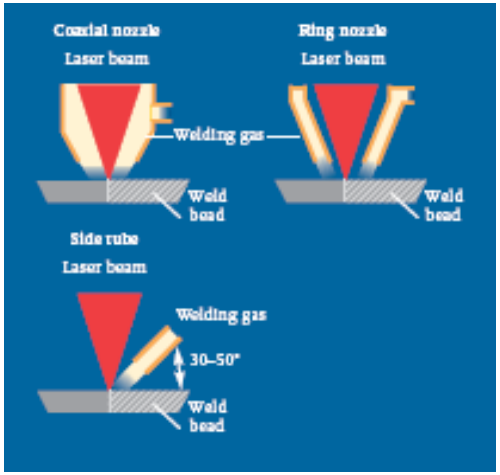
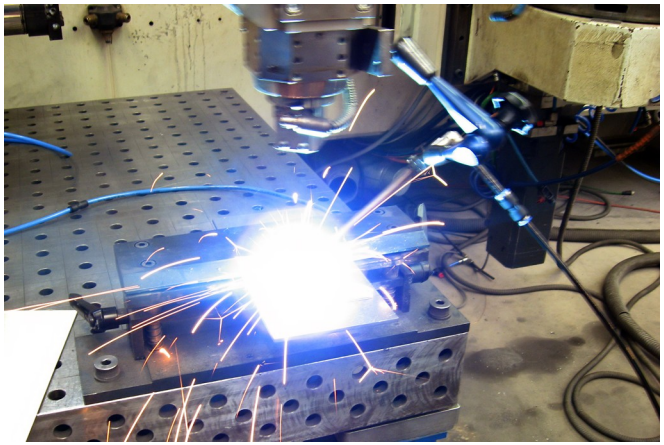
Trends and development of gas applications for laser

Bo Williamsson
Manager Laser Technology
AGA Gas AB/Region Europe North

Status

- ✓Welding with CO_2-laser: Argon, Argon/Helium, Helium
- ✓Welding with Nd:YAG-laser : Argon
- ✓Coaxial nozzle, ring nozzle, side tube
- ✓Less Helium in the welding gases
- ✓Plasma formation
- ✓Welding of different materials
- ✓Active components are added to the gases to improve performance and reduce Helium content





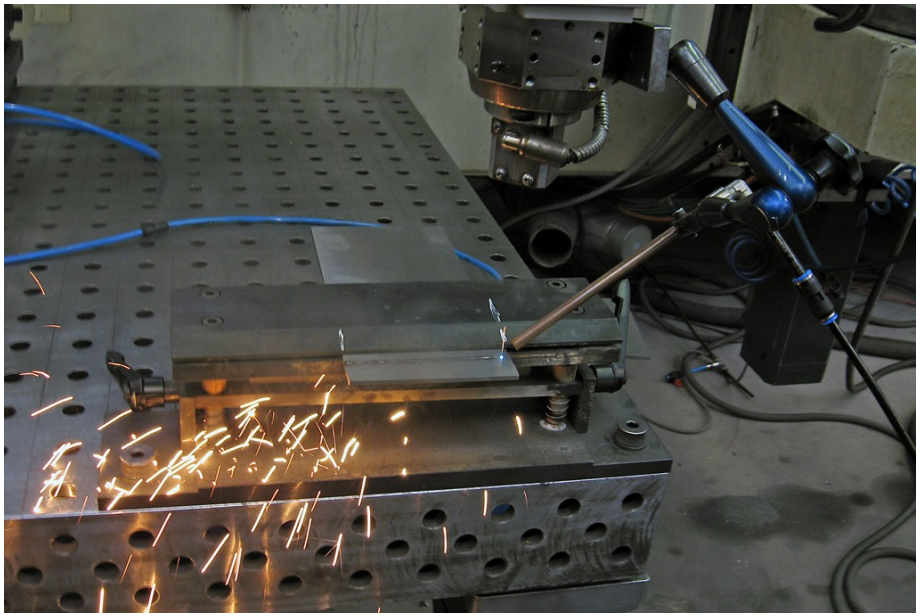
Influence from CO_2 on the welding process

Surface tension, change of the flow pattern in the weld pool which increases the penetration.

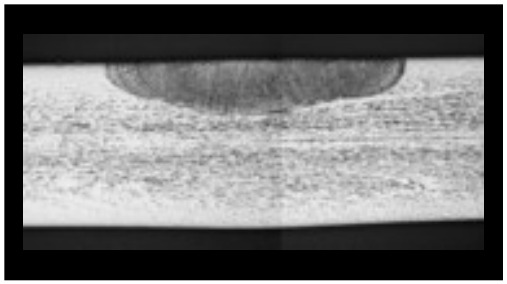
Recombination of dissociated CO_2 on the weld bead which adds energy to the process.

Minimum carbon pick-up in the weld material (at normal CO_2 content)

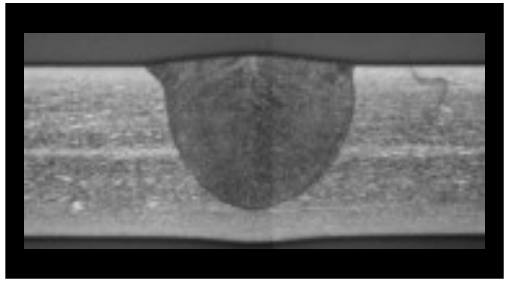
For CO_2 lasers, gas supply from the side to avoid interaction with the laser beam.



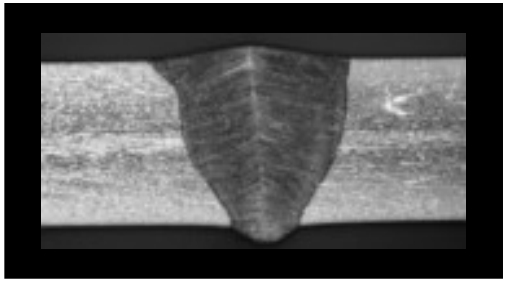
Influence of the welding gas composition



Ar



Active gases

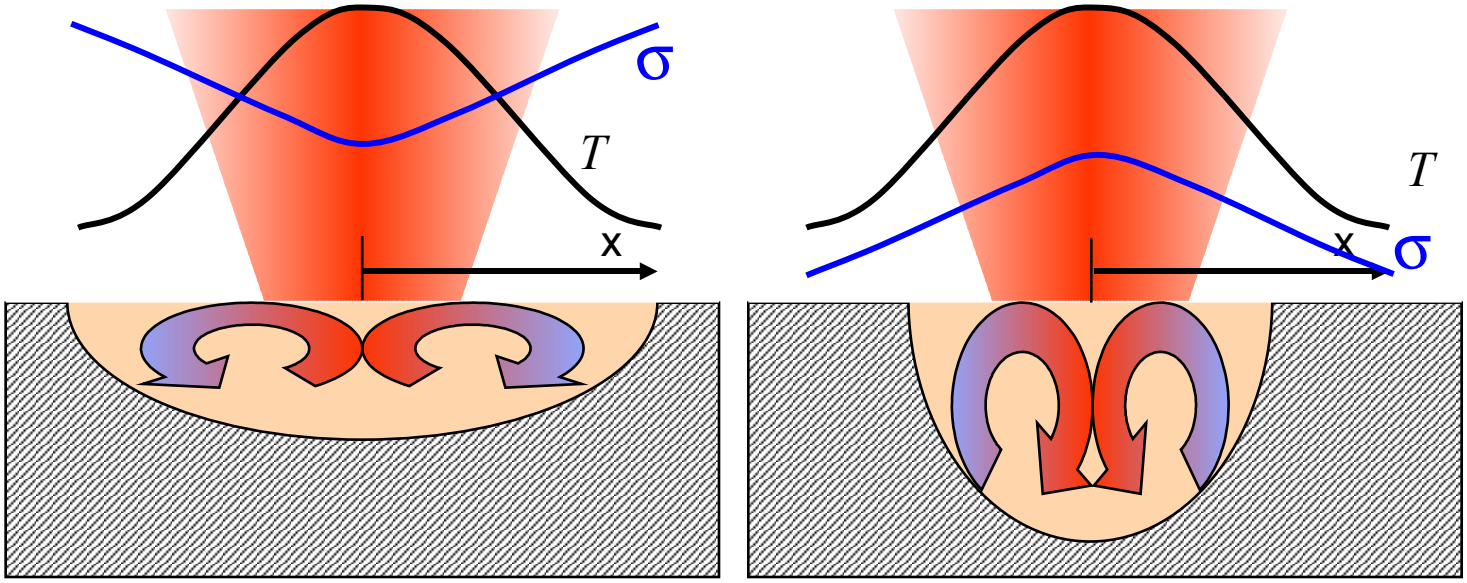


Active gases

Activation potential of the assist gas

Material:	1.4301
Thickness:	2 mm
Laser power:	3000 W
Speed:	1 m/min
Focal distance:	100 mm

Melt pool convections



$$\frac{\partial \sigma}{\partial T} < 0 \qquad \frac{\partial \sigma}{\partial T} > 0$$

Sheer tension τ

Surface tension σ

Temperature T

$$\tau = \frac{\partial \sigma}{\partial T}\frac{\partial T}{\partial x}$$

Influence from active gases on diode laser welding

Development of new welding gases

Laser welding gases for CO_2 lasers consist basically of helium as it controls plasma formation in higher-power laser welding.

Alternatives to pure helium are **helium-argon-mixtures**. The higher the laser power, the higher is the helium content. Further alternatives are LASGON mixtures (with active components).

Active gas components may improve performance of the process.

LASGON gas mixtures

LASGON C1: CO_2 laser welding of flat sheet material and especially zinc coated material, tailored blanks and fine-grain material, off-axis welding gas supply

Composition: Ar, CO_2, He

LASGON H3: Laser welding of stainless steel components with low-power CO_2 laser up to ca. 2 kW, solid state and diode lasers, improved performance, less oxidation Composition: Ar,H_2, He

LASGON H4: High-power CO_2 laser welding of stainless steel components, improved performance, less oxidation. Composition: Ar, H_2, He

LASGON gases require expert introduction and set-up at customers.

Welding gases for CO_2 laser welding in mild steel/CMn steel

Welding gas	Comment	Backing gas
Helium	All laser power. Coaxial nozzles, side tubes. High weld quality, good formability	Argon
Argon	Laser power up to 3 kW. Coaxial nozzles, side tubes.	
Argon/30% Helium Argon/50% Helium	Coaxial nozzle, side tube. High weld quality. Good formability	
Argon/10% Oxygen	Laser power up to 5 kW. Coaxial nozzle. Good formability.	
Nitrogen	Coaxial nozzles, side tubes. Steel alloyed with nitrogen.	
LASGON C1 (Ar/He/CO_2)	Laser power up to 8 kW. Side tube. High weld quality esp. In zinc coated material.	

Welding gases for CO_2 laser welding in austenitic and superaustenitic stainless steel

Welding gas	Comment	Backing gas
Argon/6-10% Hydrogen	Laser power up to 5 kW. Coaxial nozzles, side tubes. High welding speed, shiny weld surface	Argon Nitrogen/H_2
Argon	Laser power up to 3 kW. Coaxial nozzles, side tubes.	
Argon/30% Helium Argon/50% Helium	Coaxial nozzle, side tube.	
Helium	All laser power. Coaxial nozzle.	
LASGON H4 (Ar/He/H2)	High-power CO_2 laser welding of stainless steel components, improved performance, less oxidation. Composition: Ar, H_2, He	

Welding gases for CO_2 laser welding in ferritic stainless steel

Welding gas	Comment	Backing gas
Argon	Laser power up to 3 kW. Coaxial nozzles, side tubes.	Argon
Argon/30% Helium Argon/50% Helium	Coaxial nozzle, side tube.	
Helium	All laser power. Coaxial nozzle.	

Welding gases for CO_2 laser welding in duplex material

Welding gas	Comment	Backing gas
Nitrogen	Coaxial nozzles, side tubes. Steel alloyed with nitrogen.	Nitrogen
Argon/nitrogen mixtures	Coaxial nozzles/side tubes	
Helium/Nitrogen mixtures	High laser power. Coaxial nozzle, side tube.	

Welding gases for CO_2 laser welding in Aluminium and its alloys

Welding gas	Comment	Backing gas
Argon/30% Helium Argon/50% Helium Helium/30% Argon	Coaxial nozzle, side tube. High weld penetration. High weld quality.	Argon Helium
Helium	All laser power. Coaxial nozzle, side tubes.	

Conclusions

- ✓New gas mixtures for laser welding with CO_2, Nd:YAG and Fibre lasers are developed.
- ✓Active gas components are used to improve welding performance and to reduce the need for Helium.
- ✓More gas mixtures will be tailor-made for individual applications.

Thank you for your attention!