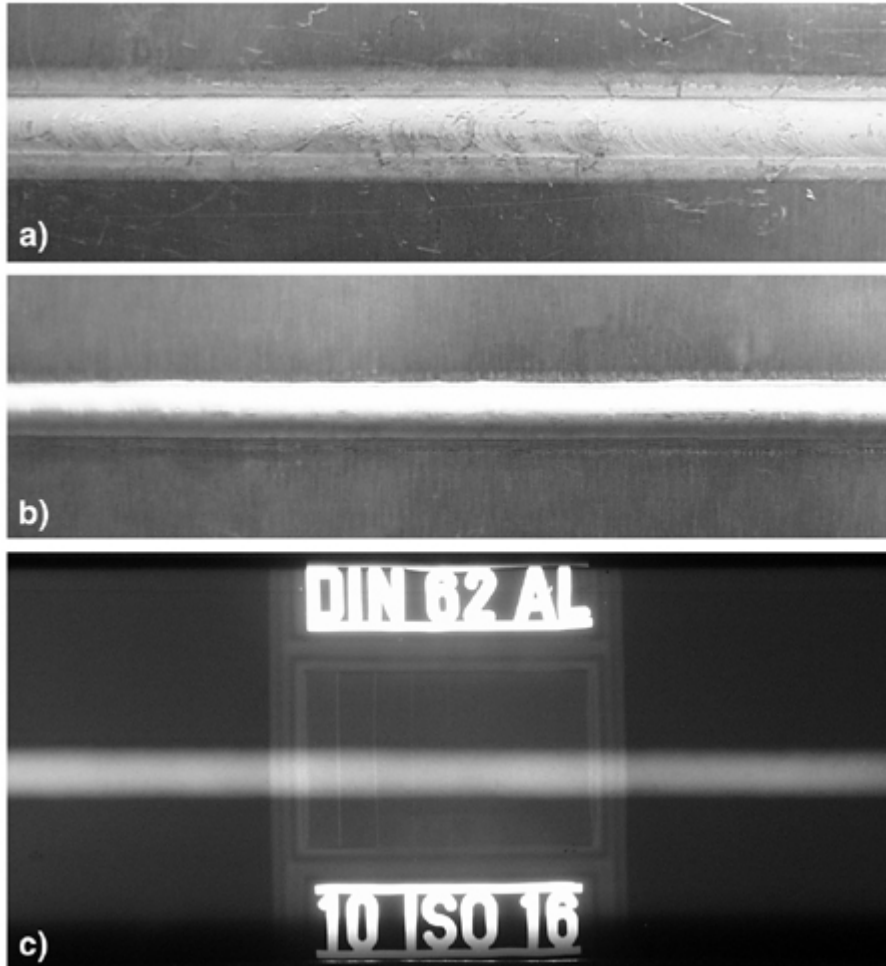


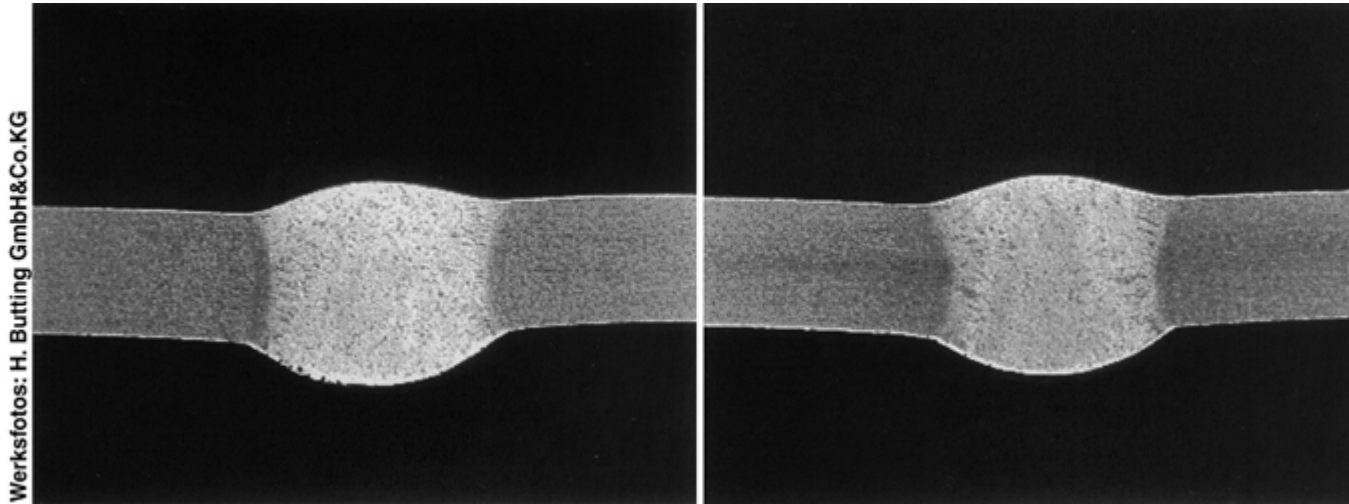
## Plasma welding with aluminium materials- direct or alternating current?

## Application example of plasma welding at the positive pole



Plasma welding at the positive pole, keyhole process,  
 $I=100\text{A}$ ,  $U=40\text{V}$ ,  $v_s=32\text{cm/min}$ ,  
parent material: AlMg3,  $t=5\text{mm}$ ,  
filler metal: AlMg5,  $d=1,2\text{mm}$ ,  
plasma gas: Ar,  
shielding gas: 70% Ar / 30% He  
a) top of the seam  
b) underside of the seam  
c) radiograph

## Plasma welding at the positive pole with aluminium alloys



**Weld formation in the case of plasma welding at the positive pole, keyhole process,**

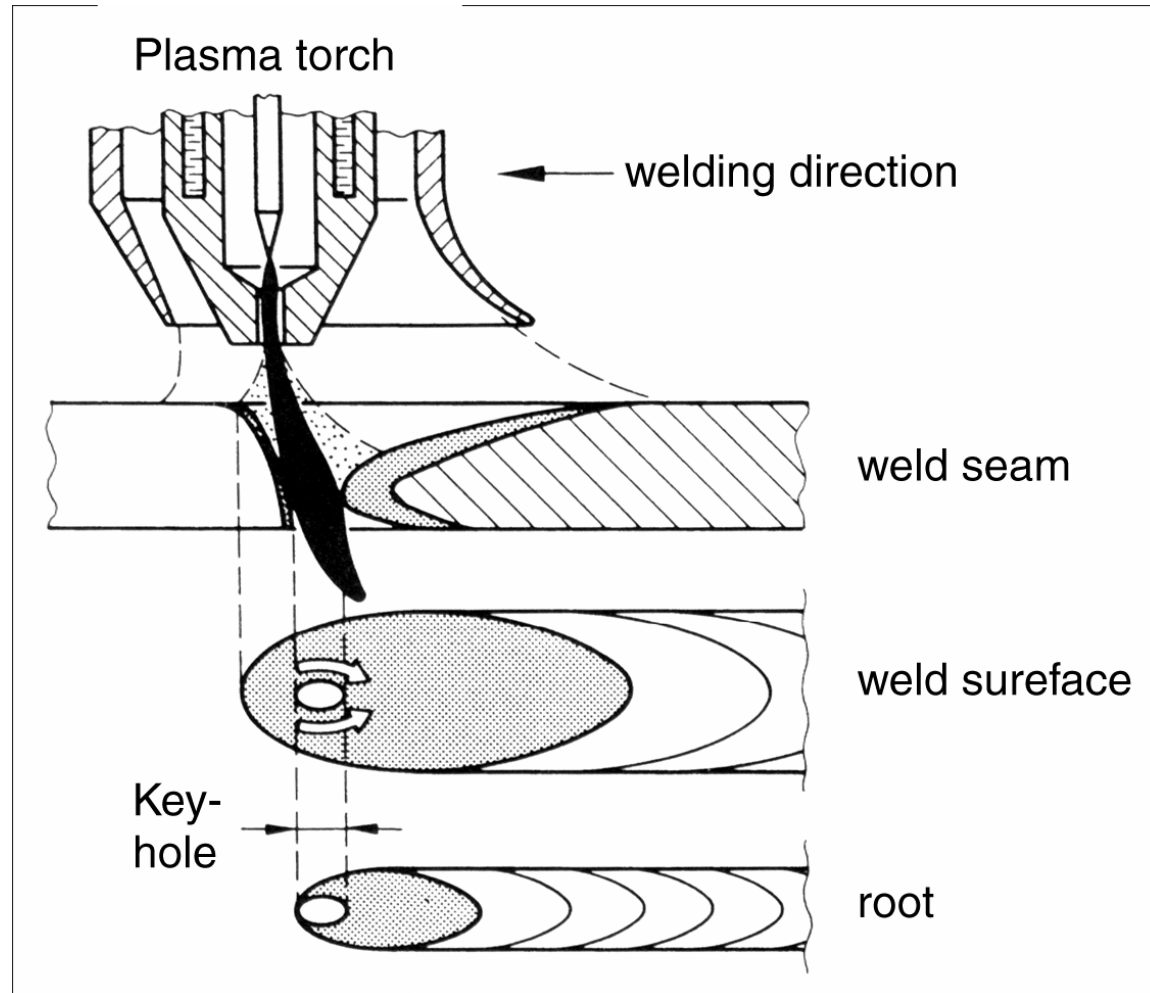
**parent metal:            AlMg3, t=4mm, I=75A, U=41V,  $v_s=27\text{cm/min}$ ,**

**filler metal:             AlMg5, d=1,6mm, plasma gas: Ar,**

**shielding gas:         70% Ar/ 30% He (left),**

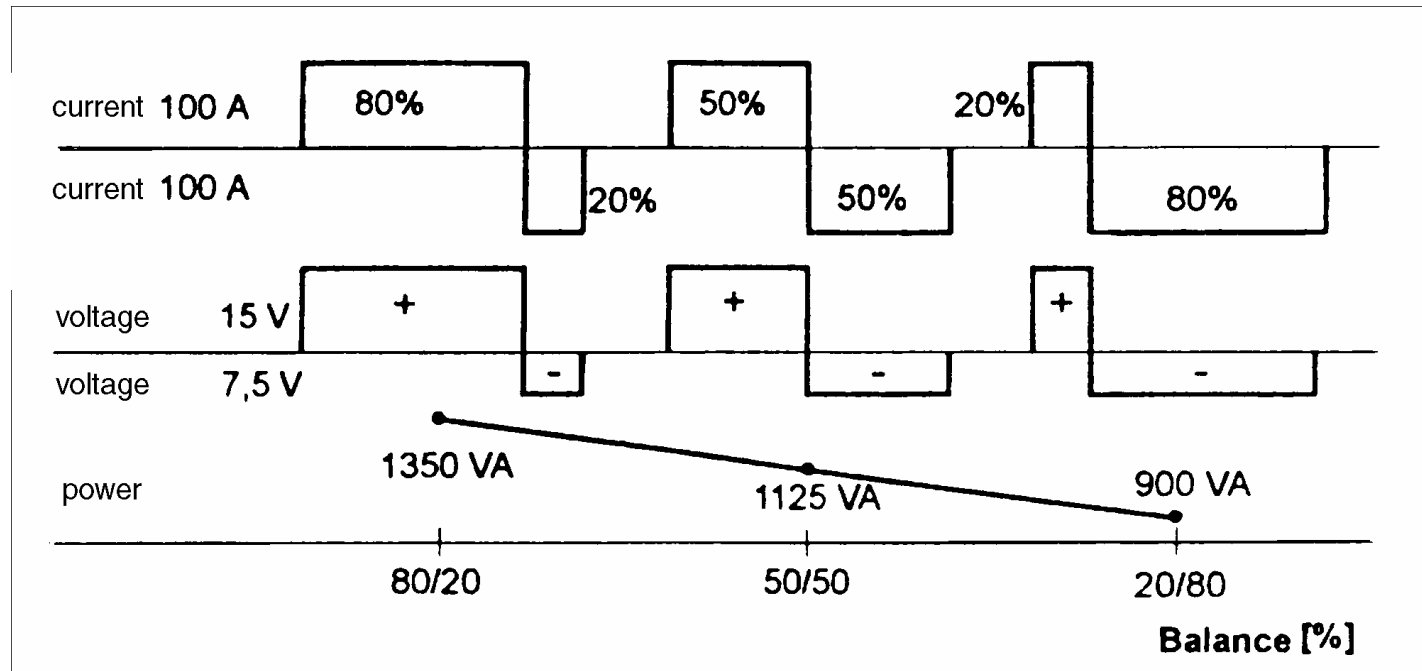
**shielding gas:         Ar / 150vpm N<sub>2</sub> (right)**

# Principle of plasma-keyhole welding



Source: Baum, L. und Fischer, H.: Der Schutzgas-Schweißer, Teil 1: WIG-Schweißen / Plasmaschweißen, Die Schweißtechnische Praxis, Band 11, Deutscher Verlag für Schweißtechnik (DVS) GmbH, Düsseldorf, 1987, S.80-81

## Welding of aluminium alloys under alternating current

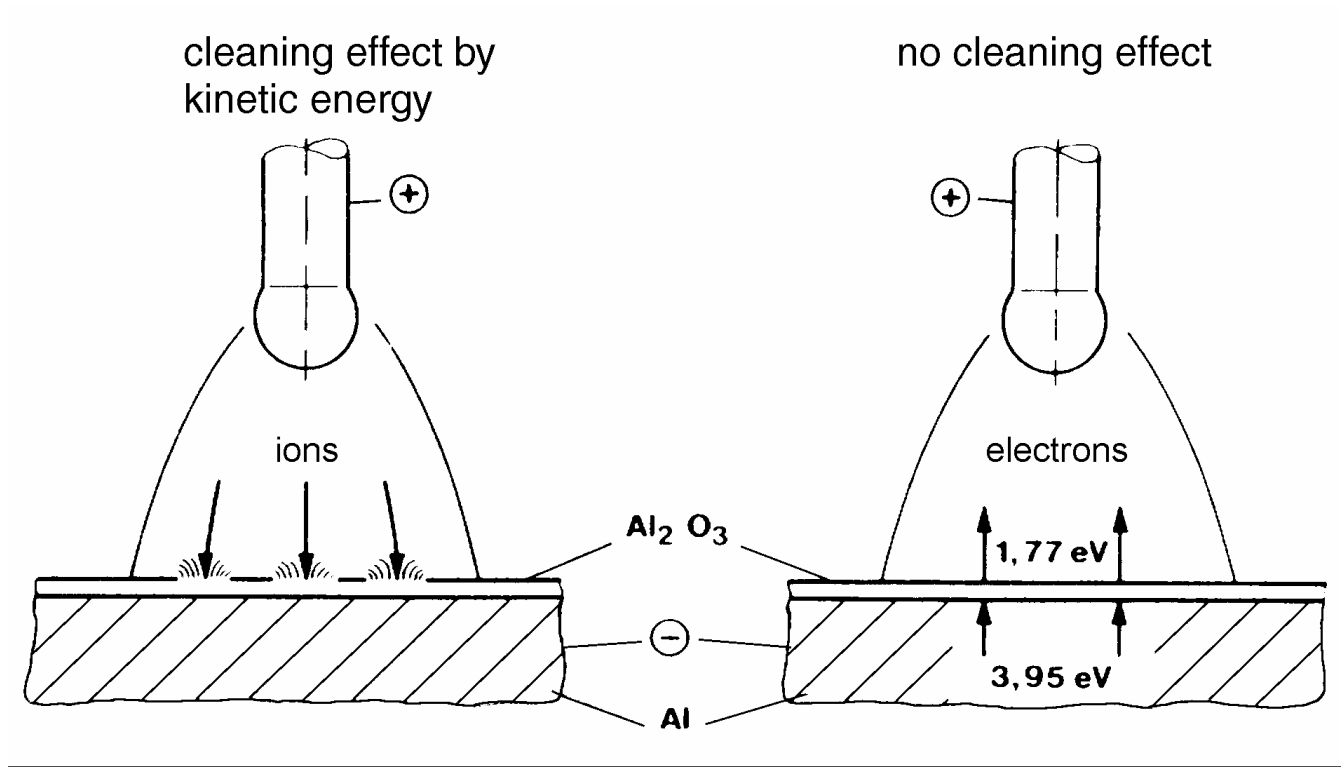


**Differing arc voltages at the electrode during the positive and negative half-wave cause different arc performances in welding with alternating current when the balance setting is changed.**

Source: Bültmann, F., Helwig, R., Knoch, R. und Nentwig, A.W.E.: Optimiertes Einstellen transistorisierter WIG-Schweißanlagen mit rechteckigem Stromverlauf auf das Schweißen von Aluminium, DVS-Berichte, Band 176, S.8-12

# Welding aluminium alloys

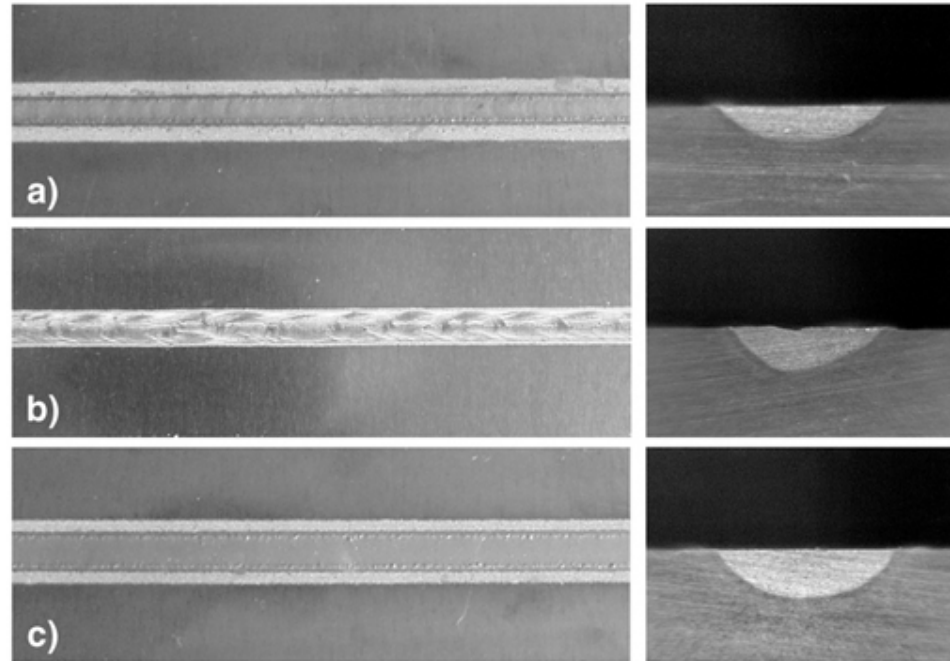
WELDING ARTICLE



## Cleaning effect and electron emission work

Source: Trube, S.: WIG-Schweißen von Aluminiumlegierungen, Einfluß von Legierung, Oberflächenzustand und Schutzgas auf das Schweißergebnis, Sonderdruck 38/97, LINDE AG, Werksgruppe Technische Gase, Höllriegelskreuth, 1997

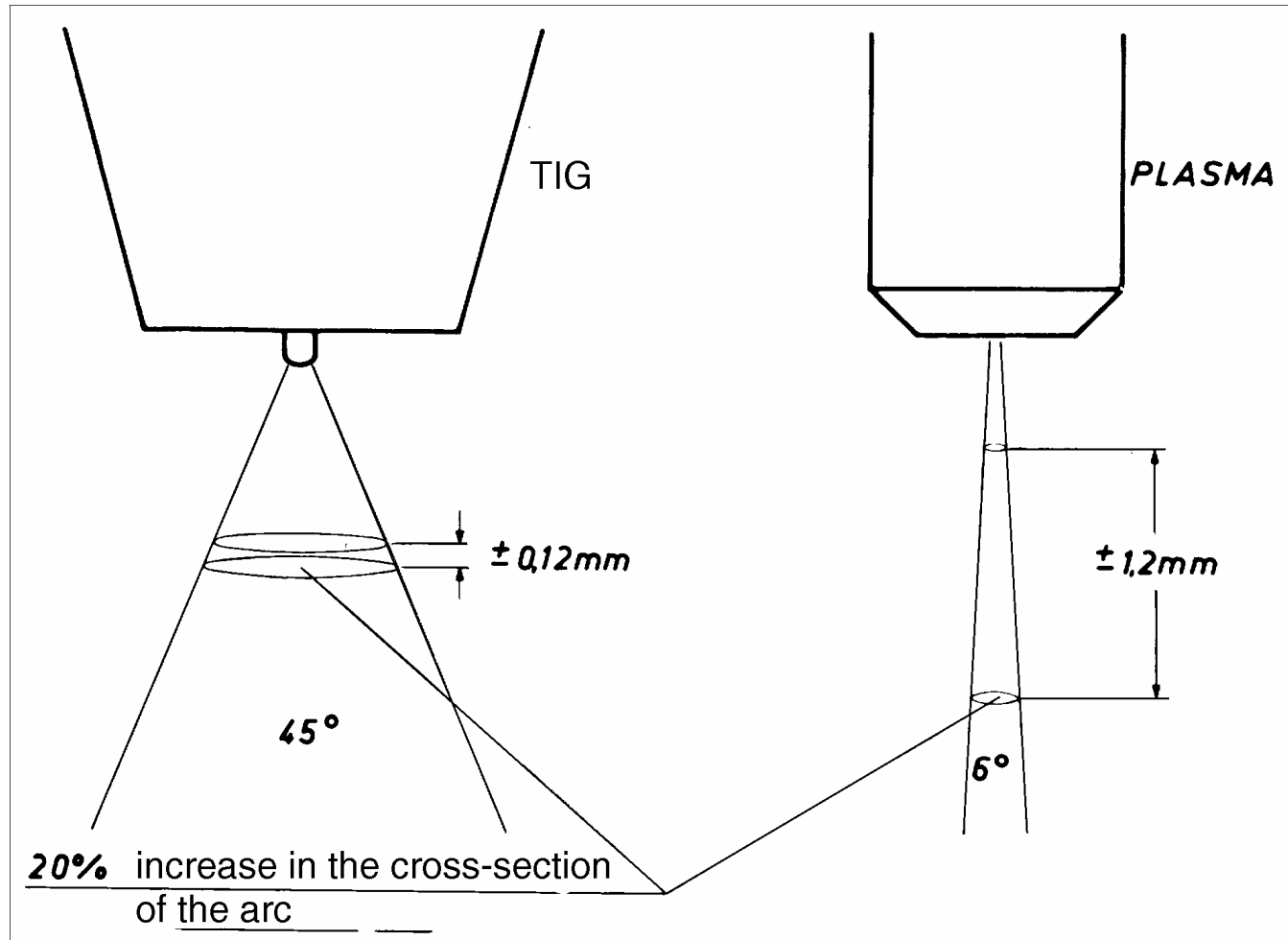
## Plasma welding of aluminium alloys



Seam surface and penetration in plasma welding of AlMg3,  $t=3\text{mm}$ , no filler material

- a) Plasma welding at the positive pole,  $I=35\text{A}$ ,  $U=26\text{V}$ ,  $v_s=40\text{cm/min}$ , plasma gas: Ar, shielding gas: 70%Ar / 30%He
- b) Plasma welding at the negative pole,  $I=70\text{A}$ ,  $U=20\text{V}$ ,  $v_s=90\text{cm/min}$ , plasma gas: 30%Ar / 70%He, shielding gas: He
- c) Plasma welding with alternating current,  $I=45\text{A}$ ,  $U=26\text{V}$ ,  $v_s=40\text{cm/min}$ , plasma gas: Ar, shielding gas: 70%Ar / 30%He

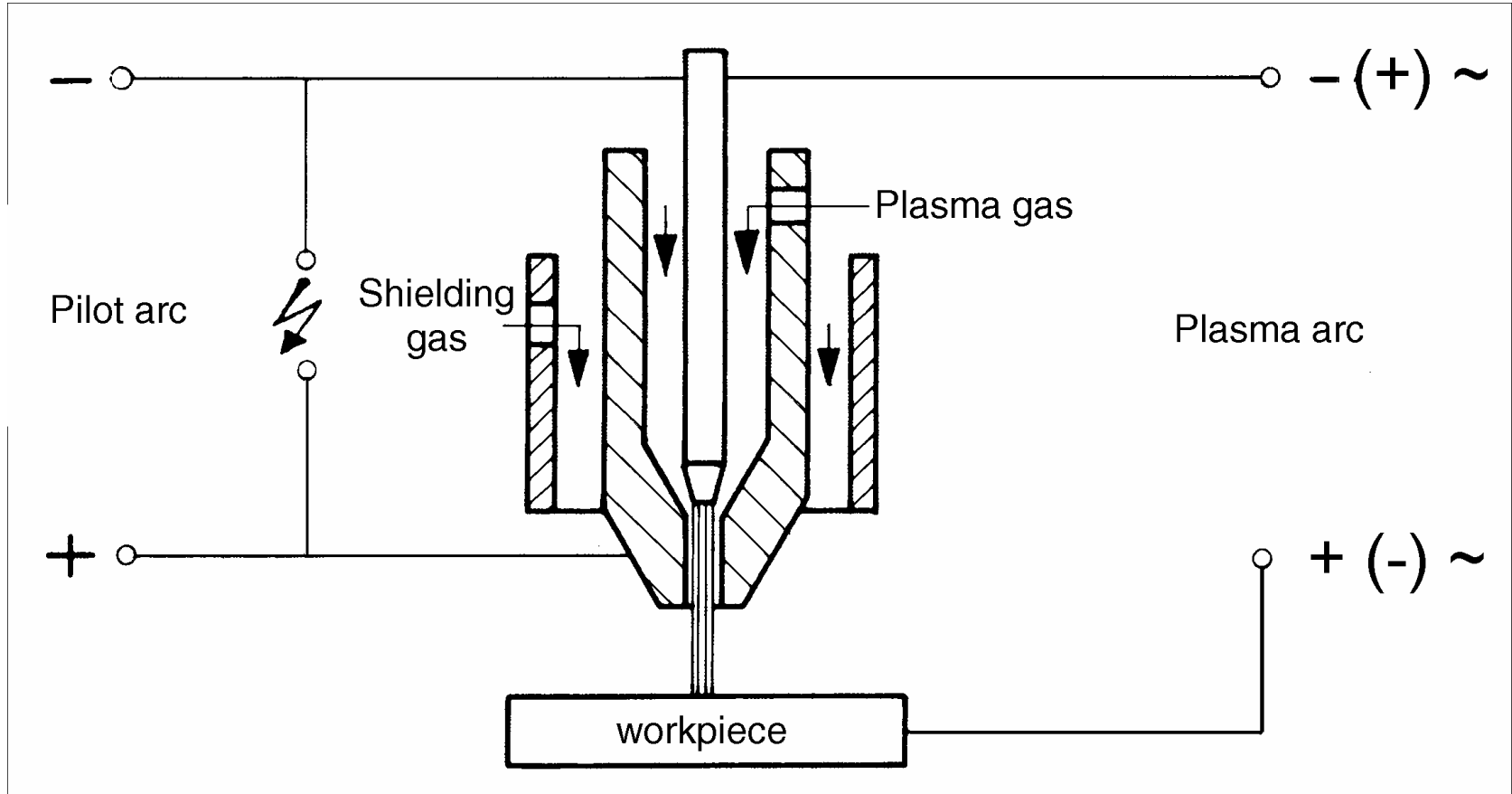
## Comparison of TIG and plasma arc



Source: Aichele, G.: Strahlförmige Lichtbogen - Plasmaschweißen hat sich bewährt, Sonderdruck aus Industrieanzeiger Nr. 51/89, S. 32-34, Konradin-Fachzeitschriftenverlag GmbH



# Principle of plasma welding processes



WELDING ARTICLE

## Physical properties of aluminium and iron

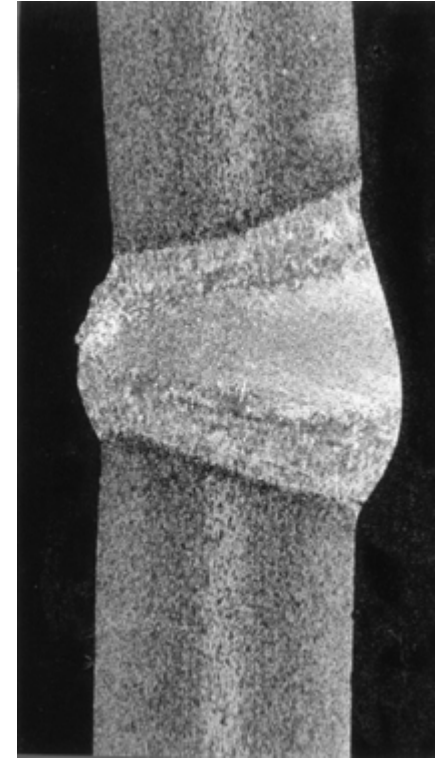
Physikal parameters	Unit of measure	Al	Fe
Atomic weight	g / mol	26,9	55,84
Density	g / cm <sup>3</sup>	2,70	7,87
crystal lattice		kfz	krz
modulus of elasticity	N / mm <sup>2</sup>	71·10 <sup>3</sup>	210·10 <sup>3</sup>
R <sub>PO,2</sub>	N / mm <sup>2</sup>	10	100
R <sub>m</sub>	N / mm <sup>2</sup>	50	200
specific heat capacity	J / (g·K)	0,88	0,53
melting point	°C	660	1539
thermal conductivity	W / (cm·K)	2,30	0,75
specific elektrik resistance	μΩ·m	28 to 29	97
Extension coefficient	1/K	24·10 <sup>-6</sup>	12·10 <sup>-6</sup>
Oxides		Al <sub>2</sub> O <sub>3</sub>	FeO Fe <sub>3</sub> O <sub>4</sub> Fe <sub>2</sub> O <sub>3</sub>
Melting point of Oxides	°C	2050	1400 1600 1455

Source: Altenpohl, D.: Aluminium von innen betrachtet, Eine Einführung in die Metallkunde der Aluminiumverarbeitung, 4. Auflage, Aluminium-Verlag, Düsseldorf, 1979, S.1-3

## Application example of plasma welding at the positive pole



parent metal: AlMg 4,5Mn, t=6mm  
 filler metal: AlMg5, d=1,2mm  
 plasma gas: argon  
 shielding gas: 70%Ar / 30% He  
 porosity surface: 0,48%

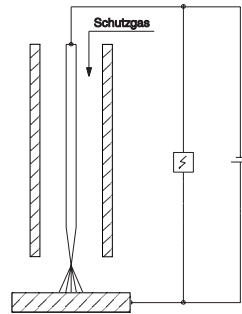


parent metal: AlMg 4,5Mn, t=8mm  
 filler metal: AlMg5, d=1,2mm  
 plasma gas: Argon  
 shielding gas: 70%Ar / 30% He  
 porosity surface: 0,23%

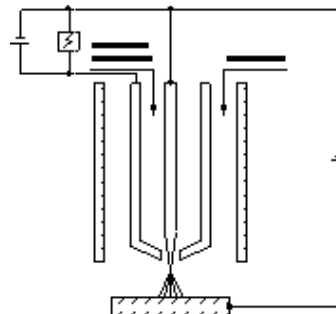
# Comparison of TIG and plasma welding

Comparison  
schematic  
drawing:

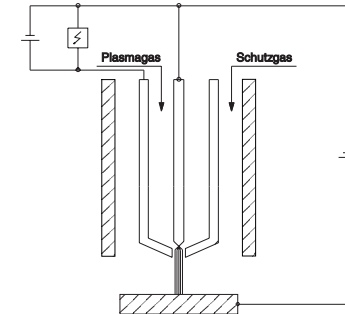
TIG welding



TIG pilot-arc welding



Plasma welding



center gas :  
shielding gas :

-  
argon  
argon / helium

argon  
argon  
argon / helium  
argon / hydrogen

argon  
argon  
argon / helium  
argon / hydrogen

welding current:  
advantages :

5 - 600 A  
secure process

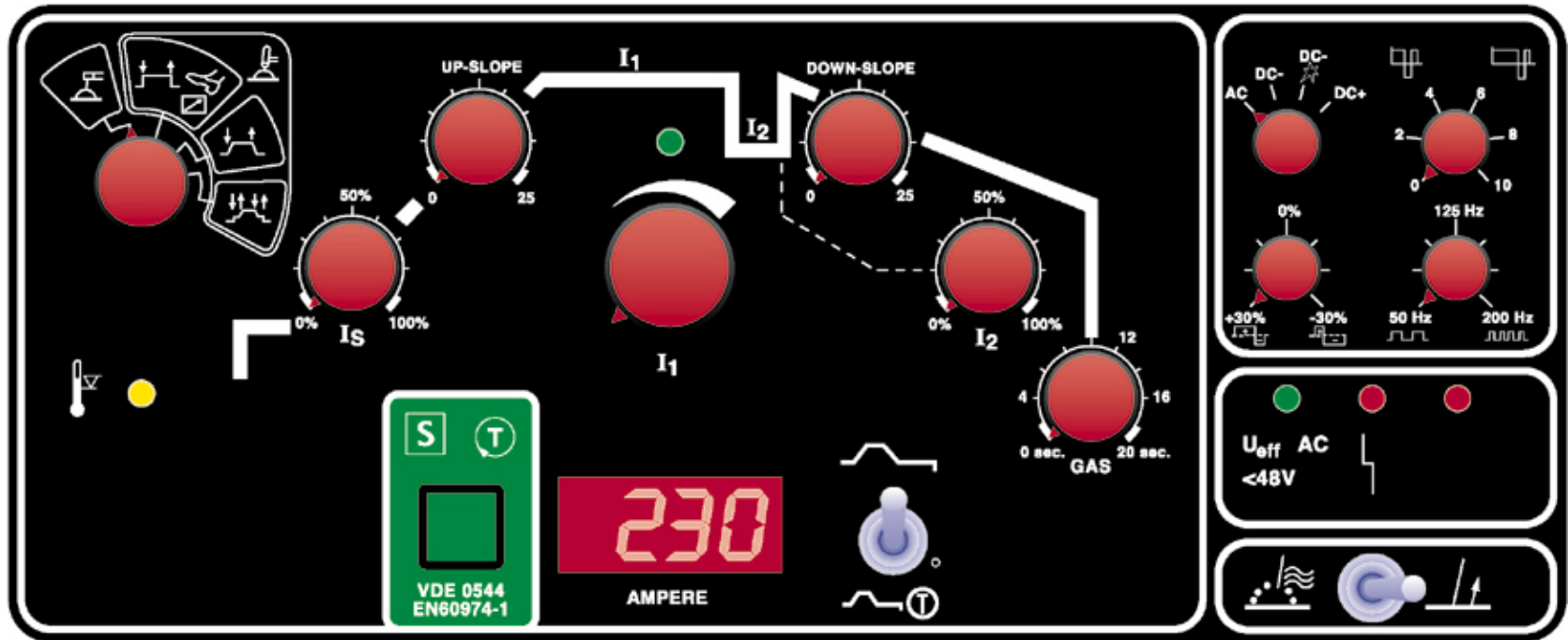
TIG range  
reliable ignition,

0,1 - 500 A  
reliable ignition, secure  
process high quality, strongly  
constricted plasma arc  
keyhole process, low heat  
input, low distortion of the  
components)

*Inverter TIG 450 AC/DC-P System*



# TIG-AC/DC- operating unit



WELDING ARTICLE

## Cutting scheme of the plasma torch

