LABS

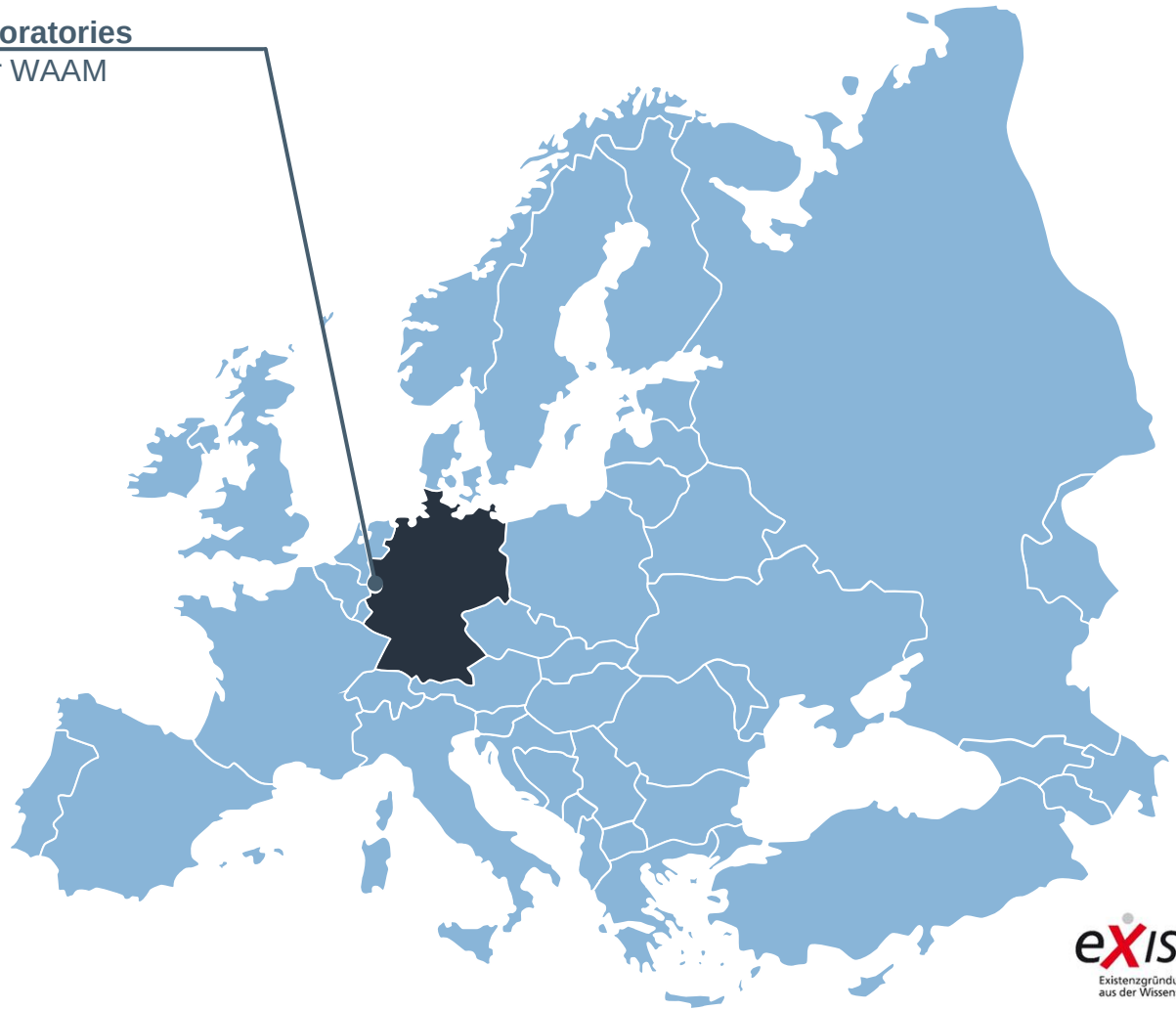
PLASMA ADDITIVE LABORATORIES

Wire Arc Additive Manufacturing of Aluminum Parts

ALUMINIUM Conference 2022

Who we are

Plasma Additive Laboratories
Full Stack Provider for WAAM applications
Aachen, Germany



- Startup initiative, with its roots at Welding and Joining Institute (ISF) of RWTH Aachen University
- 8 Employees plus students
- ~ 1 mio € funding
- Focus on full stack solutions in the field of high performance metal additive manufacturing by WAAM.

eXIST Existenzgründungen aus der Wissenschaft
ESF Europäischer Sozialfonds für Deutschland
Europäische Union
Zusammen. Zukunft. Gestalten.
Bundesministerium für Wirtschaft und Klimaschutz

ALABS

Our mission

We accompany customers from

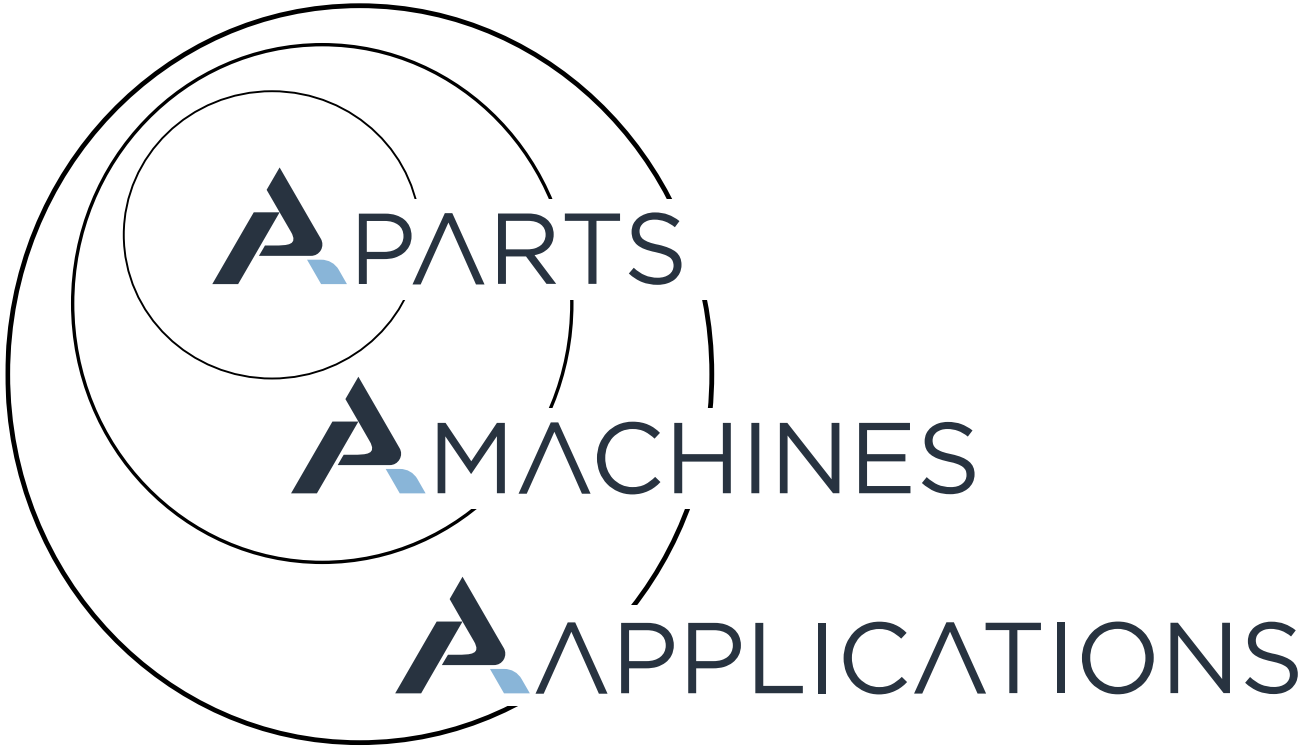
initial studies,

provide innovative and highly productive

production technology,

to enable specific

WAAM applications.



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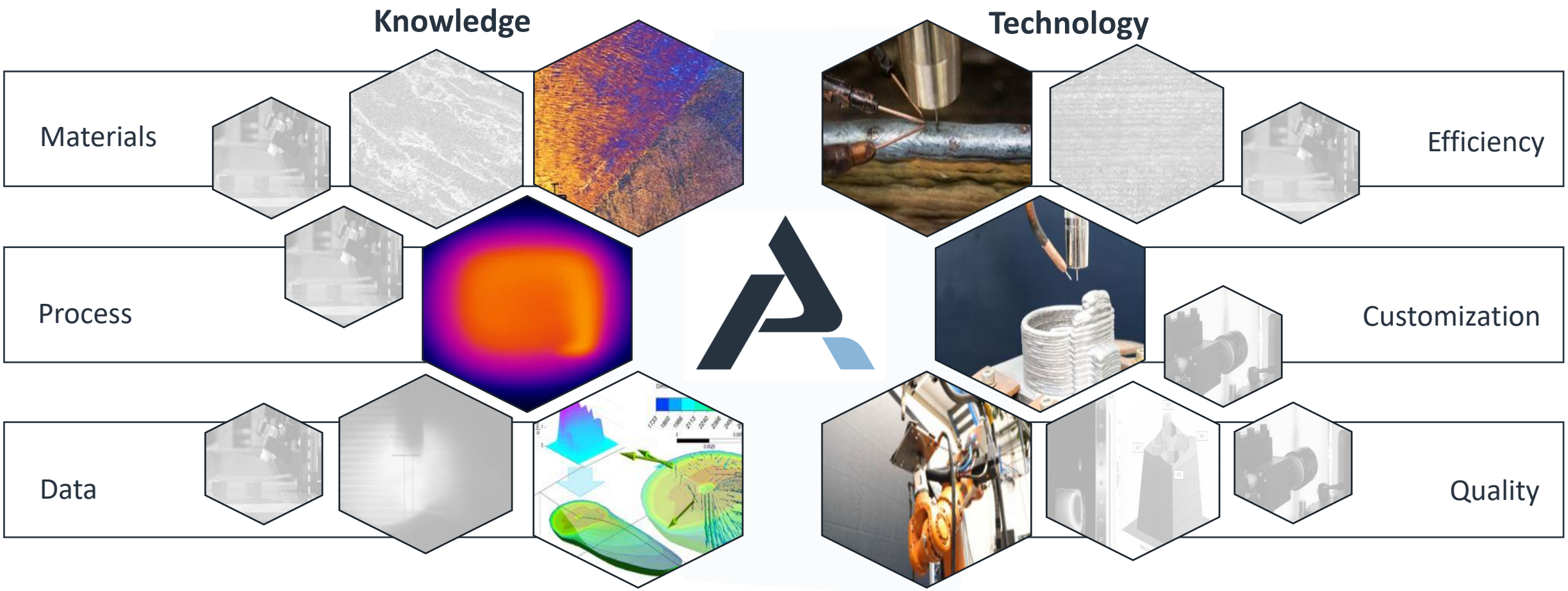
Our Profile


Knowledge
Technology
Materials
Efficiency
Process
Customization
Data
Quality

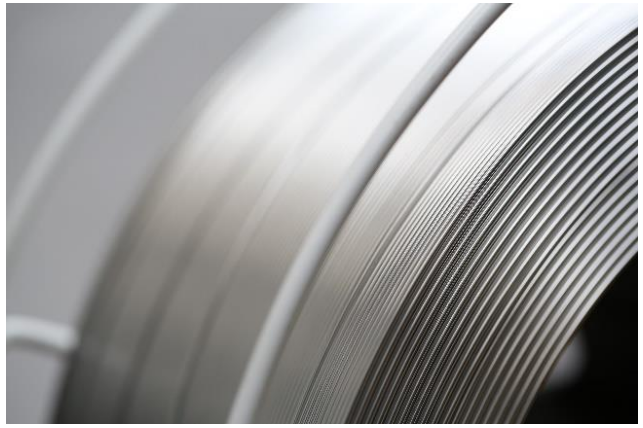
What is WAAM

WAAM is a variation of Direct Energy Depostion (DED) also called arc-DED.

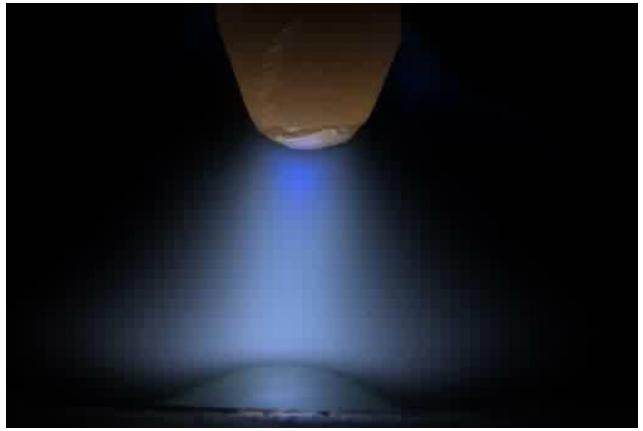
Arc welding processes are used to 3D print metal parts.

Unlike more common metal powder AM processes, WAAM works by melting metal wire using an electric arc as the heat source.

Material transfer happens in form of droplets being accelerated into a molten pool, opened by the electric arc.



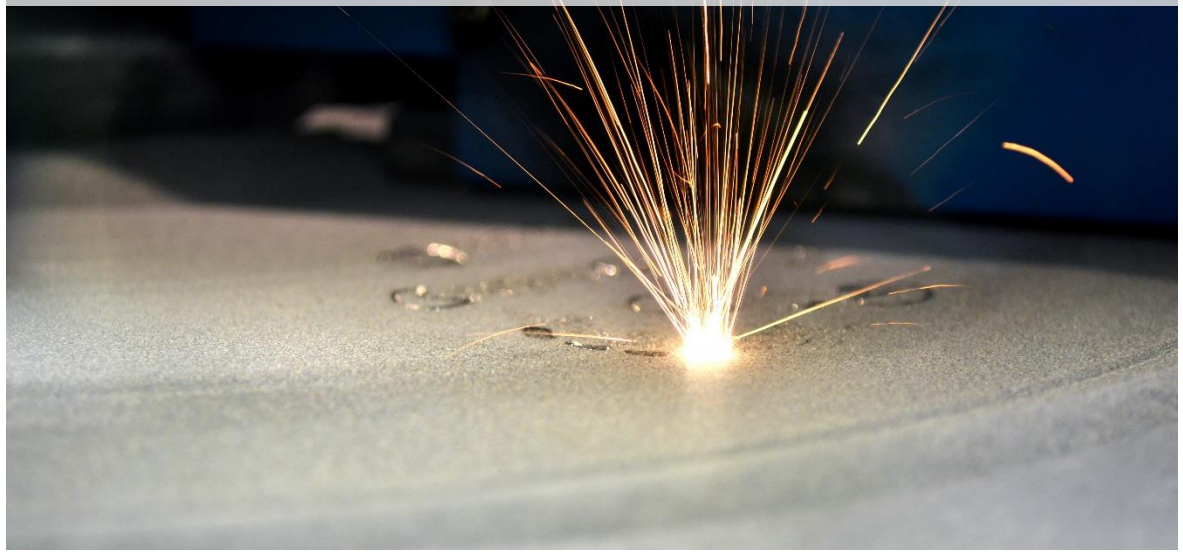
✓ Wire feedstock



✓ Electrical arc

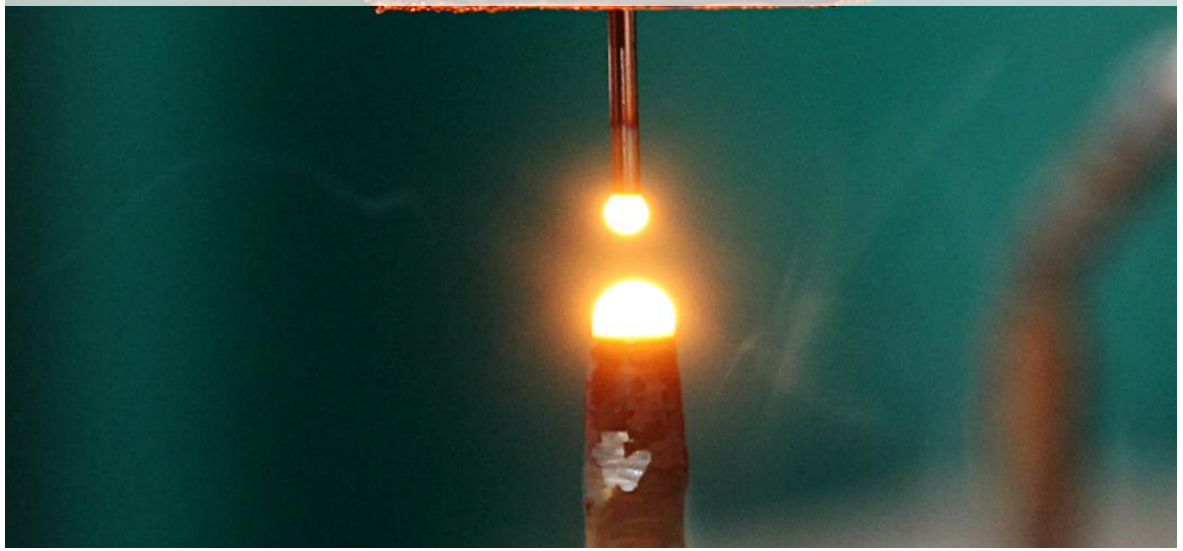
WAAM compared to powder based processes

Powder Bed Fusion (PBF)



- ✓ Straight forward process
- ✓ Established technology
- × Expensive machinery
- × Expensive powder
- × Low productivity

Wire Arc Additive Manufacturing (WAAM)



- ✓ Inexpensive machinery
- ✓ Inexpensive wire
- ✓ High productivity
- × Low resolution
- × Complex process
- × Unmature workflow

Advantages and resulting applications

Reduced Machining

Light weight aluminium and titanium components

Optimized Supply Chains

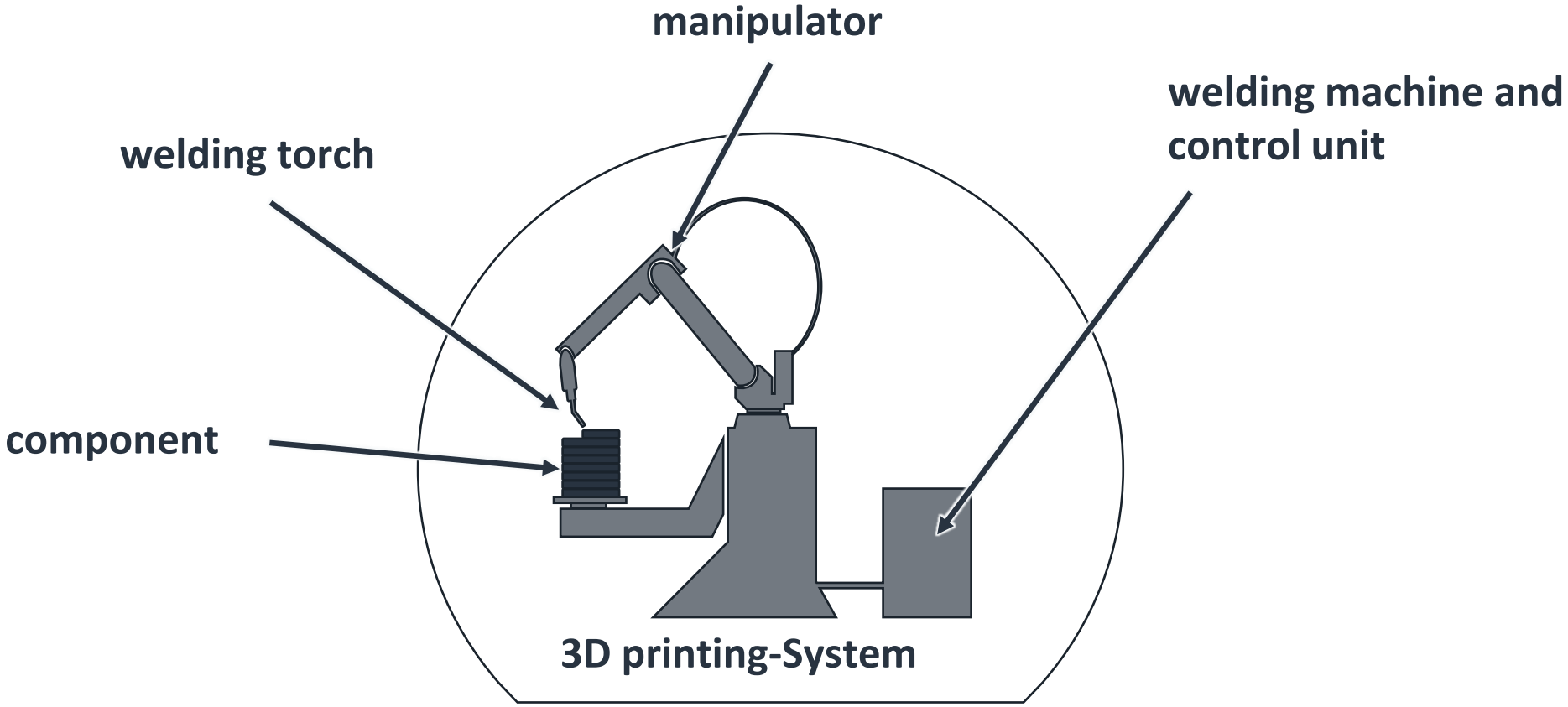
On site spare part production

High Performance Components

Components with locally adjusted materials properties

Medium to large component size
Medium lot sizes

Basic setup of a WAAM-machine



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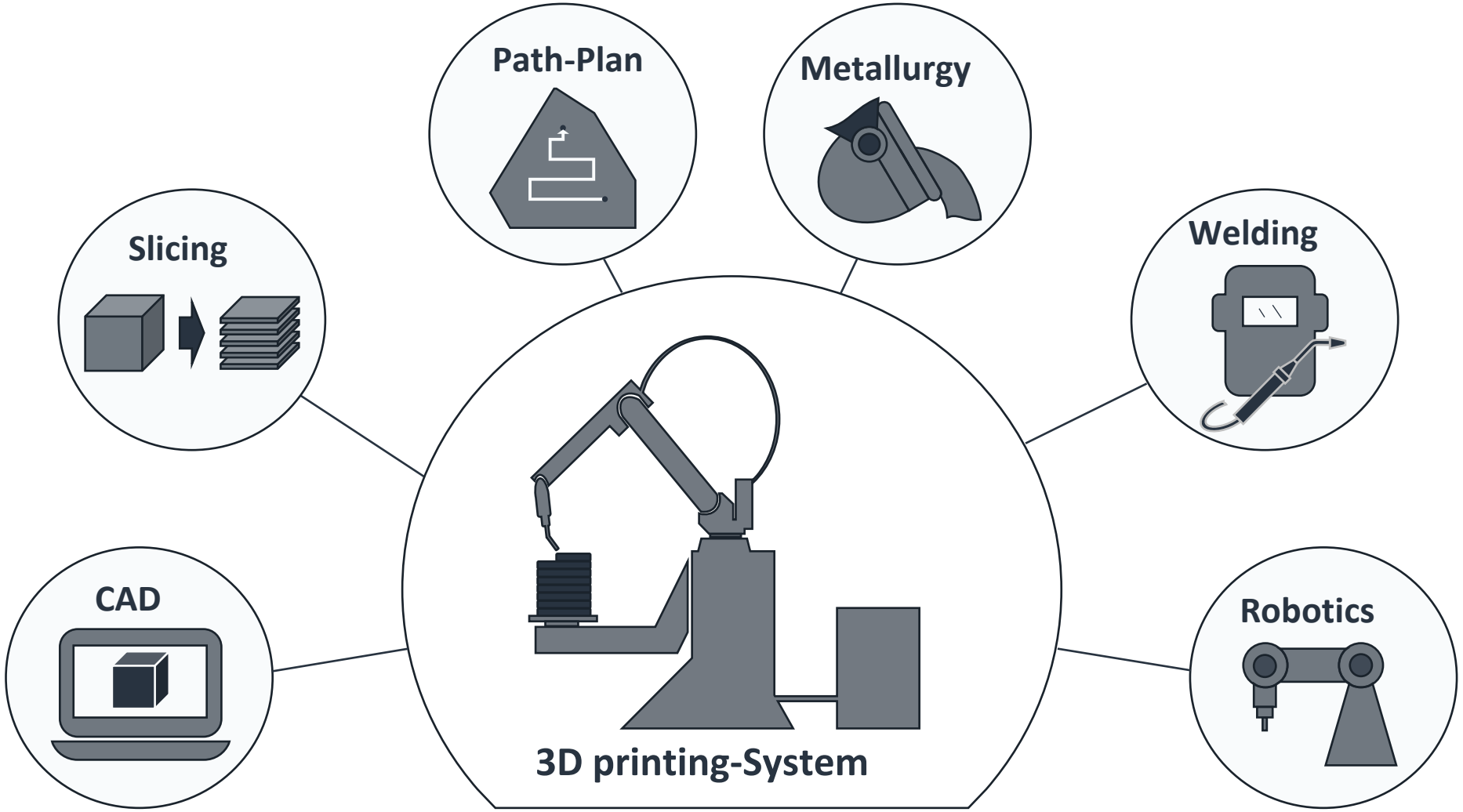
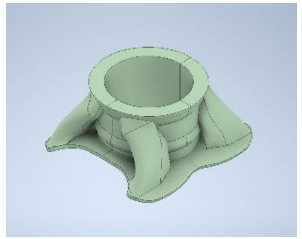


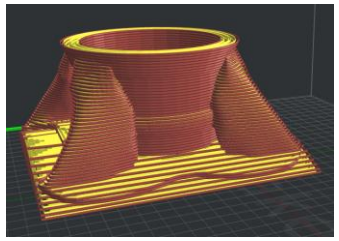
WAAM Workflow

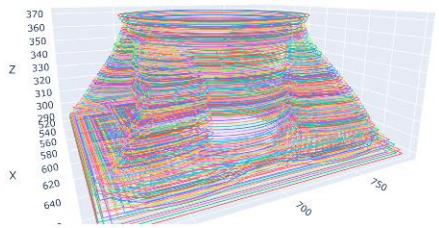
CAD-Model

Slicing

Path refactoring







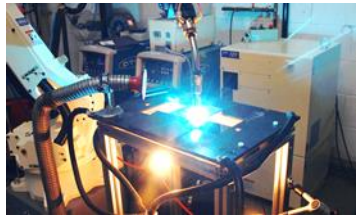
Digital

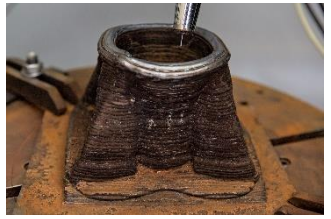
Analog

Printing

Raw component

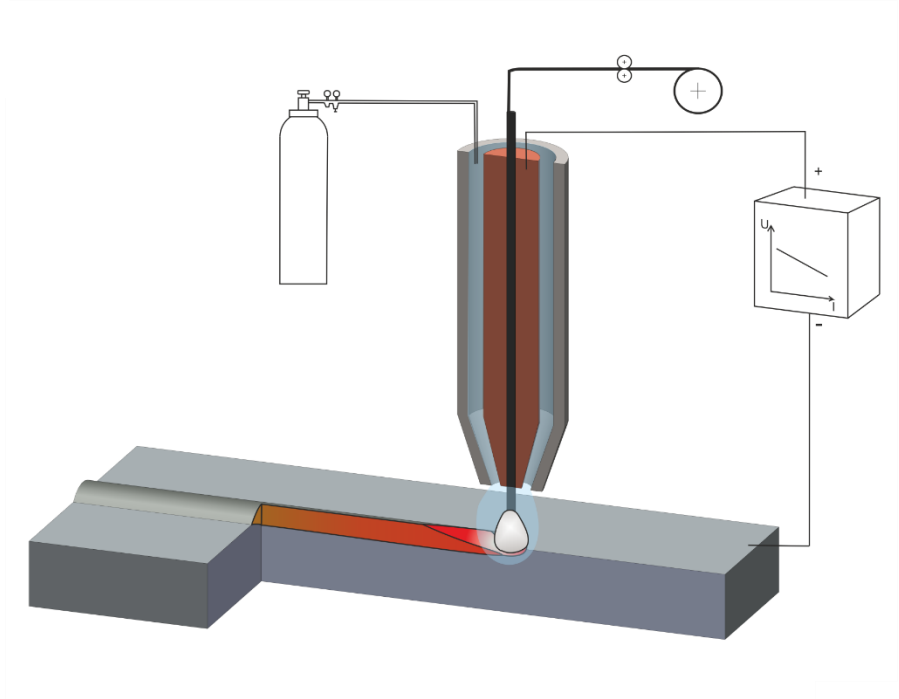
Post processing





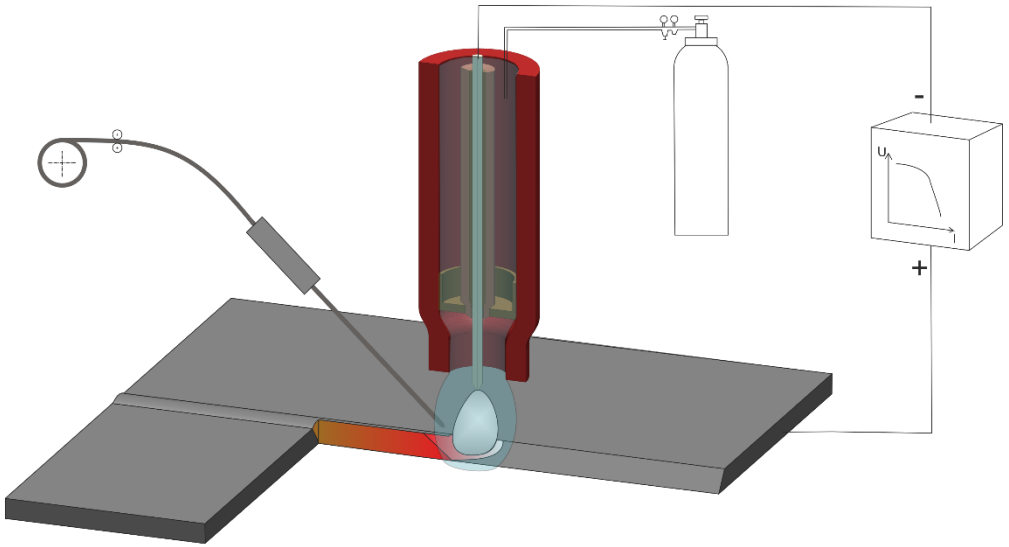
Arc welding processes

Gas Metal Arc (GMA) Welding



- High depostion rate
- Flexible
- Mainly used for steels and aluminium alloys

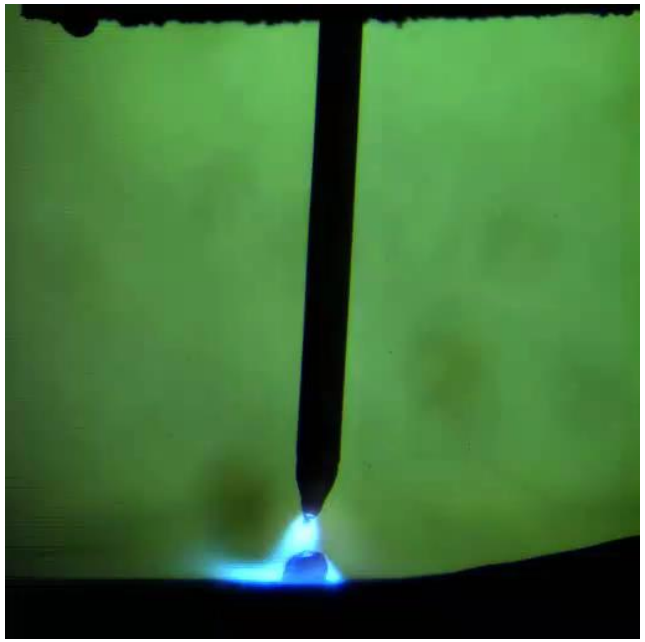
Tungsten Inert Gas (TIG) Welding



- Low deposition rate
- Lower flexibility
- Mainly used for high performance alloys

Arc welding processes

Gas Metal Arc (GMA) Welding



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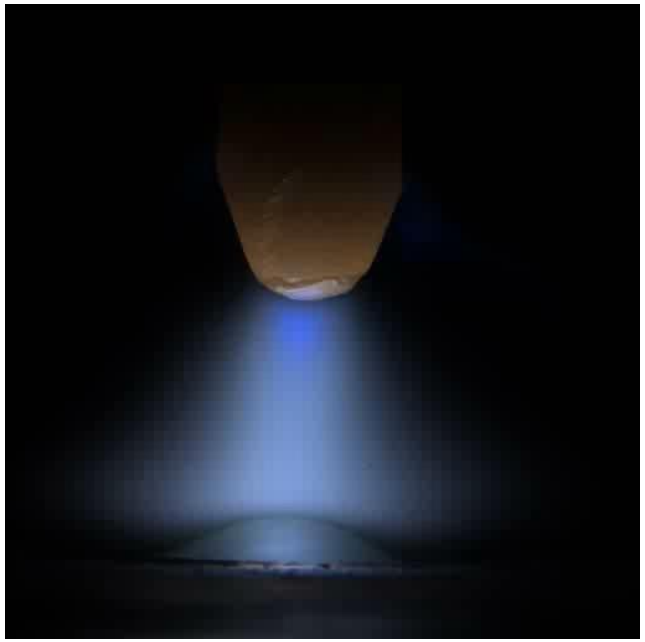
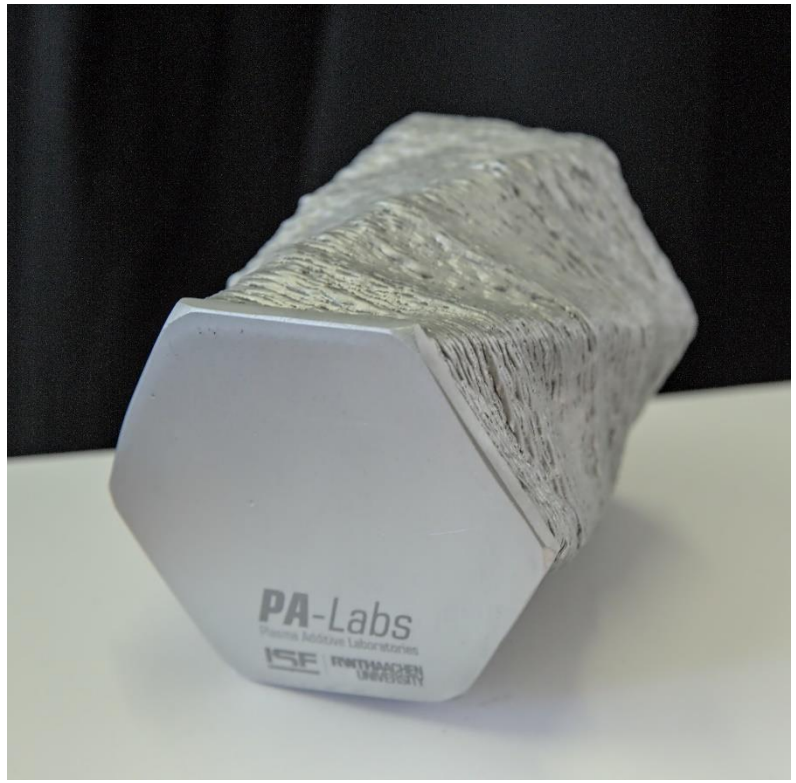


- Low deposition rate
- Lower flexibility
- Mainly used for high performance alloys

Challenges in processing Aluminum

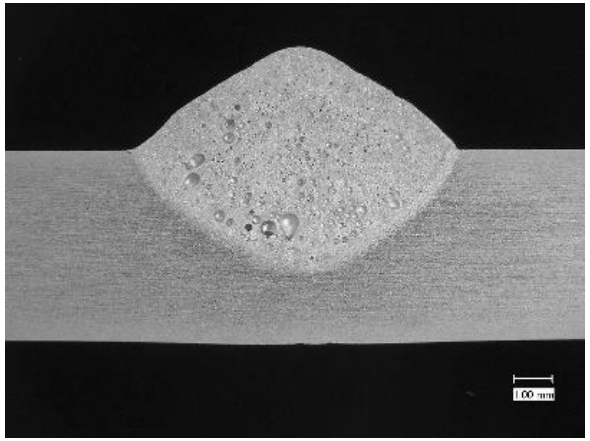
Compared to steels…

- Considerably lower melting point,
- Three times greater thermal conductivity,
- Twice the coefficient of expansion,
- Melting point of Al2O3 is considerably higher than that of aluminum,
- No phase transformation comparable to low alloyed steels.

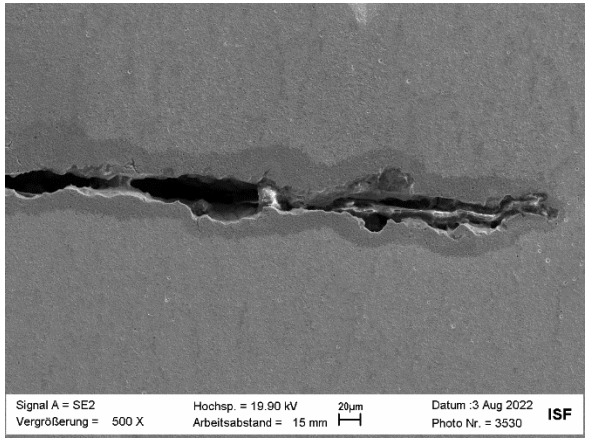


Challenges in processing Aluminium

Pores



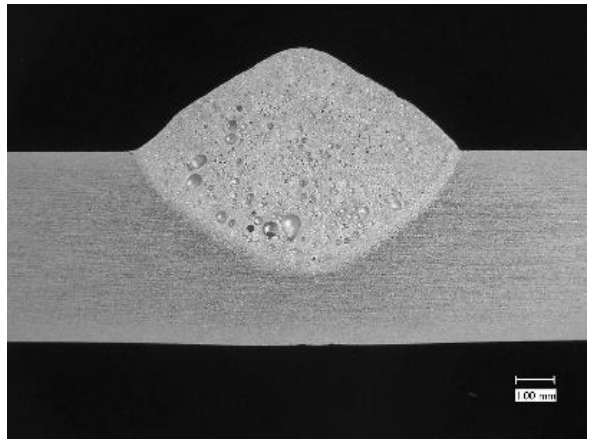
Hot Cracks



Lack of Fusion

Challenges in processing Aluminium

Pores



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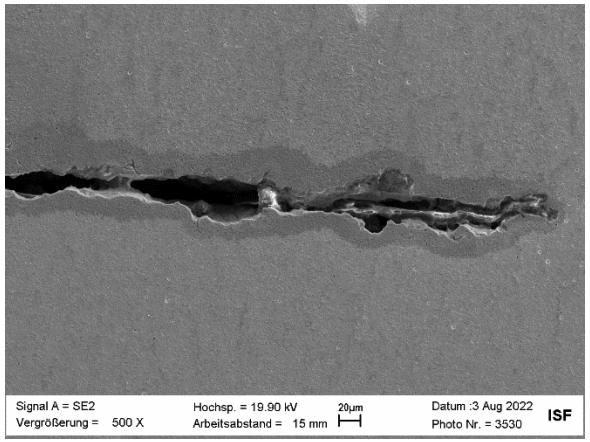
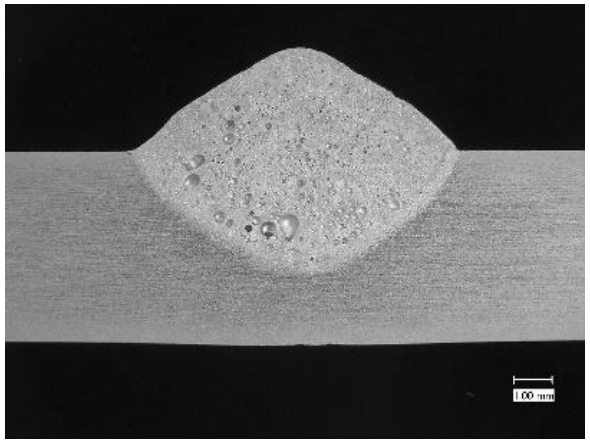


Lack of Fusion

- Can result in hydrogen induction into the molten pool
- Hydrogen source mostly the oxide layer of the welding wire
- Proper storage and the prevention of condensation mandatory
- Proper shielding gas atmosphere needs to be provided

Challenges in processing Aluminium

Pores



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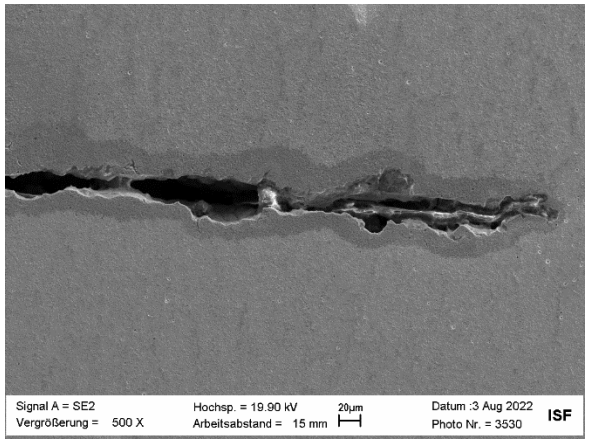
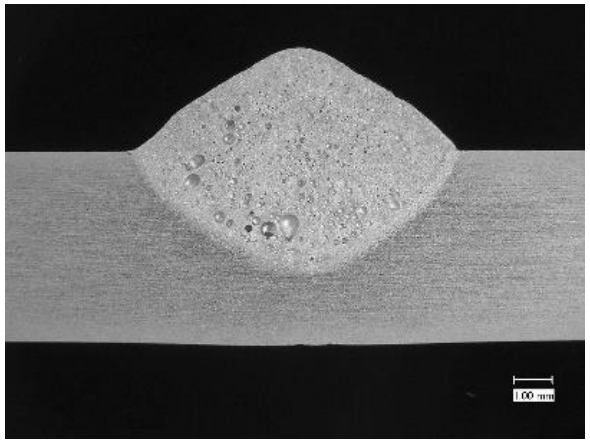


Lack of Fusion

- Results in high thermal expansion and high solidification interval.
- Especially precipitation hardenable aluminum alloys are sensitive.
- Reduced energy input and low inter layer temperature required.

Challenges in processing Aluminium

Pores



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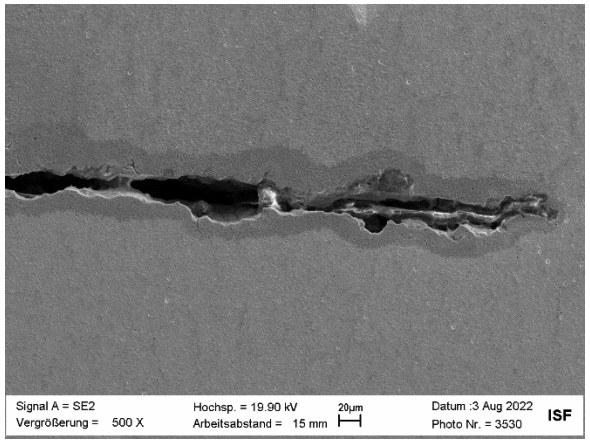
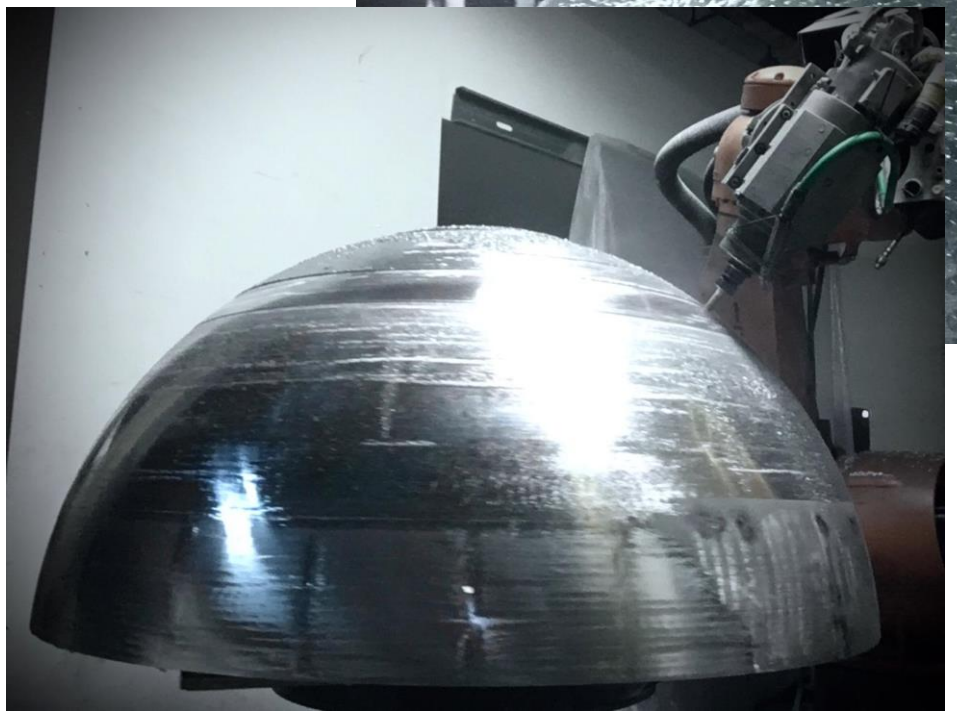


Lack of Fusion

- Oxidic layer hinders wettability of weld layers.
- Proper path planning and kinematic control of the process required.
- Defined energy input and increased energy density of the arc preferable.

What we do at PA Labs – Neoset Design “Death Star”

- Additive manufacturing of a sphere of 2 m diameter for an art exhibition.
- Full accompaniment of the project from the acquisition of hardware, over material choice to process parameters.
- WAAM Process embedded into a process chain, starting from raw material till surface finished final component.



What we do at PA Labs – Neoset Design “Death Star”

- Additive manu
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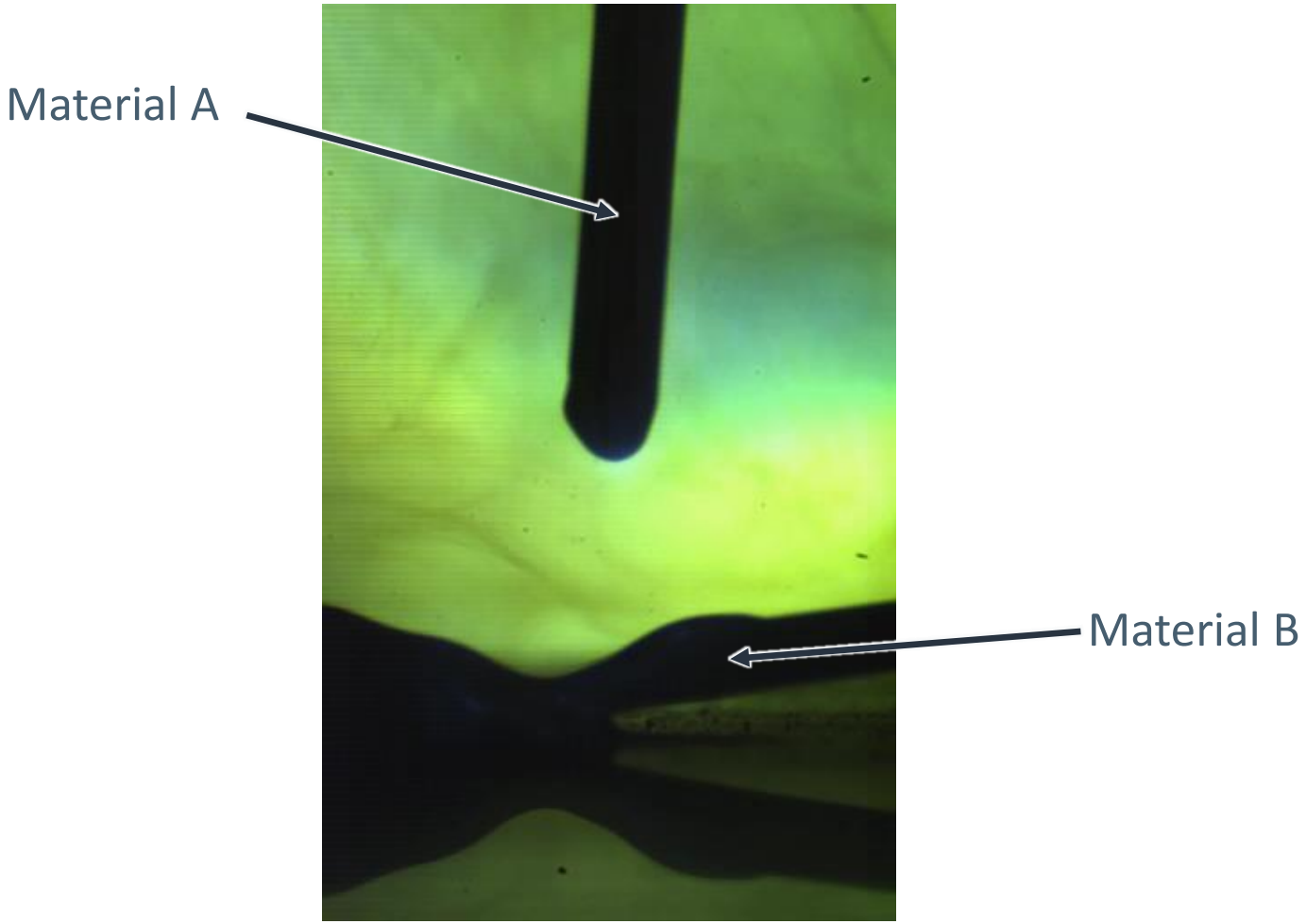
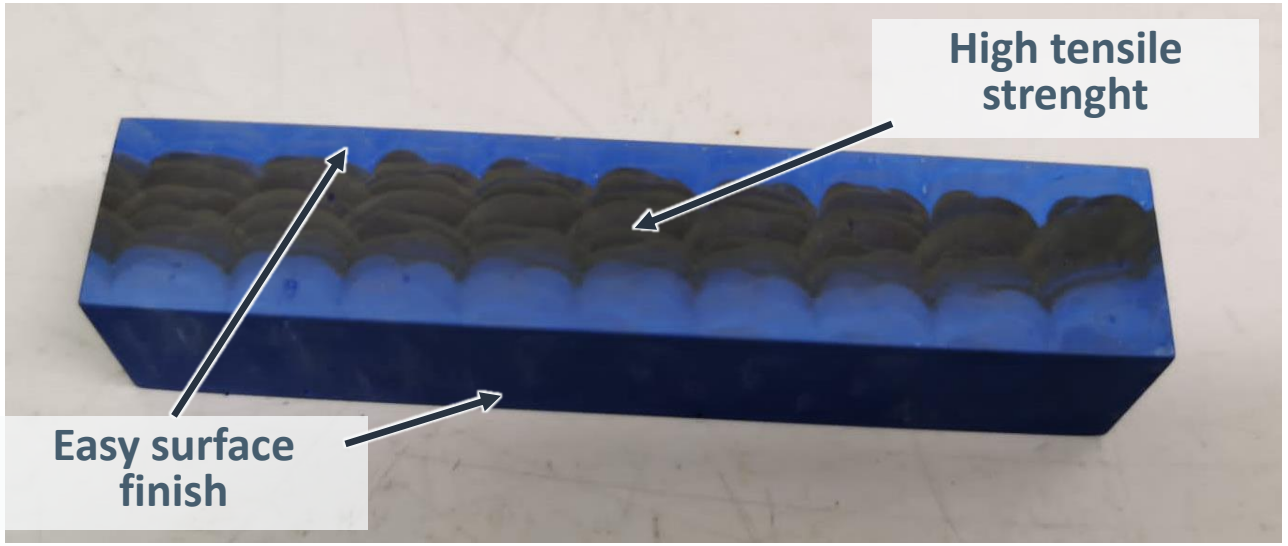
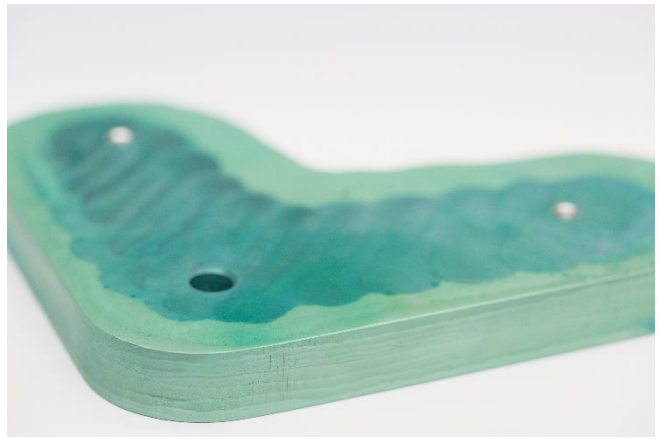
What we do at PA Labs – Multi material printing



What we do at PA Labs – Multi material blanks

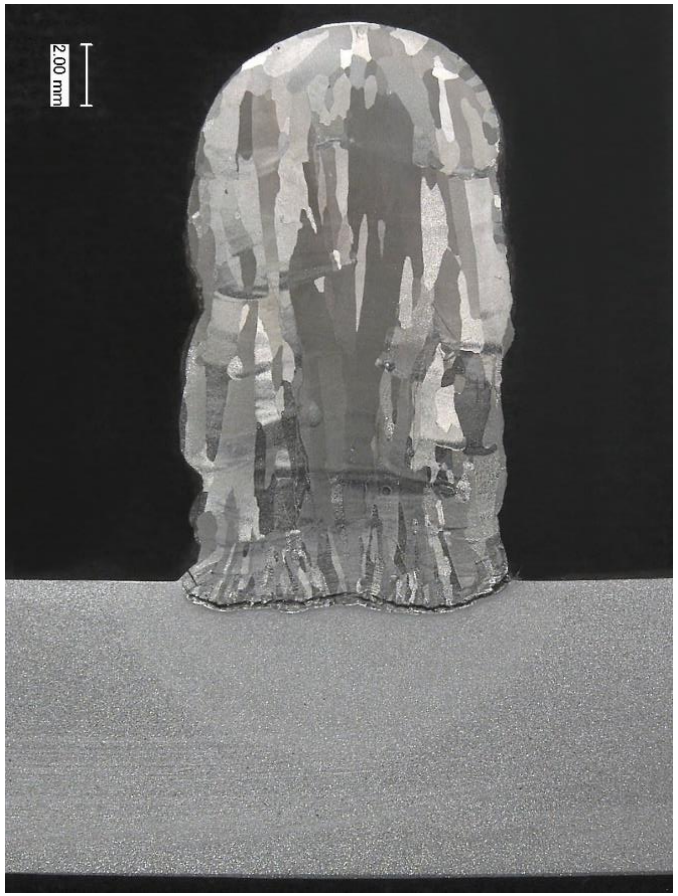
- Feasibility study for additive manufacturing of multi material components.
- High strength 2xxx alloy as infill in combination with surface material with good anodizability.
- Manufacturing of initial blank components for milling operations.





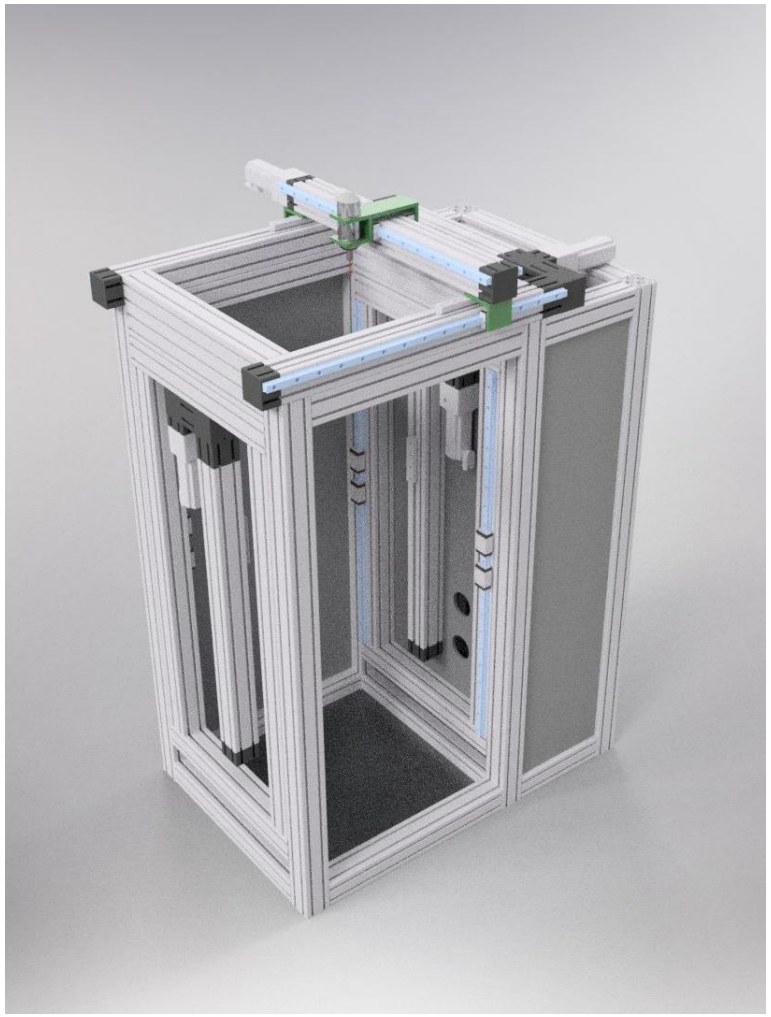
What we do at PA Labs – New materials by in-situ alloying

- Sample production for fundamental research projects at research institutes.
- Manufacturing of iron aluminides and titanium aluminides by in situ alloying.
- Manufacturing of test specimens for further material characterization.



Where are we heading?

- Integration of all the process knowhow in an industrial WAAM machine.
- Self developed control unit enables high automation level and easy usability.
- Enable high performance WAAM processes without the need for deep process knowledge.



Kontakt

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