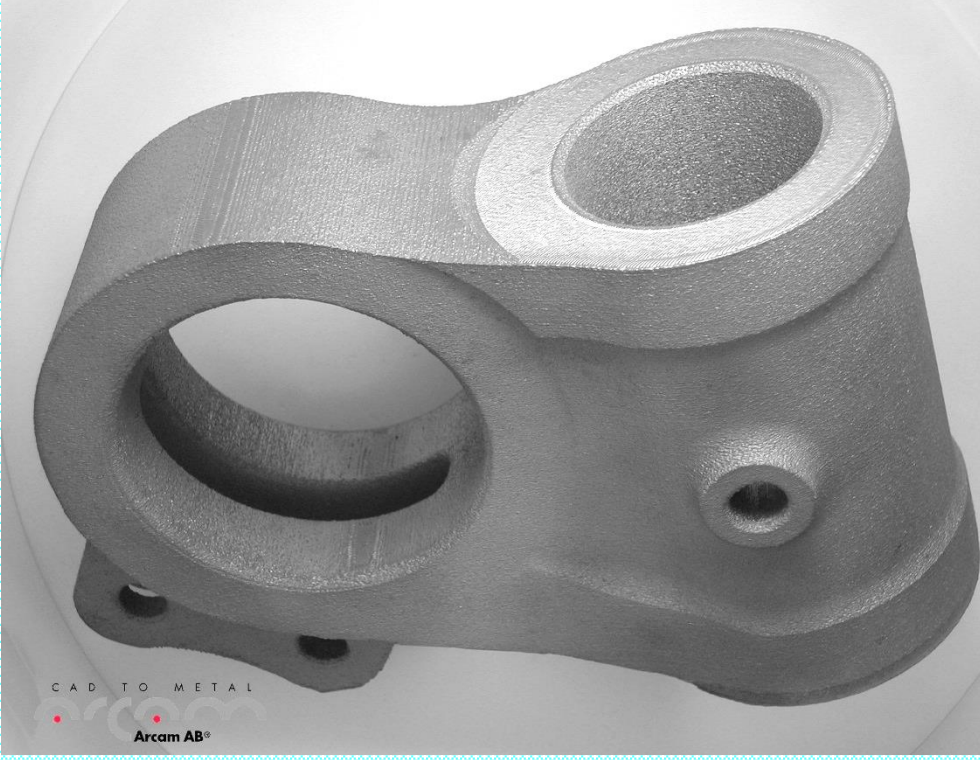
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Introduction:

3D printing, also known as additive manufacturing (AM), refers to various processes used to create three-dimensional objects. Essentially, the 3D printer is an industrial robot, which synthesize 3D objects layer by layer under computer control. These objects, produced from virtual 3D models, can be almost of any shape and geometry. Our ARCAM A2X machine, using Ti6Al4V ELI 45 – 105 μm powder, is one of the most advanced tools in the field of 3D printing of titanium. However, in some cases, when special treatment of the internal surfaces is required, the 3D parts can be produced segmentally with the subsequent joining after the treatment is over. Here, our welding process cannot be over-appreciated. This feasibility study is focused on the welding process of the 3D parts using our continuous 935 nm diode laser.

3D Machine: ARCAM A2X

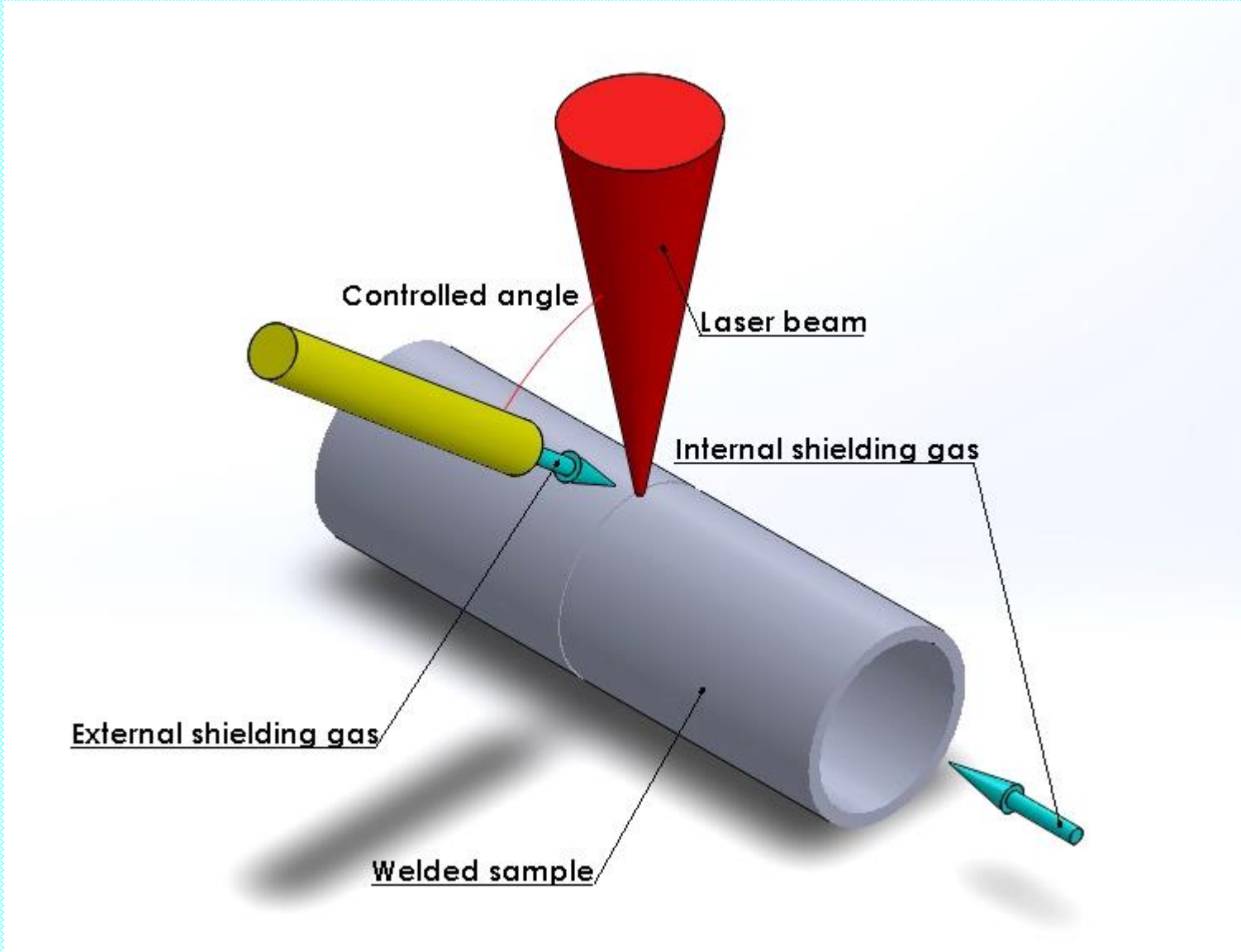
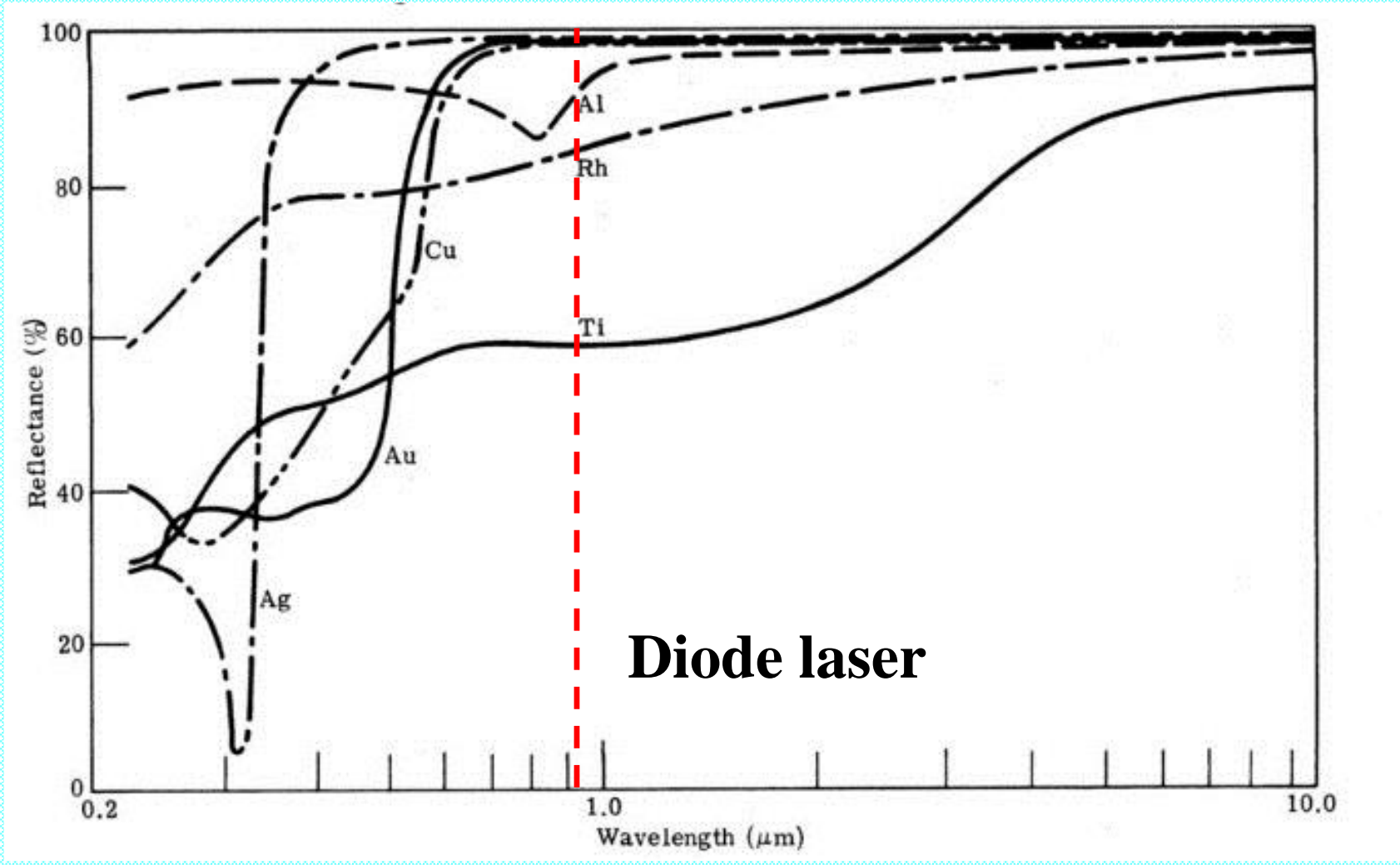


Diode Laser System: Laserline

High-power diode laser (HDL) CW	
Wavelength (nm)	935 \pm 10
Laser power (kW)	2
Laser heads	Welding: Spot size ~ 1 mm Hardening: 13mm X 6mm
Options	Cladding, Pyrometer
Moving stage	Controlled X-Y-Z and Rotation

Diode laser welding advantages:

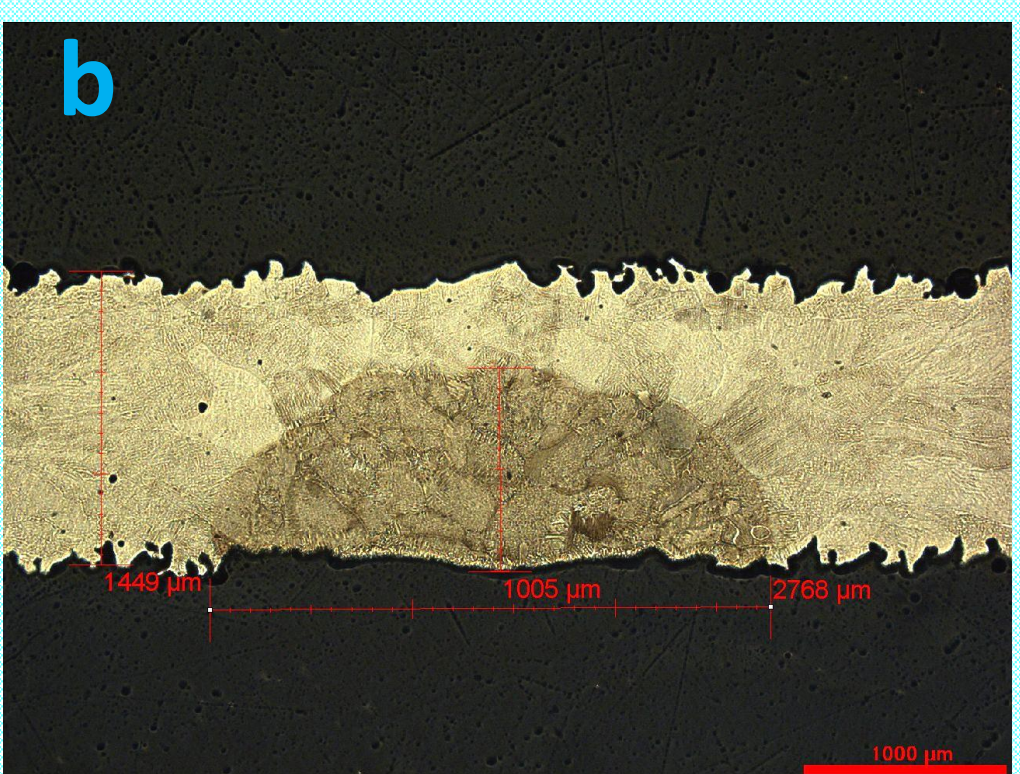
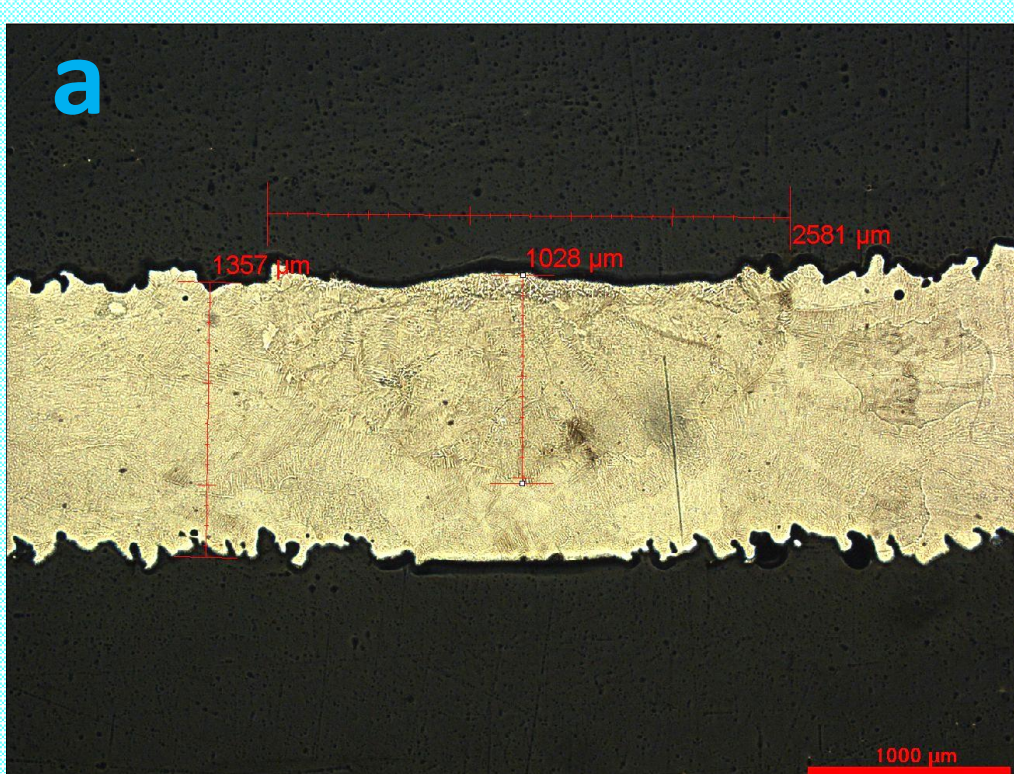
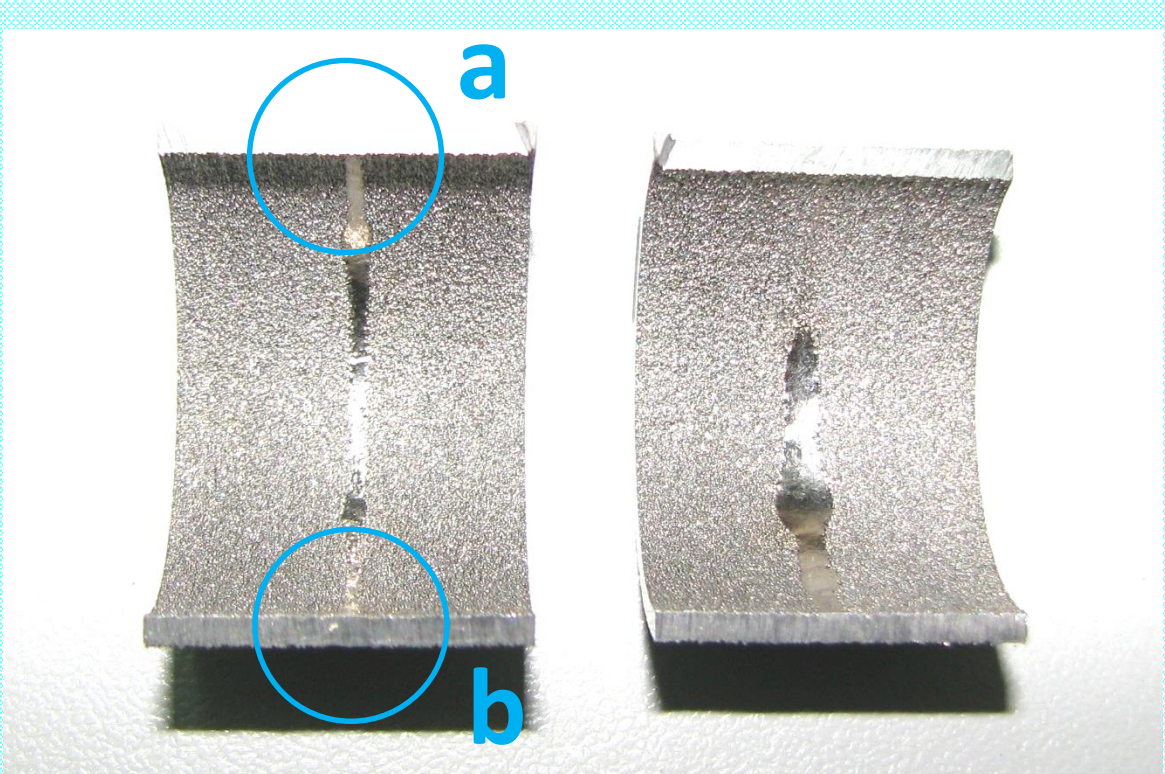
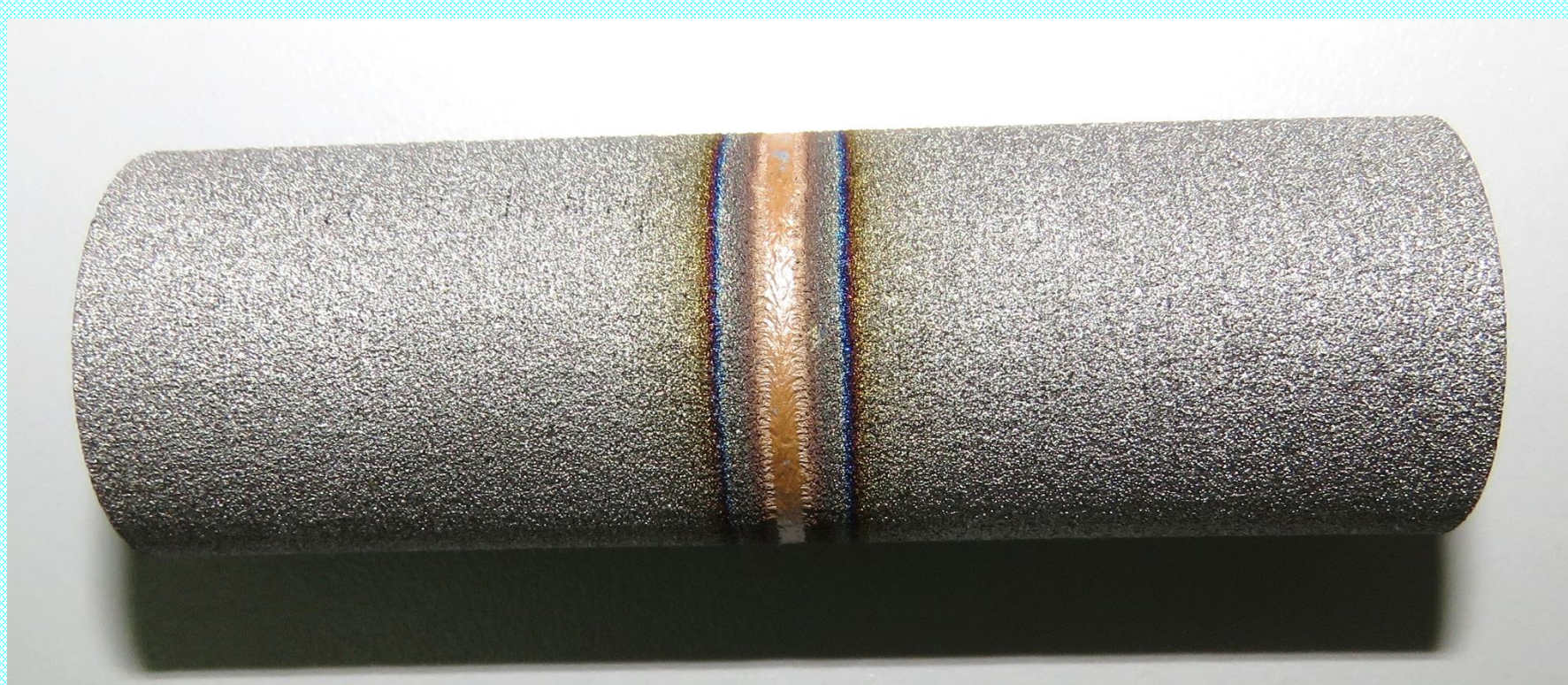
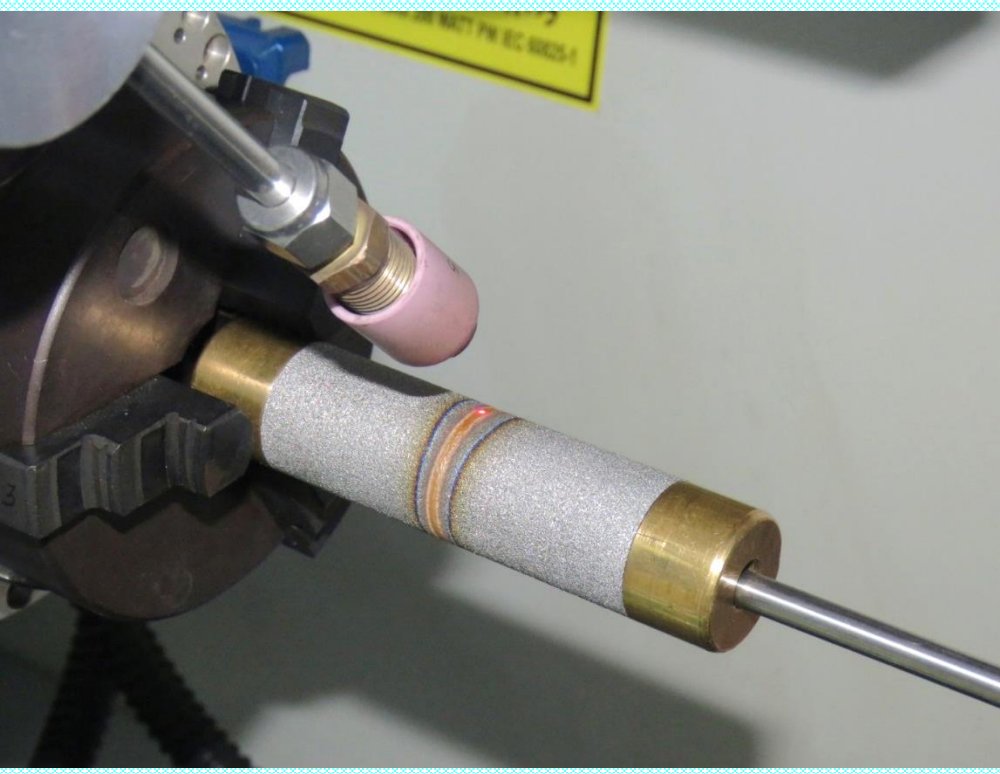
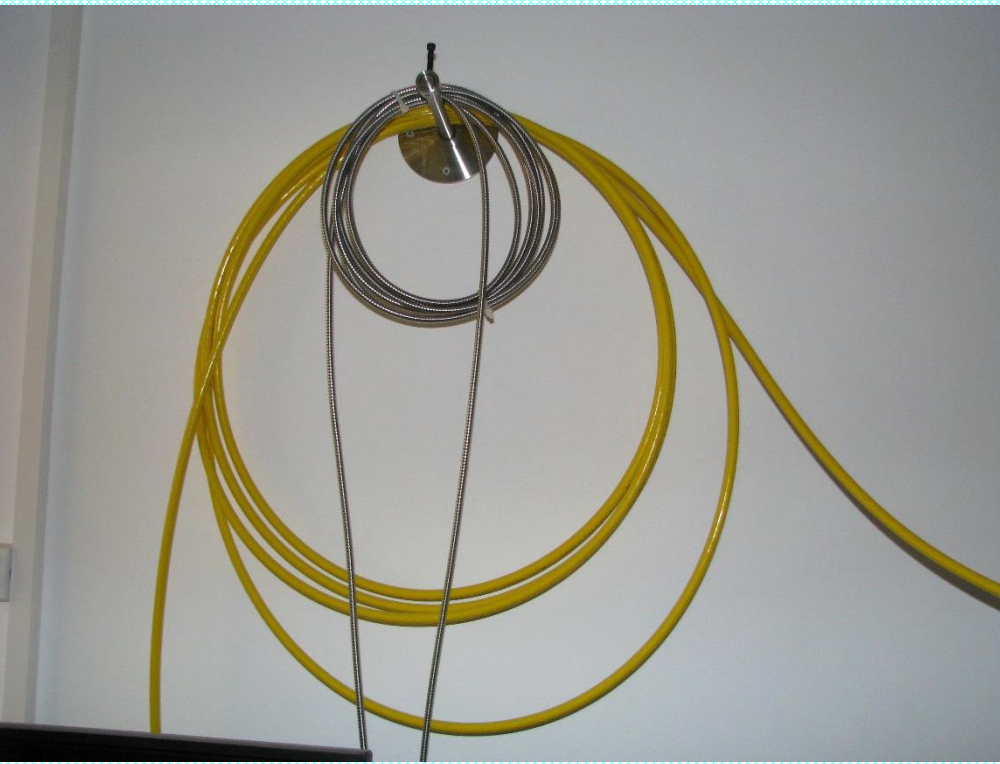
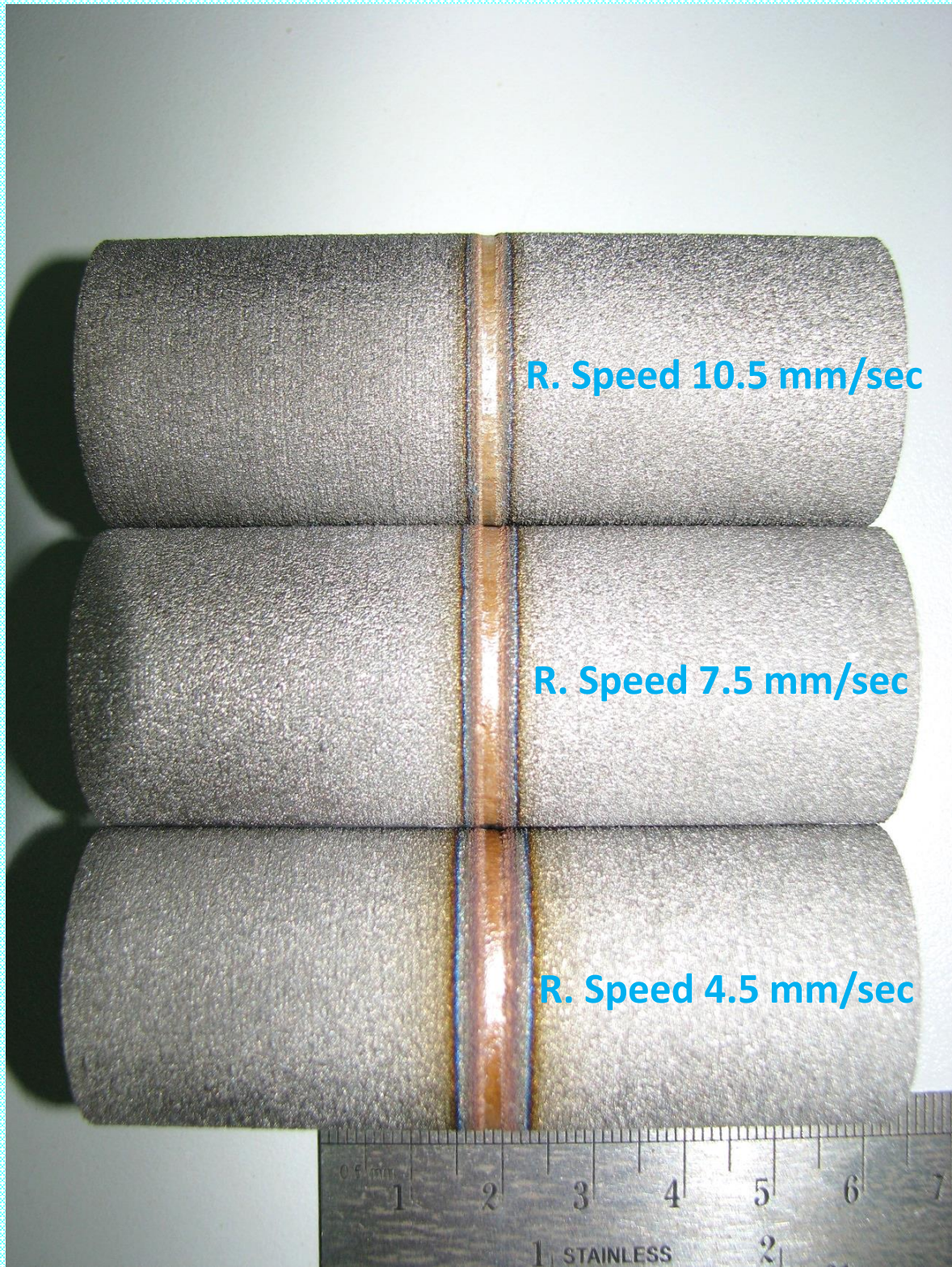
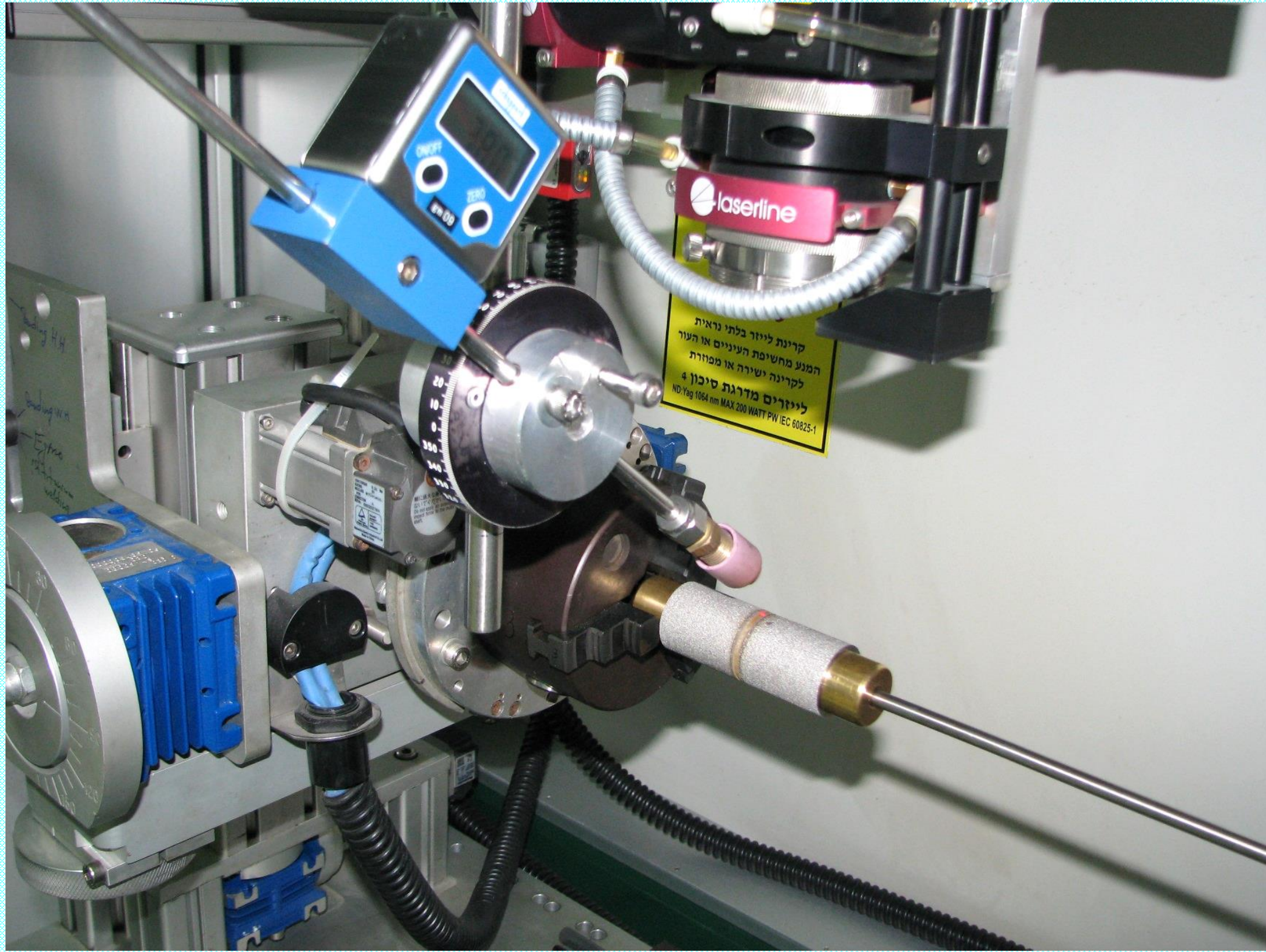
- High electrical efficiency of about 40%.
- Lower operating costs
- The small size of diode lasers makes them easier to integrate into workstations.



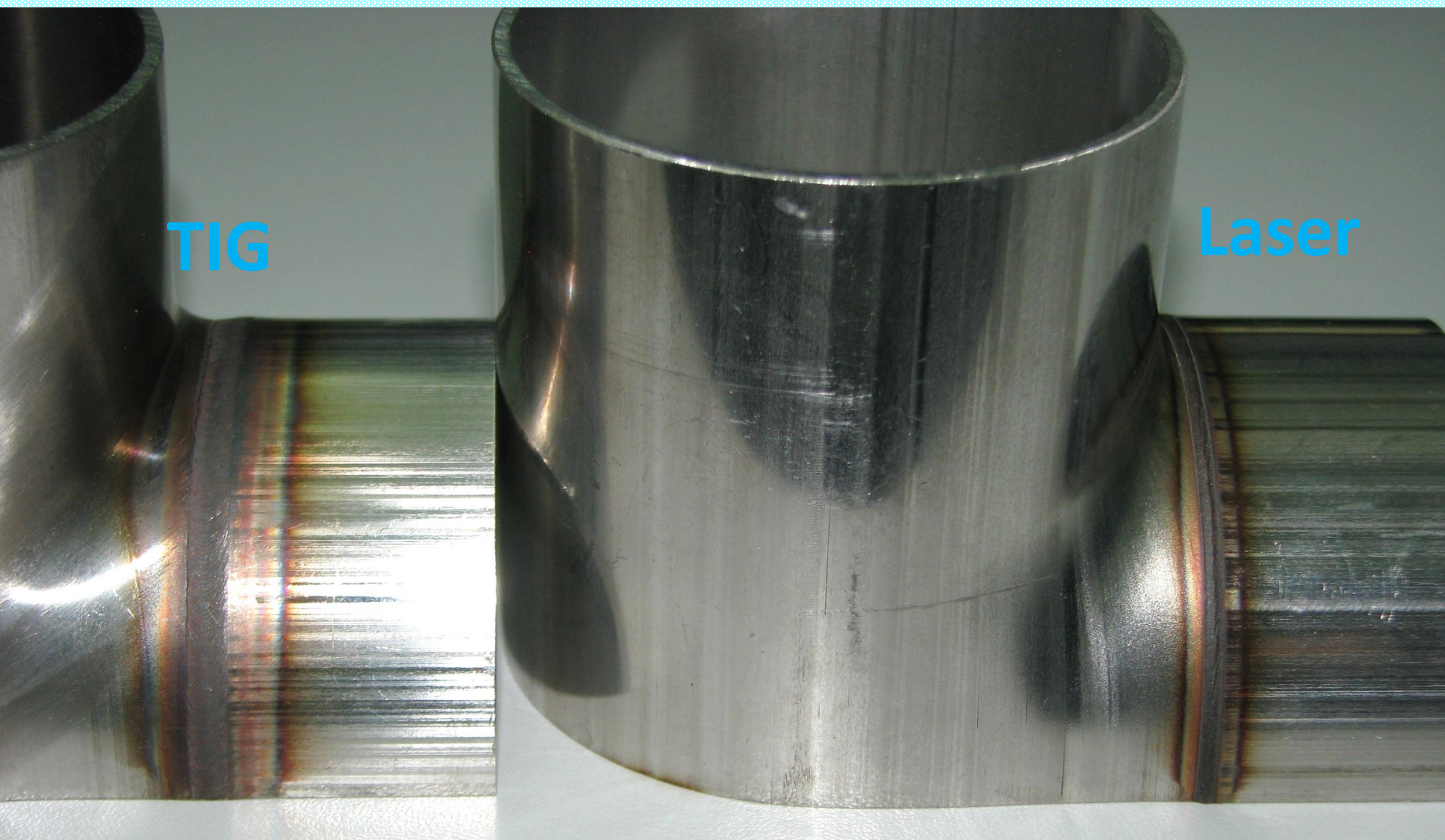
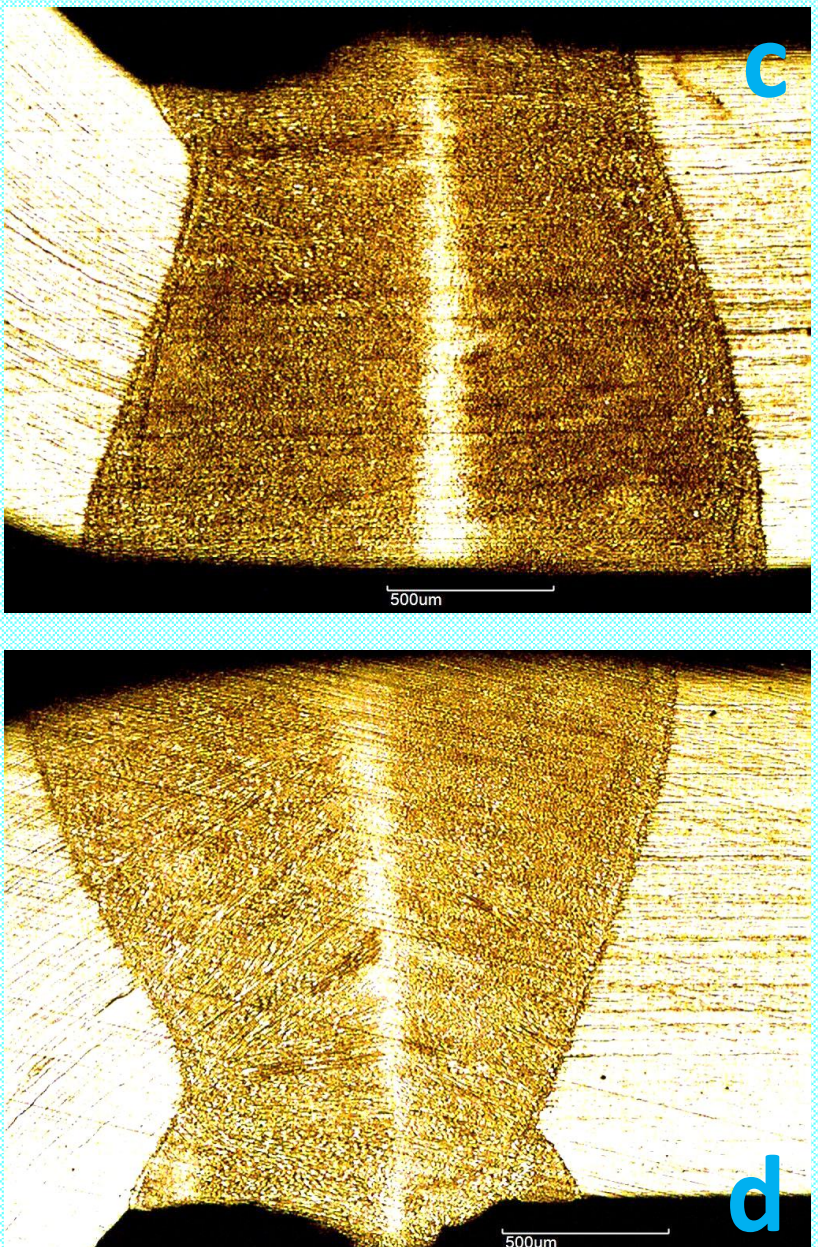
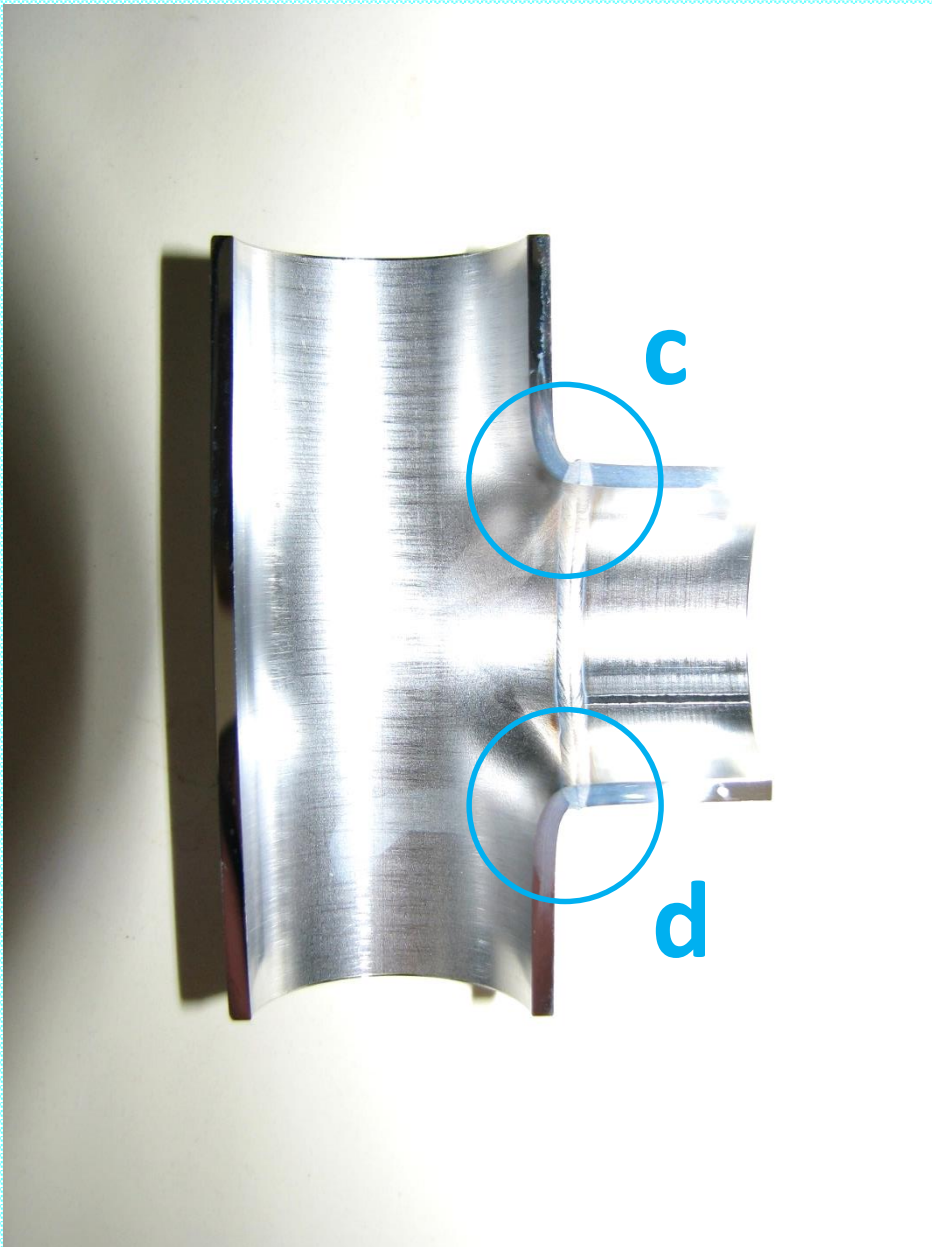
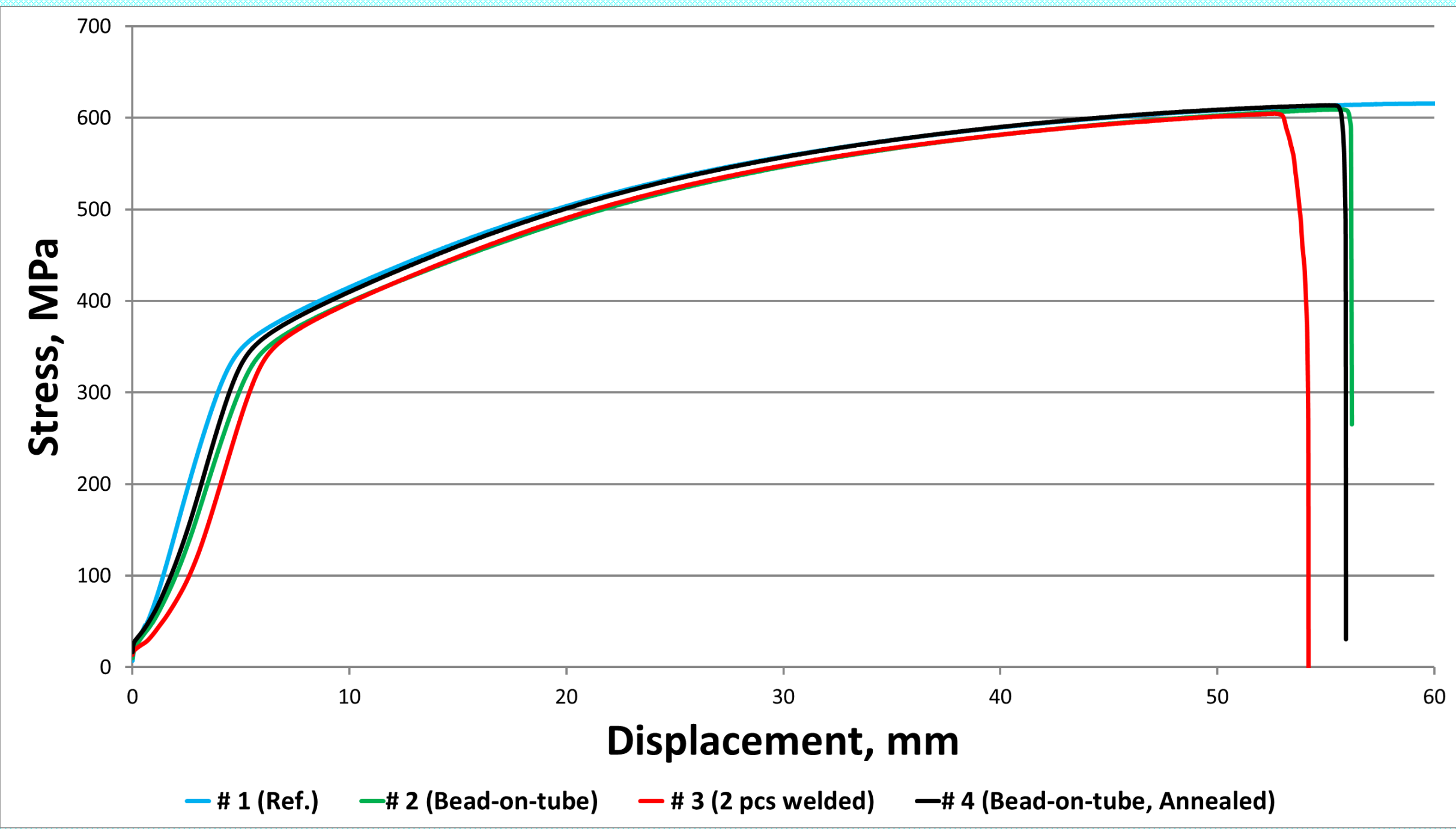
Configuration of tubes welding:

- Internal and external separate gas flow
- External flow of inert gas in direction opposite to sample rotation
- Sample holder provide inert gas supply inside the tube at the seam zone

Parameters which affect the welding process: head type, laser power, rotation speed, internal & external shielding gas flow, shielding gas flow rate & angle, shielding gas type, working distance between sample and laser head (in focus, out of focus), pre & post gas flow, rotation overlapping, energy slow down.



Previous experience with stainless steel:



Sample #	Maximum Extension, mm	Maximum Load, kN	Stress, MPa	Comment
# 1	66.64	75.67	616	No welding, Reference
# 2	56.20	74.87	609	Bead-on-tube
# 3	54.20	74.29	605	2 pcs welded
# 4	55.93	75.41	614	Bead-on-tube & Annealing

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