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WIRE-BASED LASER METAL DEPOSITION (LMD-W) OF TITANIUM GRADE 5

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MOTIVATION

Titanium is an astonishing lightweight material, however:

- The machining of titanium grade 5 is cost intensive and time consuming.
- For lightweight constructions often lattice frameworks are used. Therefore, the machined volume is very high.

➢ Additive manufacturing is one way to overcome this drawback by near-net-shape manufacturing.

TECHNICAL CHALLANGES

While processing titanium, oxidation is one of the main challenges. The material, especially the melted material, has a high affinity to oxygen. Already an amount of ppm oxygen reduces the mechanical strength drastically. Therefore, the heat-affected area has to be protected by argon. To guarantee the surface quality, titanium grade 5 usually has to be processed in a gas chamber or even vacuum.

➢ Fraunhofer IPT investigated the technical feasibility of a local shielding gas concept for a wire-based laser metal deposition process with wire (LMD-W).

MATERIALS AND METHODS

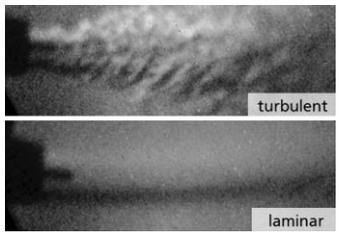
- Parts have been manufactured on a 5-axis machine center (see further details in the box)
- The shielding gas nozzle was investigated with a striation optics.
- The volume flow of the material was changed systematically. The quality of the beads as well as the coloring due to oxidation was evaluated.

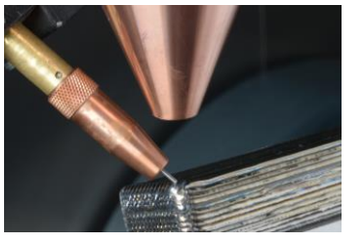
RESULTS

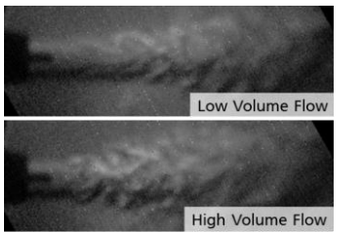
- The wire gas nozzle as well as the additional coaxial nozzle should be as sharp edged as possible to avoid vortexes.
- To realize a homogenies shielding, the nozzle should be ideal round shape.
- At a certain point, the laminar flow becomes turbulent. A stable shielding was not realizable within the laminar condition.
- The gas stream of the coaxial nozzle can be described as an open jet. According to the boundary-layer theory such a jet can be separated in a near field and a far field. In the near field no oxygen is sucked into the stream.
- Higher flowrates cause higher impulses. Higher impulses enlarge the length of the near field. This result was confirmed by an increased bead quality.
- Above a certain gas flow the jet interacted with the melt pool. The bead quality thereby is reduced drastically.

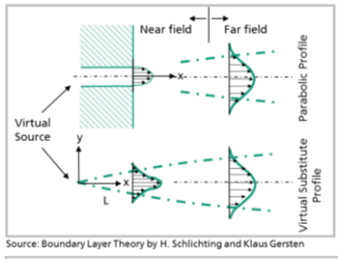
CONCLUSION

- It is technical possible to realize a local shielding for additive manufacturing of titanium grade 5.
- The feasibility of the process was demonstrated by building up demonstrator part.
- LMD-W with local shielding thereby becomes an alternative to the classical manufacturing of light weight parts from titanium grade 5









Source: Boundary Layer Theory by H. Schlichting and Klaus Gersten

Alzmetall 5-axis-machining center »LOB«

- Diode laser 4500 W (Laserline)
- CAM module for Additive Manufacturing (Fraunhofer IPT)
- Control unit SINUMERIK 840 D Solution Line (Siemens)
- Max. travel: X-, Y-axis: 800 mm, Z-axis: 600 mm
- Max. part weight: 200 kg
- Feeding system: Powder (coaxial) or wire (lateral) as well as combined feeding

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