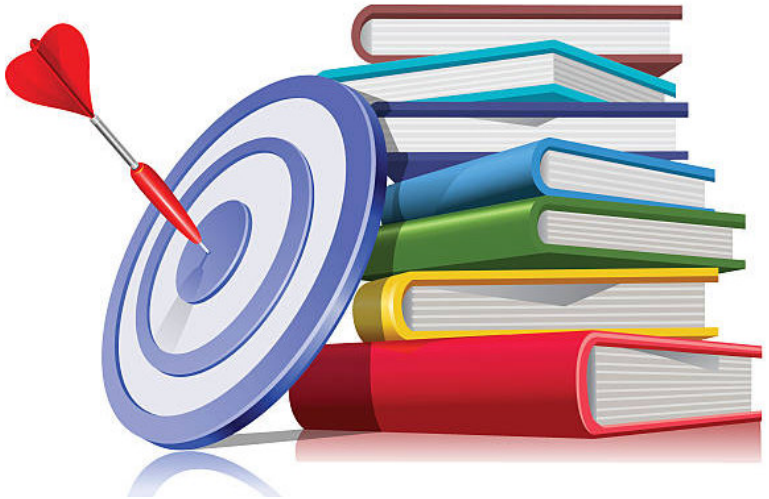
Advance Welding Techniques

Fronius India Private Limited , SasiAnand Parthasarathy, 18.01.2024

Objectives

- ✓ Comparison the various metals based on welding process
- ✓ Innovative Welding Process for Ferrous /Non Ferrous
  - GMAW Process-CMT
  - CMT AC
  - Robotic Welding - PMC for Stainless Steel
  - DED Arc + Additive Manufacturing on Stainless Steel
  - Cycle Tig
  - TIG Dynamic Wire
  - PAW-Plasma Arc Welding Process
  - ✓ Conclusions



Comparison-Joining

Base Material/Process	TIG	Plasma	GMAW
Aluminum and Aluminum alloys	Very Good	Not Satisfying ,k↑	Very Good
Carbon steel	Good	Good	Good
Zinc coated material	Not Satisfying	Good	Good
Stainless Steels	Very Good	Very Good	Very Good
Nibas Alloys	Good	Good	Good
Copper & Alloys	Good	Satisfying	Good

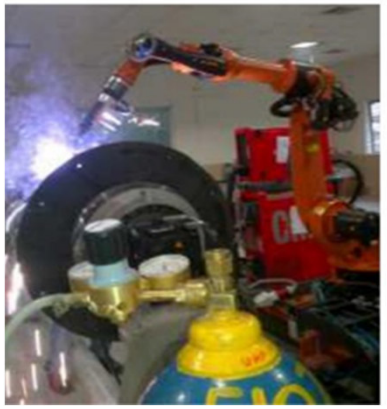
Gas Metal Arc Welding

Cold Metal Transfer

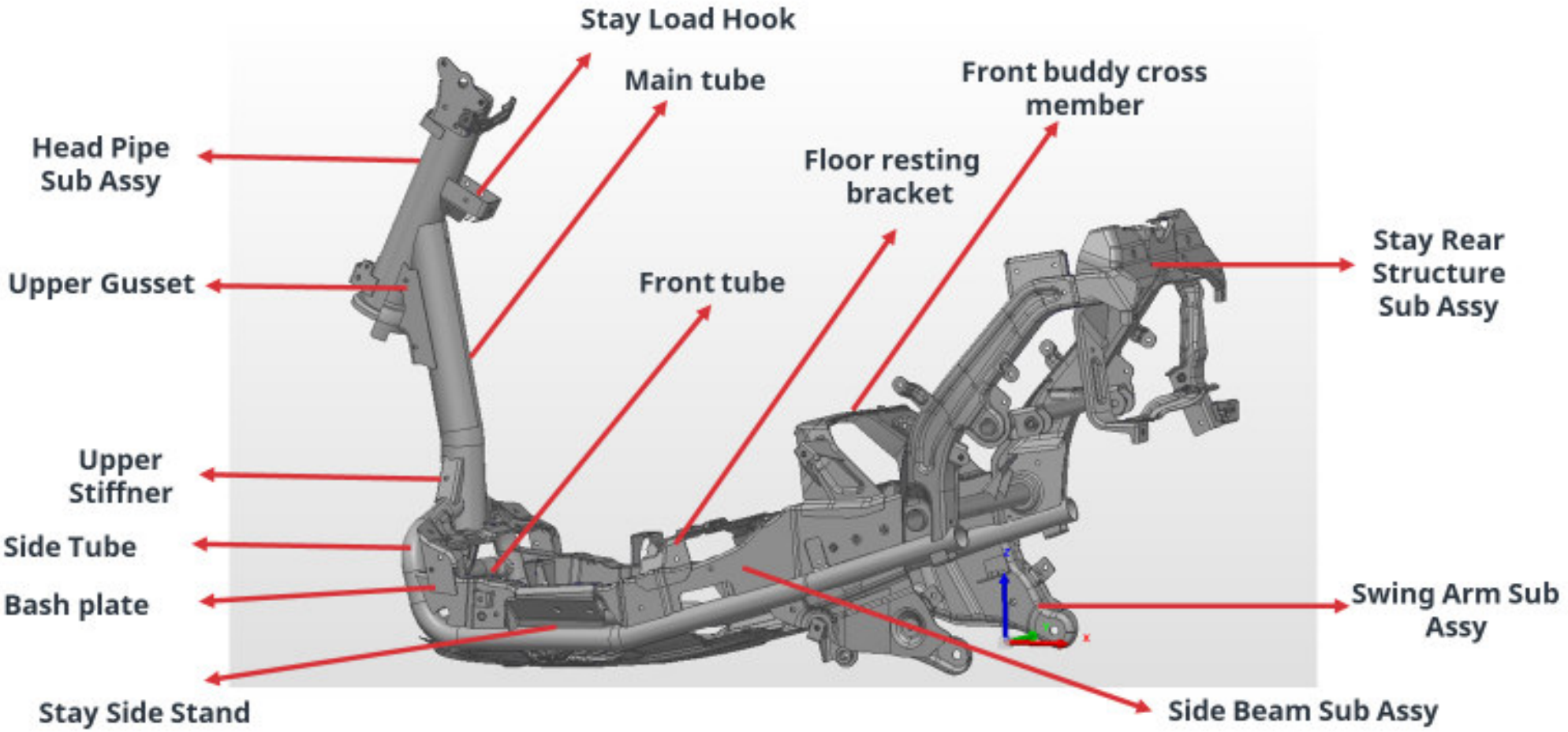
- Low Heat Input
- Stable Arc
- Used Everywhere in Every Position
- Can Join Dissimilar Materials
- Low Current
- Spatter Free

CMT Aerospace Application

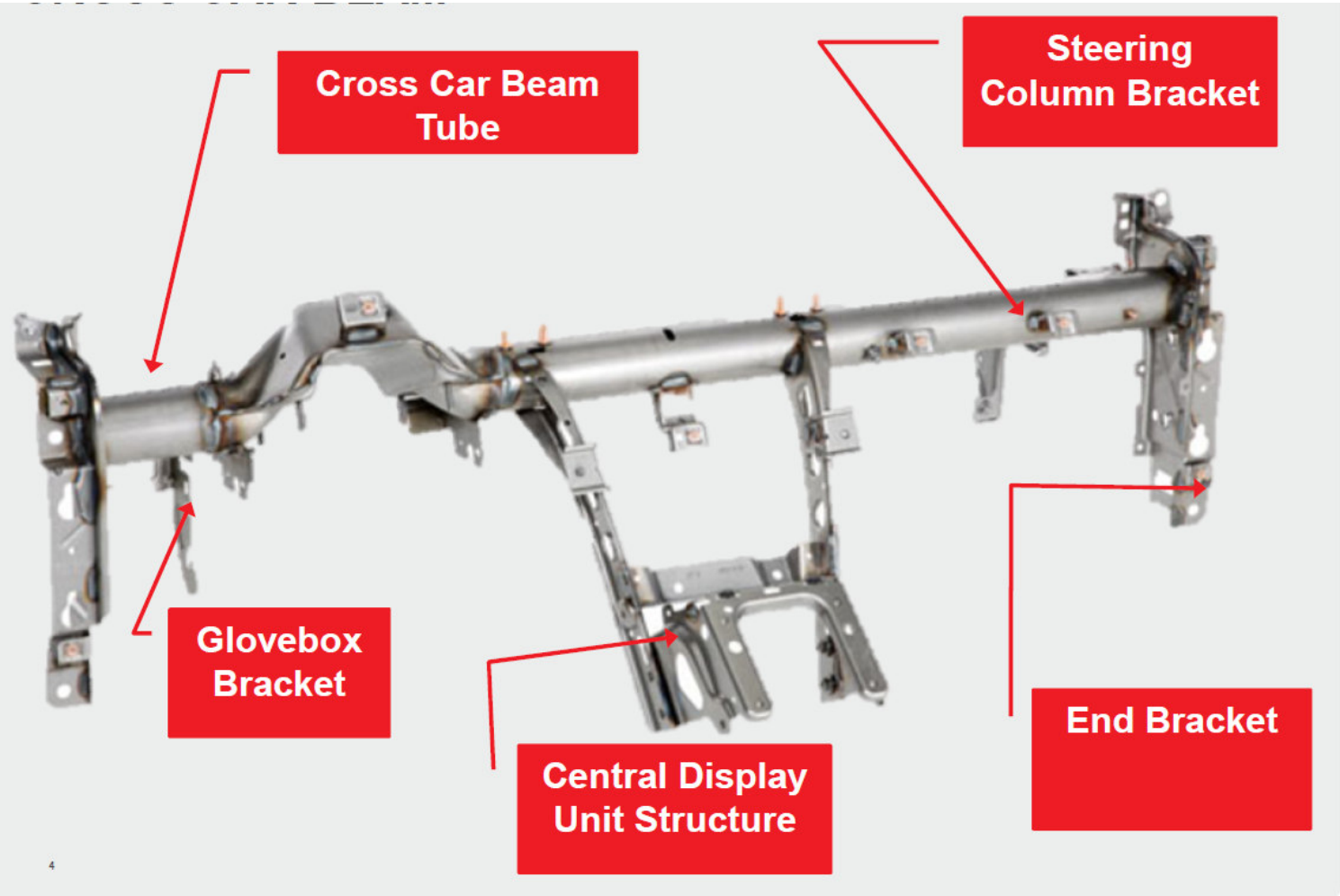
- GMAW process for Al 2219 grade material welding With Fronius TPS 5000CMT .
- Thickness range : 2 to 15mm
- Filler wire : Al 2319, 4043, 5356 (1.2mm to 1.6mm)
- Gas : Argon , Argon+ He mixture, He , etc
- Process modes : CMT, Pulsed, Pulse with synchropulse.
- Travel speed : 1.0mtr /min
- .



CMT Automotive Application



CMT Automotive Application



Pulse Multi Control (PMC)

- PMC Special Processes are additional synergic lines under PMC that have been created to reduce heat input and provide good cosmetic appearance. All of the processes can be optimized using the „Process Mix“ menu under the „Process Parameters“ tab.

- PMC Mix – alternating cycles of PMC and LSC-Low Spatter Control
- PMC Mix Drive – PMC with an induced adjustment phase and a wire retraction
- PMC Ripple Drive – PMC and a stop in wire feeding which extingushes the arc

PMC Process

MIG/MAG AC-Processes

MIG/MAG AC-Processes

The intelligent MIG/MAG AC-Solution

The Fronius MIG/MAG welding packages “PMC” and “CMT” reverses the wire polarity.*

1 **PMC AC**

2 **CMT AC**

***available on the iWave AC/DC with Multiprocess Pro**

MIG/MAG | System requirements

OPT/i Multiprocess Pro

iWave AC/DC 300-500A

Welding Package

WELDING PACKAGE PMC

or

WELDING PACKAGE CMT

AC synergic lines automatically available as characteristic

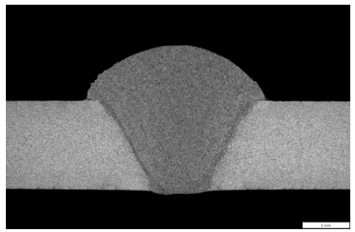
MIG/MAG | PMC AC

An additional polarity change has been implemented to the modified pulse characteristic "PMC".

- The process is optimally suited for welding thin and ultra-thin sheet metals.
- Due to the polarity change, an even lower heat input is generated by maintaining the same deposition rate.
- With the **AC-power balance** correction, the negative and positive phase ratio can be easily adjusted.

MIG/MAG | PMC AC | AC-power balance for aluminum and CrNi-steel

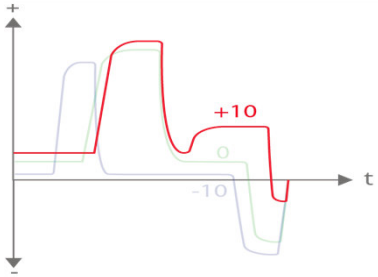
Due to the AC-power balance the heat input can be adjusted individually and precisely for each application.

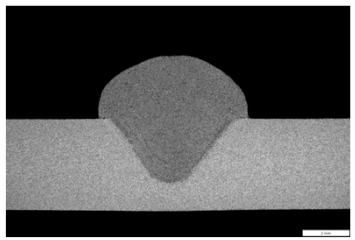


+10

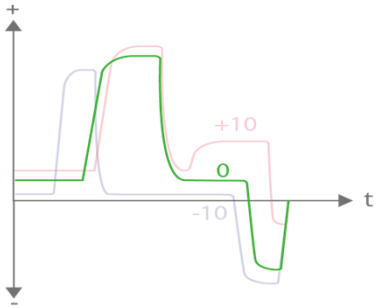
Increasing **the AC-power balance**

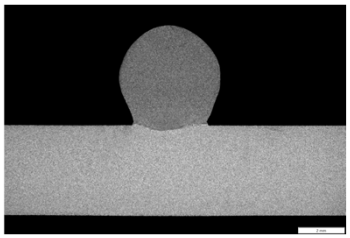
- increases positive phase current
- heat input is increased





0 **Standard setting**

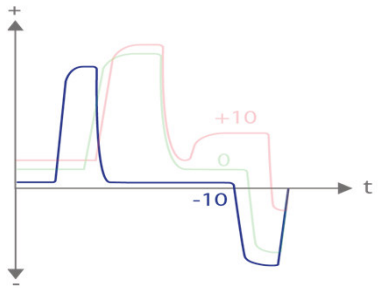




-10

Decreasing **the AC-power balance**

- increases negative phase current
- heat input is decreased



All welds have been welded at the same working point (wfs) and therefore with the same deposition rate.

MIG/MAG | PMC AC | Advantages

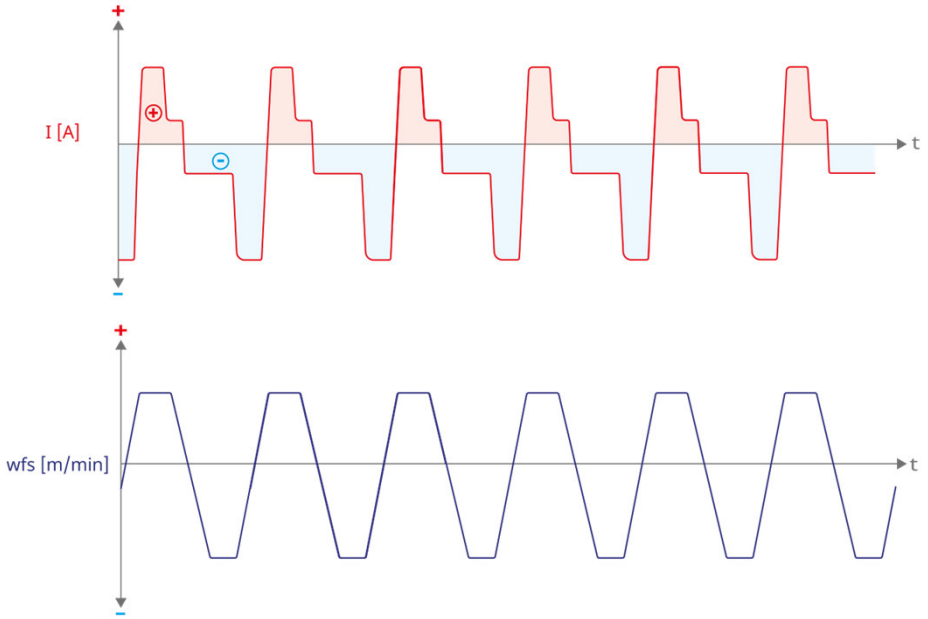
- Simplifies manual welding of very thin sheet metals
- Less heat input compared to DCEP (DC+)
- Very good gap bridge ability
- Shiny welds due to reduced Magnesium burn-off (especially when AlMg/ 5XXX series wire is used)
- Less welding fume emissions

Enhanced gap bridge ability possible.

MIG/MAG | CMT AC

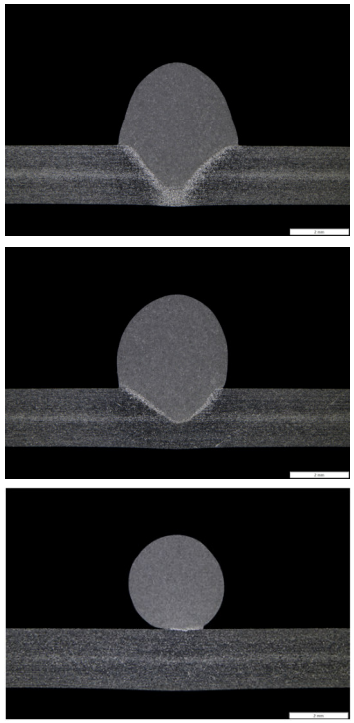
The Fronius process with the lowest heat input!

- The CMT forward backward motion characteristic combined with an additional polarity change.
- Due to the polarity change, an even lower heat input is generated by maintaining the same deposition rate.
- Precise controllable heat input.
- Perfectly suitable for additive manufacturing



CMT AC | AC-Power Balance for aluminum

Due to the AC-power balance the heat input can be adjusted individually and precisely for each application.



+10

Increasing **the AC-power balance**

- increases positive phase time
- heat input is increased

0

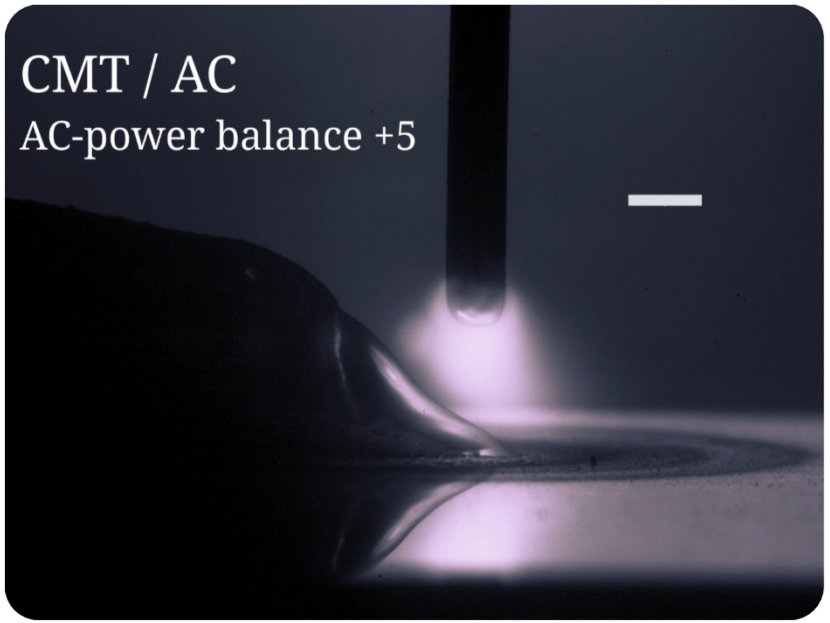
Standard setting

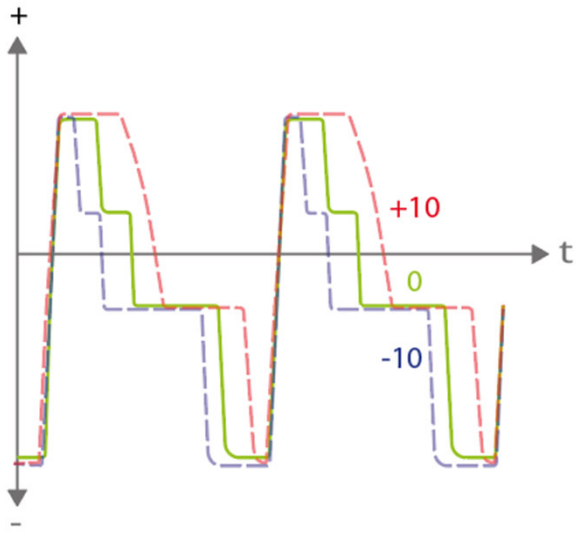
-10

Decreasing **the AC-power balance**

- increases negative phase time
- heat input is decreased

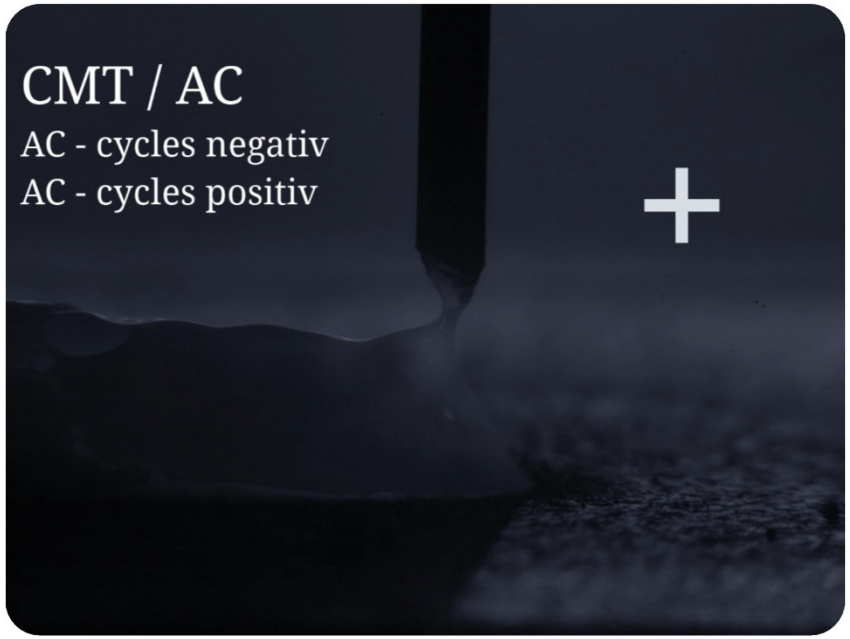
Material	Parameter	Range
Aluminum	AC-Power Balance	-10 ... +10





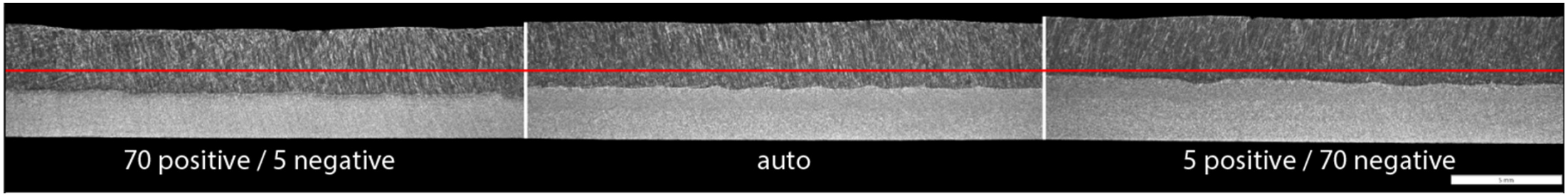
All welds have been welded at the same working point (wfs) and therefore with the same deposition rate.

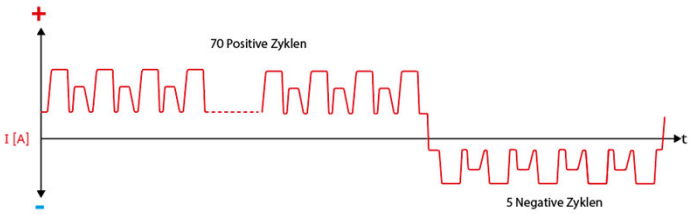
CMT AC | AC-cycles positive negative for steel & CrNi-steel

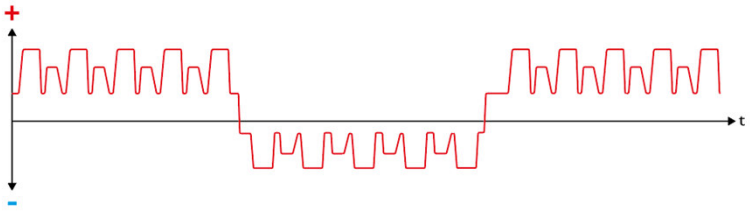


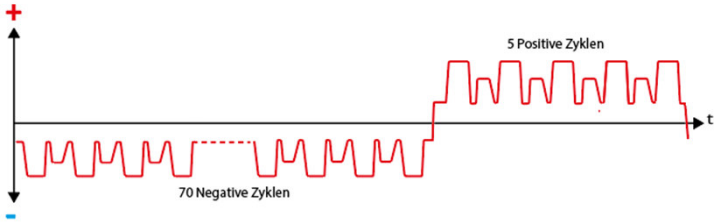
The parameter AC-cycles allows to set the amount of positive and negative cycles individually.

Material	Parameter	Range
Steel & CrNi-steel	AC-cycles positive	1 ... 100
	AC-cycles negative	1 ... 100







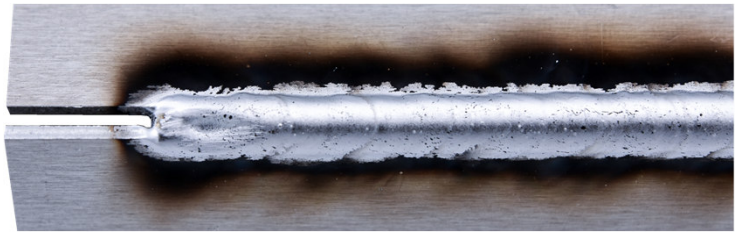


MIG/MAG | CMT AC | Advantages

- Very good gap bridge ability
- Highly controllable heat input, especially for additive manufacturing applications
- Shiny welds due to reduced Magnesium burn- off (specially when AlMg/ 5XXX series wire is used)
- Process with the lowest welding fume emissions

CMT AC

Filler: AlMg4.5/ 5XXX series



CMT DC+

DED Additive Manufacturing -SS

Red Hot condition

After cooling

Before Machining

After Machining

NEW

Definition & CycleTIG in SS

NEW

Definition & where does CycleTIG work

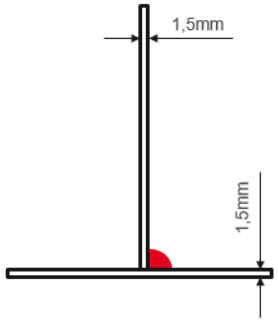
- CycleTIG is based on interval welding. It allows to combine different parameter configurations which makes TIG welding simple and easy to work with.
- CycleTIG is a process variation for DCEN welding.

Advantages of CycleTIG

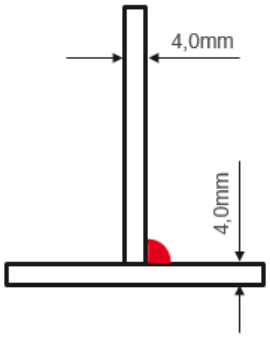
Advantages of CycleTIG

- **Easy control of weld puddle:** due to the short weld time the weld puddle can be controlled easily and burn through is avoided especially on corner and butt joints.
- **Can be combined with the Pulse and TACKING function:** in combination with the TACKING function an excellent seam appearance can be easily achieved.
- **Targeted heat input:** due to a low “interval time”, low or no “base current” and increased “interval break time” setting an aimed heat input is generated which allows to build up corners e.g. repair welds on die casting molds.
- **Less tempering colors:** results in less rework.
- **CycleTIG** allows to set Pulse parameters via ms (milliseconds) and absolute values.

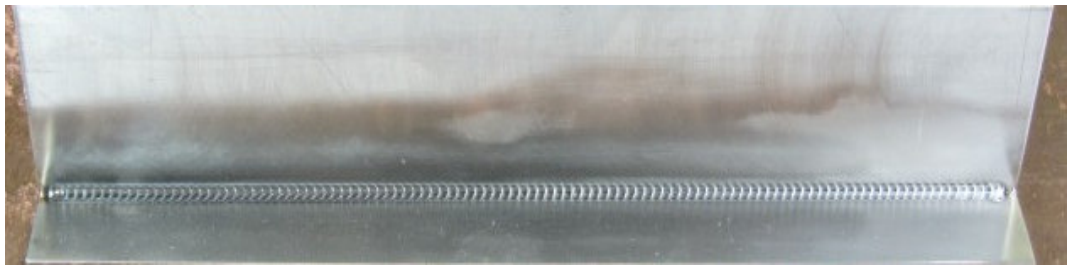
Stainless Steel -1.5 & 4.0 mm

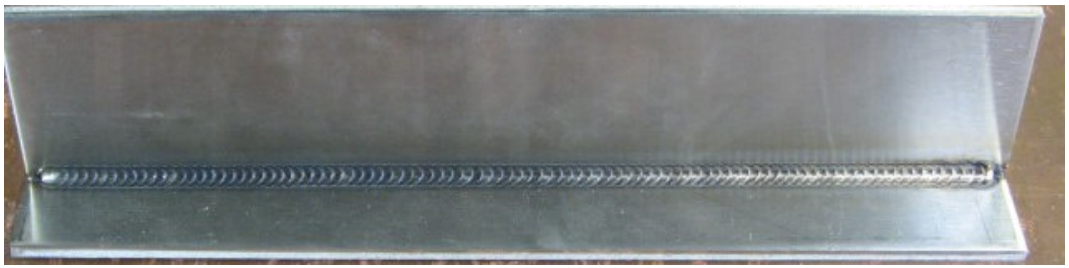


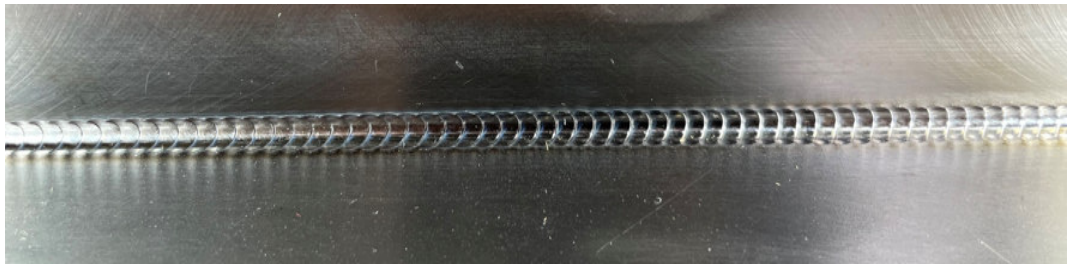
Stainless Steel -1.5 mm

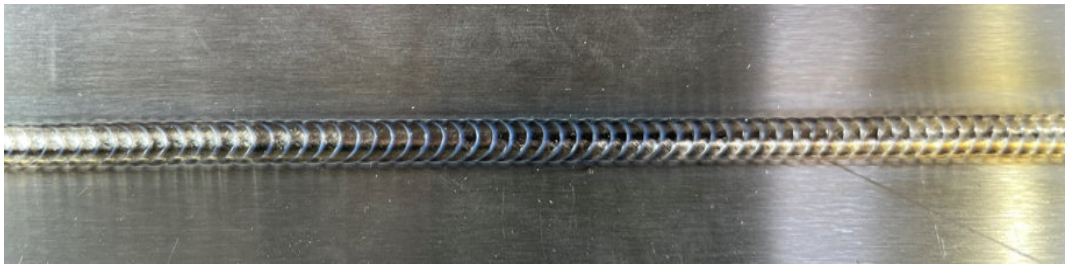


Stainless Steel - 4.0 mm

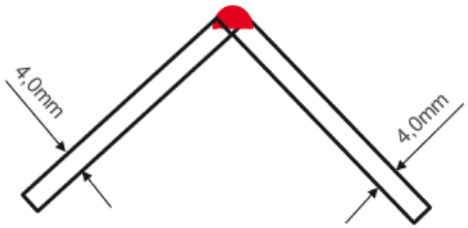


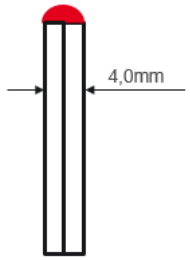


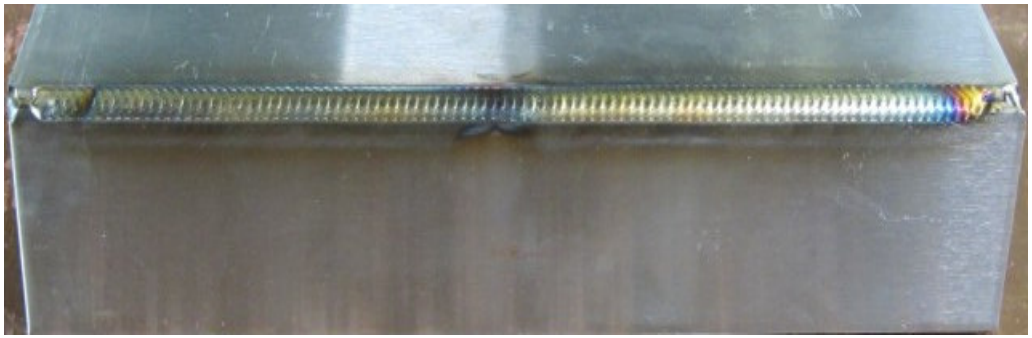


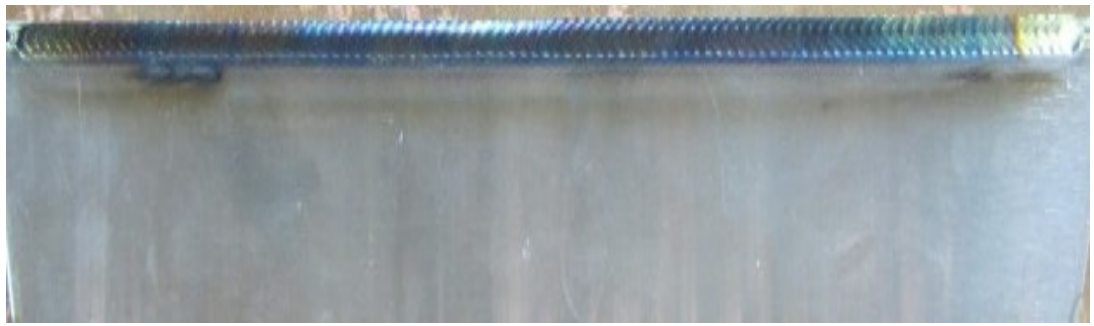


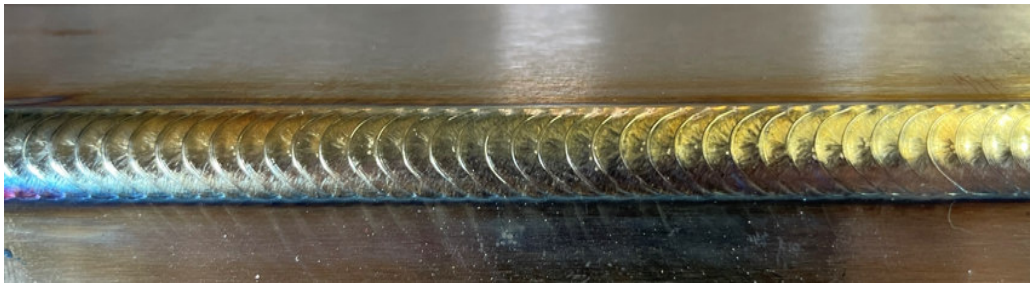
SS – Corner & Edge Joint

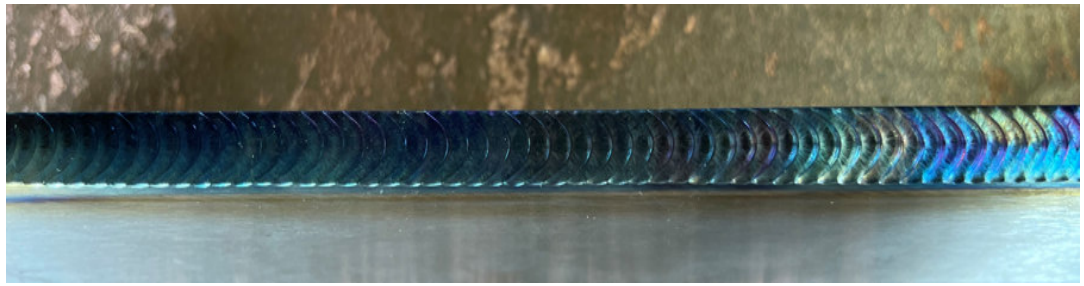






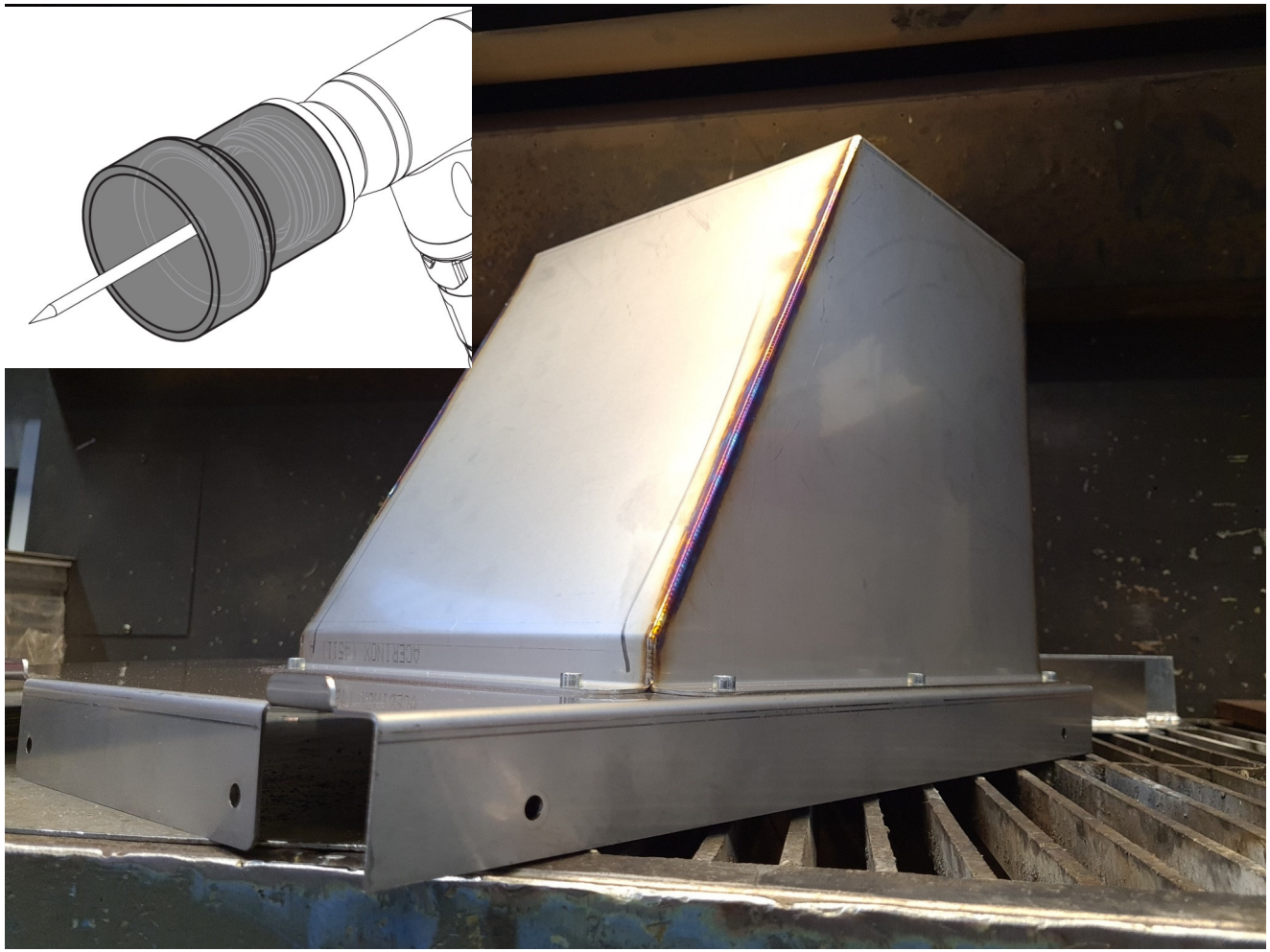


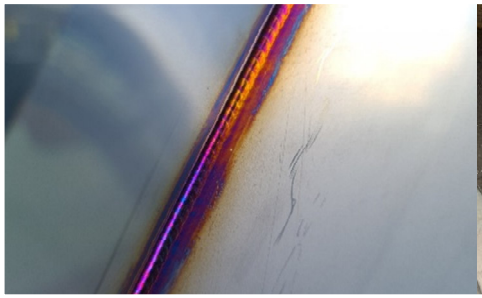


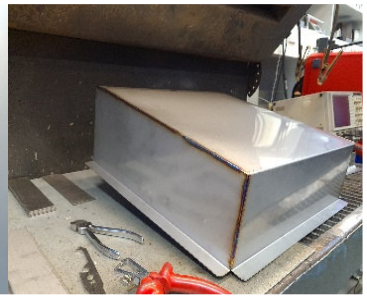


CycleTIG on Stainless Steel

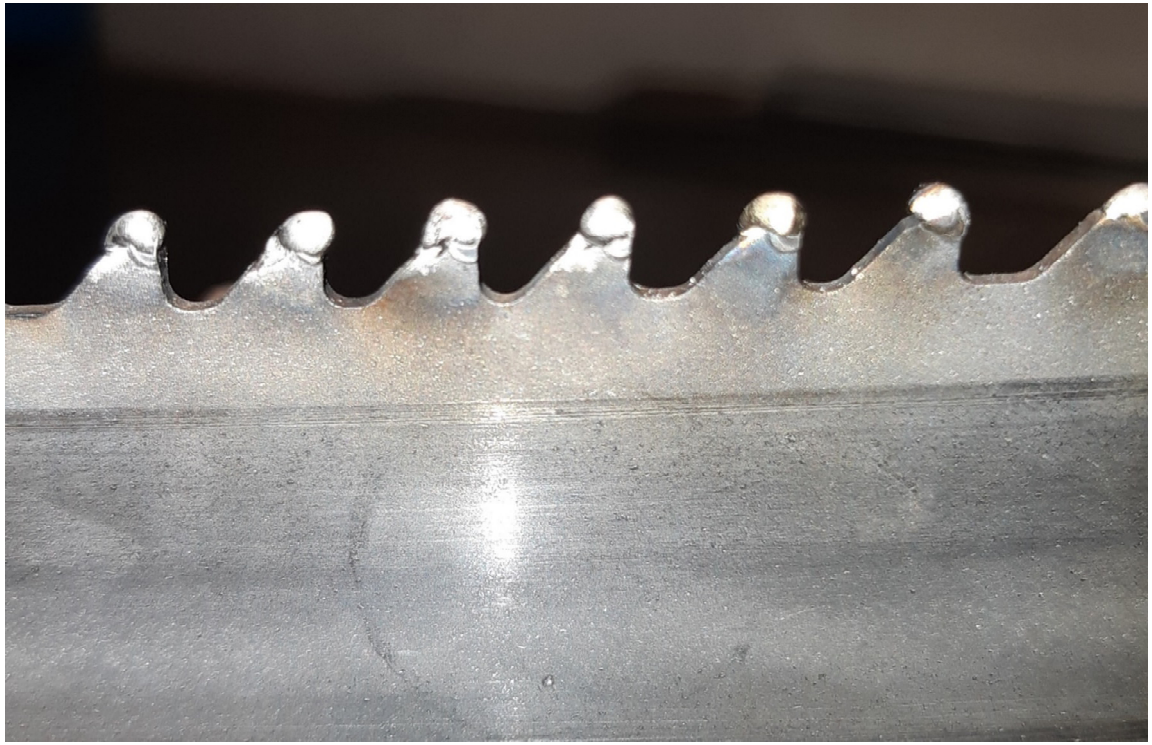
Material: **CrNi steel 1.4301**
Material thickness: **1mm**
Main current: **63A**
Base current: **3A**
Interval time: **0.2s**
Interval pause time: **0.7s**
E: **0.778 kJ/cm**
Champagne gas nozzle: **15 l/min**





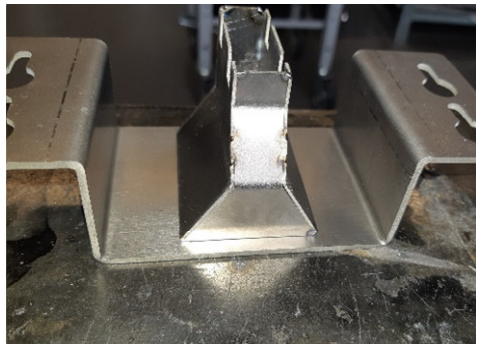


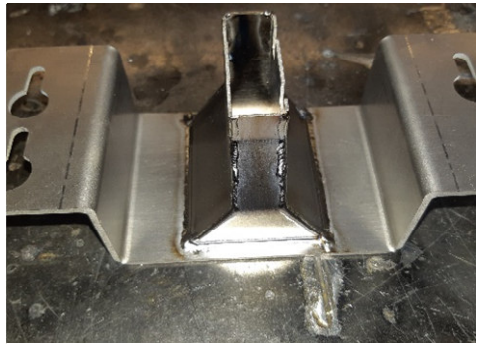
CycleTIG – Edge Application



Main current: **230A**
Base current: **off**
Interval cycles: **3**
Interval time: **0.02 s**
Interval pause time: **0.02 s**
Pulse frequency: **100 Hz**
E: **0.027 kJ/cm**
Champagne gas nozzle: **15 l/min**
Electrodes ø: **1.6 mm WC**

CycleTIG Titanium





Material: **Titanium Grade 2**
Material thickness: **2 - 1.3mm**
Main current: **65A**
Basic current: **3A**
Interval time: **0.2s**
Interval pause time: **0.45s**
Interval cycles: permanent
E: **7.6 kJ/cm**
Champagne gas nozzle: **15 l/min**
Tungsten electrode: **ø 1.6mm WC**

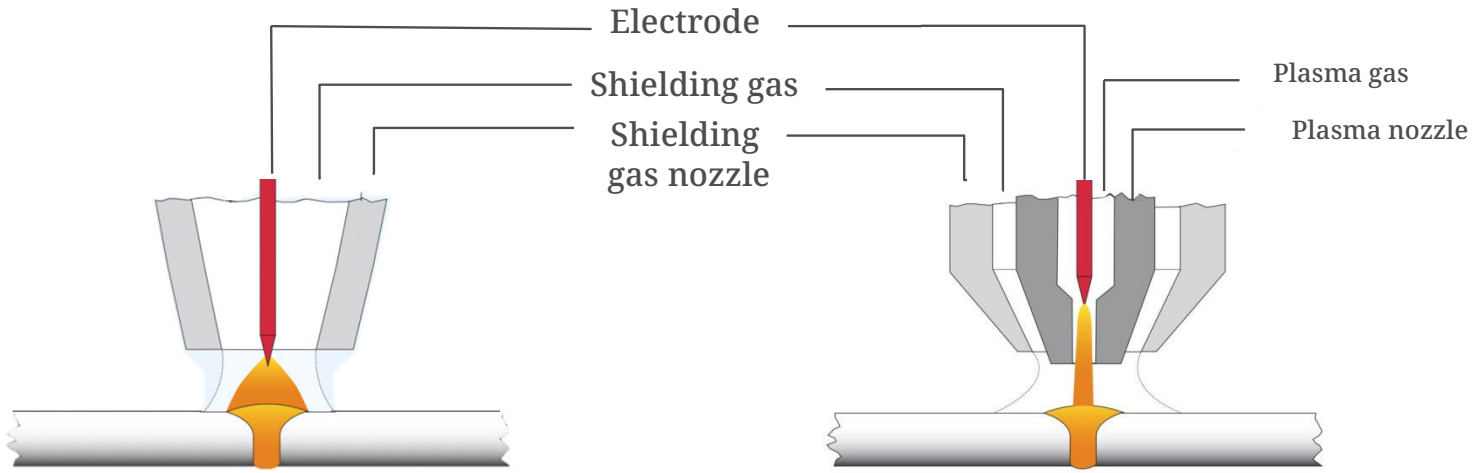
TIG DynamicWire

- TFC/Tungsten Fast Clamp System
- Automatic Self Regulation of Wire Feed Speed
- Component Compensation up to 30%
- Simplify Training of Arc Welders

WATCH VIDEO

Plasma Arc Welding

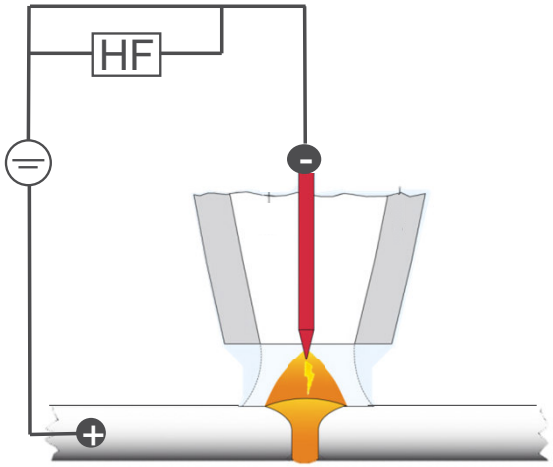
Principle



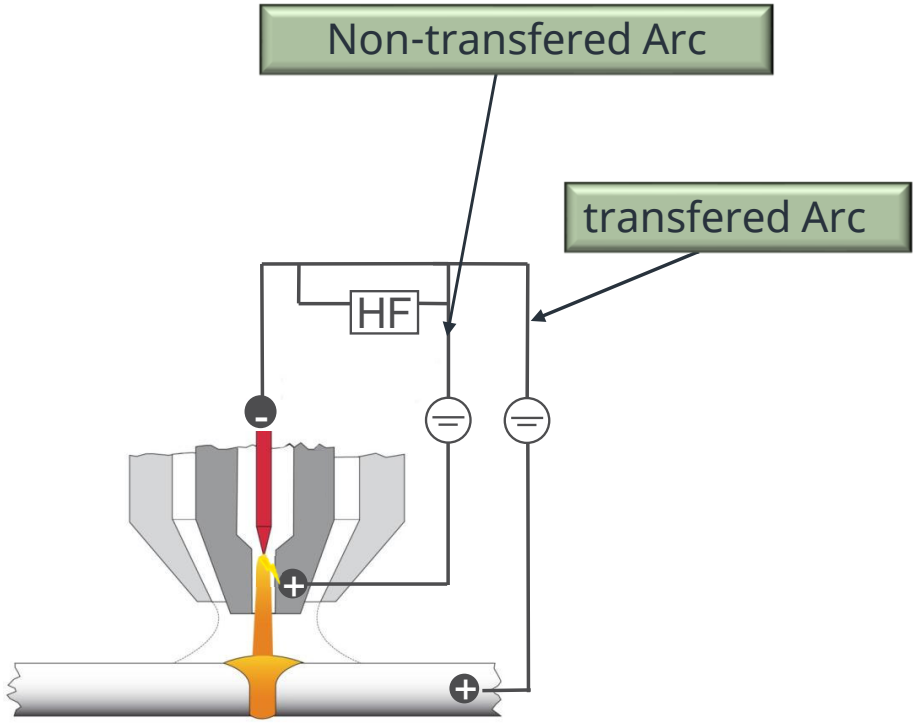
TIG

PLASMA

Principle



TIG



PLASMA

Processes of Plasma technology

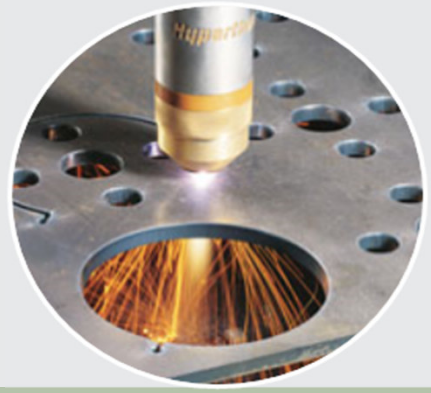
Joining

- Micro-Plasma
- Soft-Plasma
- Keyhole-Plasma

- Plasma Brazing
- Plasma MIG Welding
- Plasma Powder Welding

Cutting

- Plasma cutting on air
- Plasma cutting under water
- Plasma gouging

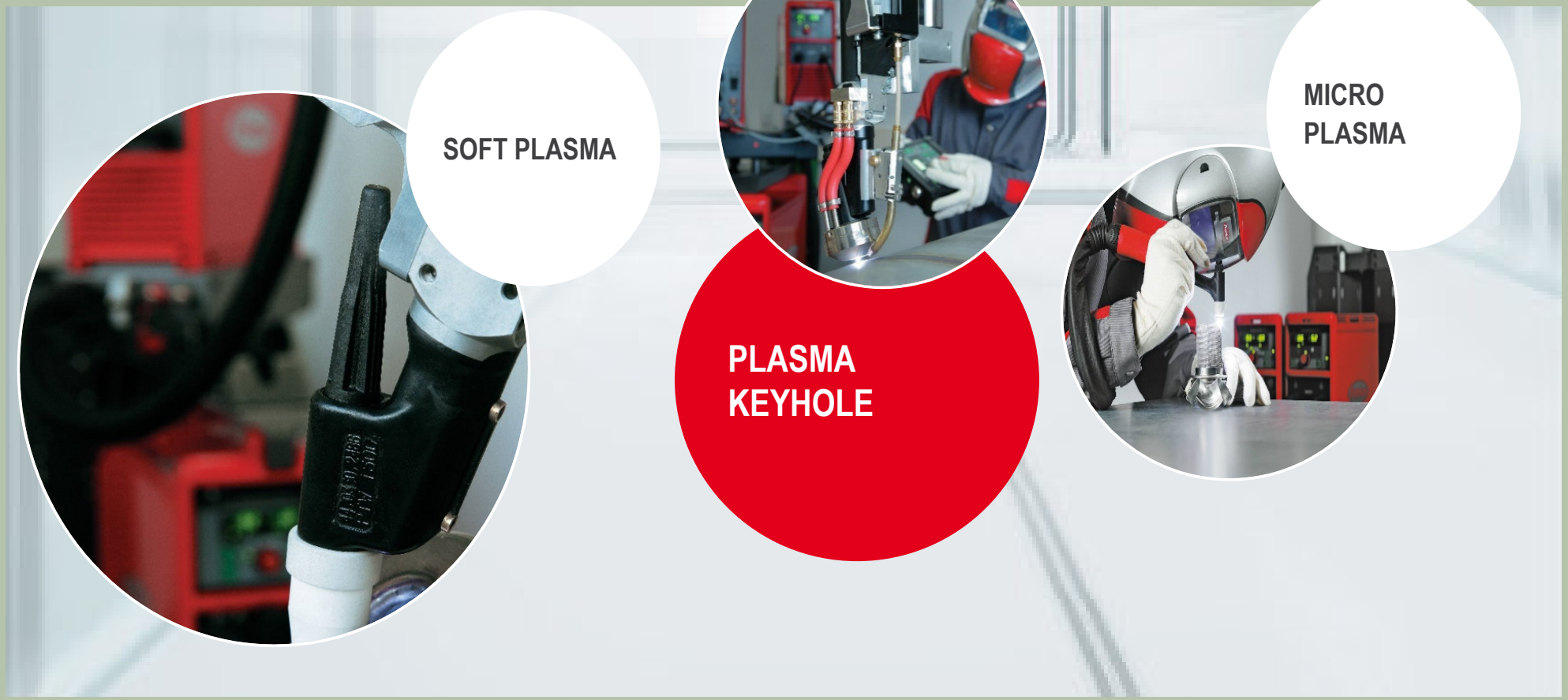


Cladding

- Plasma powder welding
- Plasma hotwire welding

- Plasma spraying
  - Powder
  - Wire

Plasma Welding

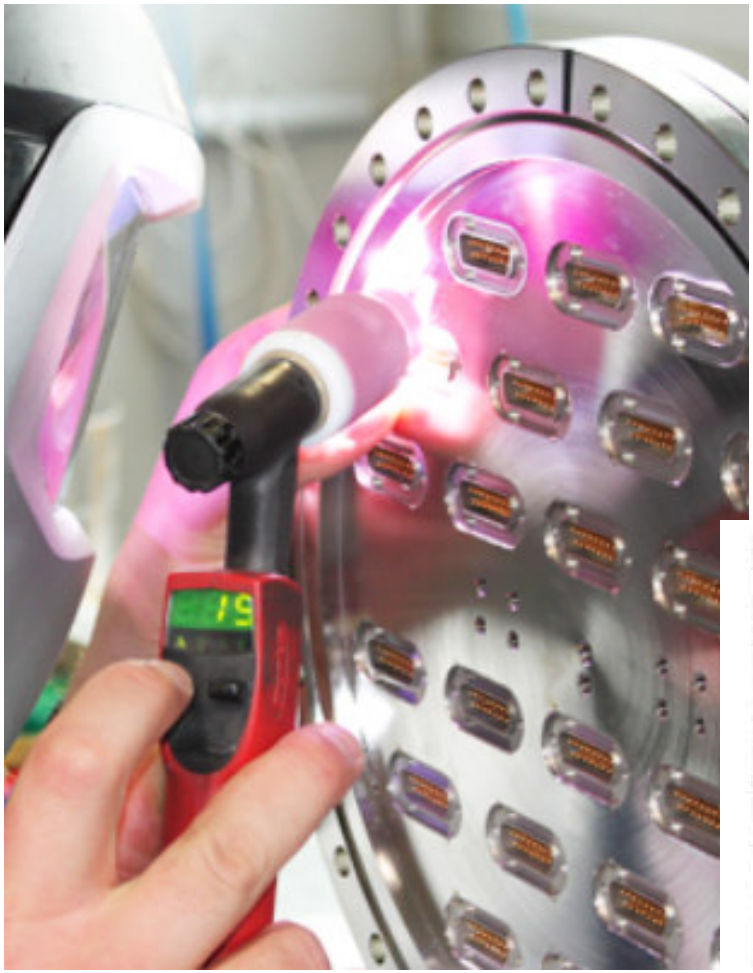


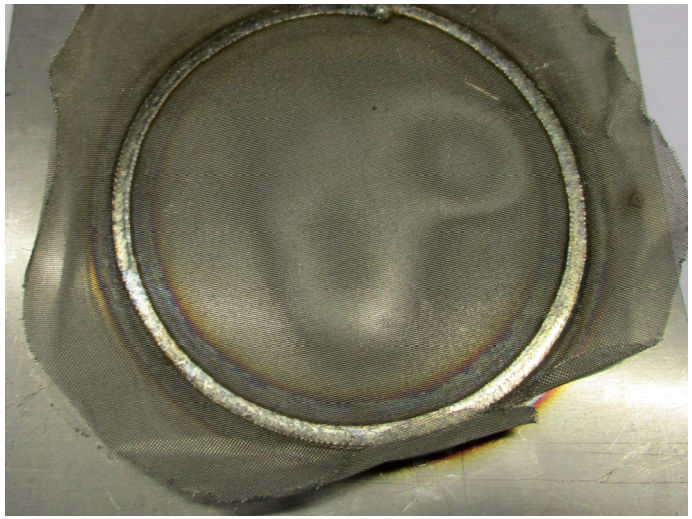
SOFT PLASMA

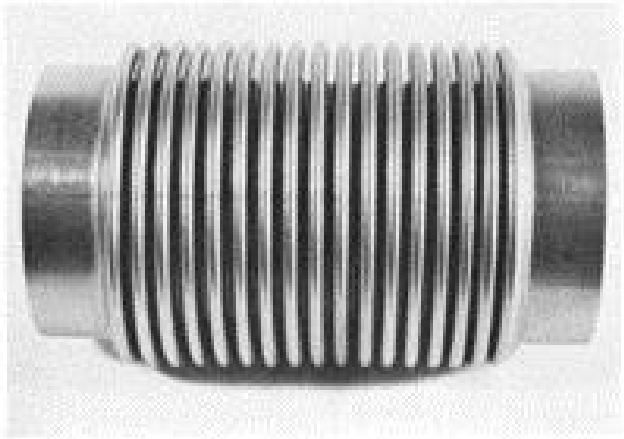
PLASMA KEYHOLE

MICRO PLASMA

Micro Plasma Application







Material thickness (mm)	Current (A)	Plasmagas (l/min)	Shielding gas (l/min)	Welding speed (cm/min)
0,1	3	0,2	6	30
0,2	6	0,2	6	30
0,4	18	0,2	6	30
0,5	25	0,2	6	30
1,0	38	0,3	7	30

Seam:	Butt weld
Material:	1.4301; 1.4571
Plasma gas:	Argon 5.0
Shielding gas:	Argon 4.6 /
Welding position:	PA

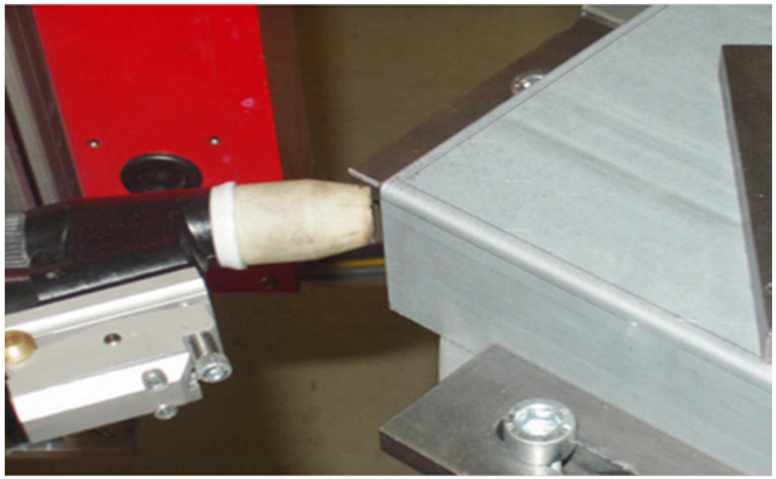
Soft Plasma Application

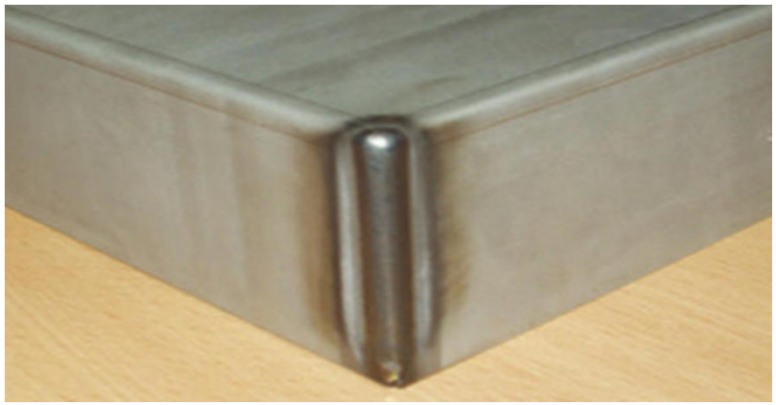
Exhaust systems Automotive industry

Material thickness (mm)	Current (A)	Plasmagas (l/min)	Shielding gas (l/min)	Welding speed (cm/min)
1,0	73	0,4	14	40
2,0	105	0,8	14	32
3,0	130	1,1	17	23

Seam:	Butt weld
Material:	1.4301; 1.4571
Plasmagas:	Argon 5.0
Shielding gas:	Argon 4.6
Welding position:	PA

Cabinet production Lamp Housing





Plasma Keyhole Application

Plasma Arc Pipe & Tank construction

Material thikness (mm)	Current (A)	Shielding gas (l/min)	Plasma gas (l/min)	Welding speed (cm/min)
2,5	200	24	1,5	75
3,0	210	26	2,0	70
4,0	220	27	2,5	65
5,0	230	28	2,7	40
6,0	250	29	2,8	35
8,0	300	30	3,5	20

Seam:	Butt weld
Material:	1.4301; 1.4571
Plasma gas:	Argon 5.0
Shielding gas:	Argon 4.6
Welding position:	PA

Conclusions

- Material Selection: Choosing the right MOC for the application is crucial, as it significantly affects mechanical & microstructure Properties.
- Challenges in Welding: Challenges associated with welding sheet metals and the need for precise techniques.
- Proper Welding Techniques: Employing proper welding methods, including shielding gas, electrode selection, and parameter control, is essential for success.
- Future Trends: Emerging trends in the welding shows a promise for material advancements.
- Safety First: Safety considerations in welding needs to be overemphasized, ensuring the well-being of all involved.

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