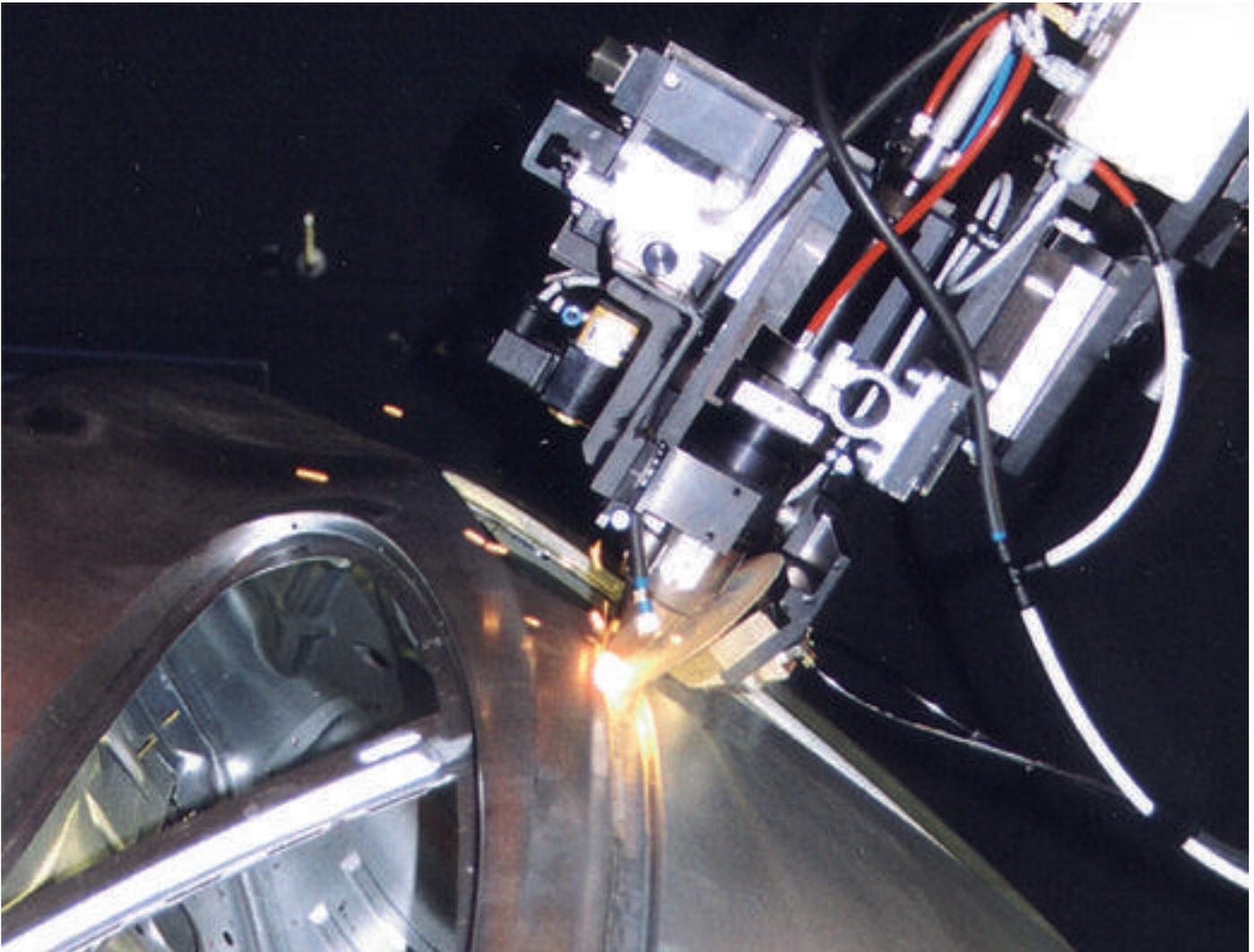


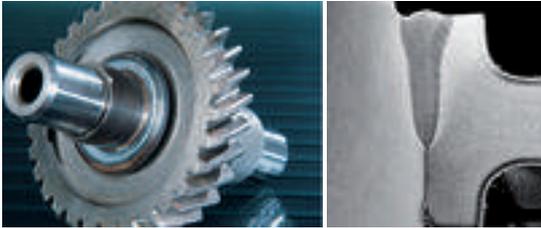


MegaLas – gases for laser welding and brazing

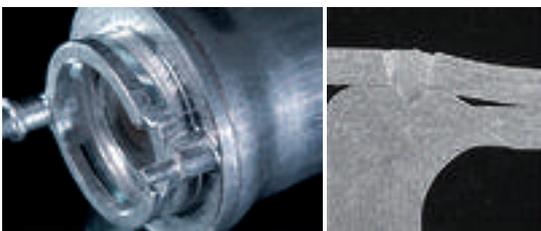
Expertise that gets right to the point



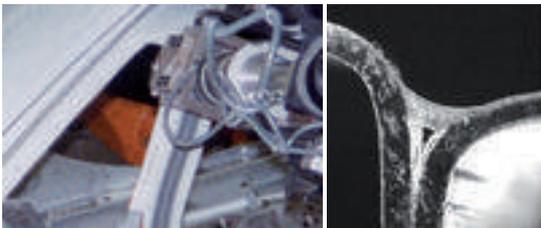
Laser technology – high-tech that has made its mark



Gear wheel/shaft connection, CO₂ slab laser



Fuel filter made of aluminium, CO₂ slab laser



Laser soldering, automobile body

Increasing demands on productivity, cost-effectiveness and quality require new solutions. One such solution – laser technology – has become indispensable in many areas of production, research and medicine. The number of applications and process technology solutions here is growing continuously. The use of lasers to process materials offers a whole range of advantages over conventional processing techniques: high product flexibility, excellent quality and reliability, and low unit costs.

One of the keys to the optimal application of laser technology is the selection of the operating and process gases. With the **Megalas®** product line, Messer provides all of the gases and gas mixtures you need in order to successfully process materials using lasers.

Flexibility for many applications

Through its special characteristics, laser welding performs welding tasks like no other process. Its most distinctive feature is the highly concentrated heat input.

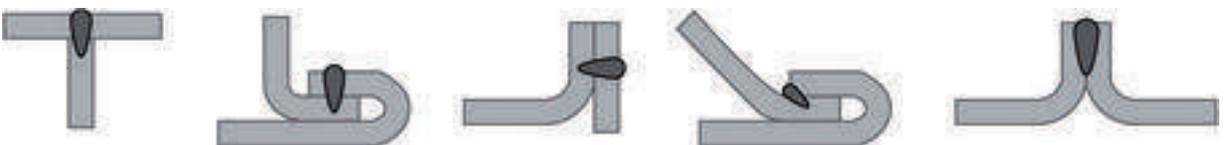
Laser welding ensures:

- **high welding speed**
- **narrow HAZ**
- **low heat input into the component**
- **low distortion**

And the types of joints are also somewhat special as compared with other welding processes: the laser is capable of penetrating straight through a component. This makes it possible to weld in areas that would otherwise be inaccessible. The automotive industry, in particular, takes full advantage of this – on car bodies, where weld points are often very well hidden, for example. In addition, the laser addresses the need for high welding speeds and low distortion. And laser welding is also ideally suited for medical technology and micro-electronics.

Remote welding

Remote welding is used to weld complex components from distances of up to two metres away, for example. The principal advantage of the process is the very rapid positioning of the laser beam. It is carried out by means of multi-axis adjustable mirrors from a central unit. Additional advantages of this approach include time savings and elimination of the need for sophisticated mechanical assemblies for beam guidance.



Laserwelding-compatible designs

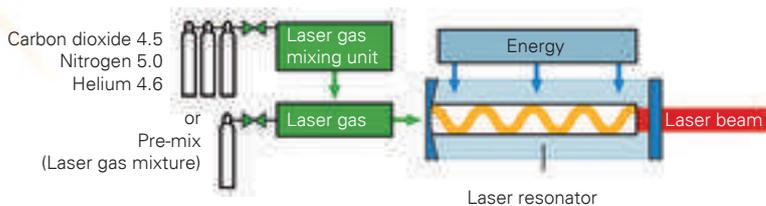
Types of lasers – no universal solution

The requirements of laser beams vary just as widely as the range of processes and applications that make use of them as a tool. Suppliers of laser equipment respond to those requirements with different configurations and power classes. Most systems can be classified into one of three main groups: **CO₂ lasers**, **diode lasers** and **solid-state lasers** – depending on the medium in which the laser light is generated.

CO₂ lasers – the dominant solution

The most commonly used type of laser by far is the CO₂ laser. The laser beam is generally produced using a three-component gas consisting of helium, nitrogen and the component that gives the system its name, CO₂. The wavelength of the CO₂ laser light is 10.6 μm and invisible to the human eye. Mirrors and lenses are used to direct and shape it. One of the special configurations used is the particularly efficient, diffusion-cooled CO₂ laser.

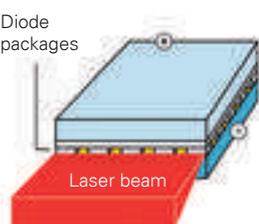
Depending on the equipment configuration, either the laser gas is produced from the three components in an internal mixer or else a pre-mixed product is used. The better reproducibility of the latter approach has made it the preferred option. **The Megalax®** product range offers a suitable selection here.



CO₂ laser

Diode lasers – the economical alternative

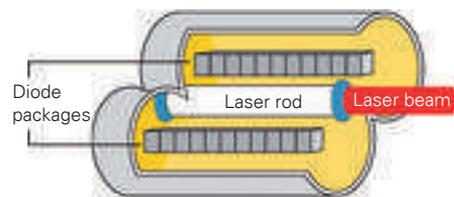
This type of laser is based on high-power diodes. The diode laser achieves its high power output through the arrangement of many electronic components in a block. Due to their comparatively poor beam quality, high-performance diode lasers are less suitable for cutting – but they are perfectly acceptable for welding, brazing or hardening applications.



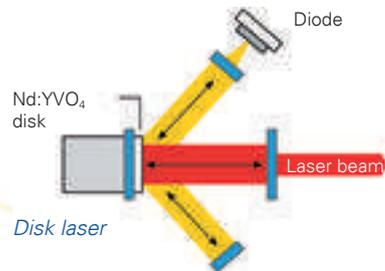
Diode laser

Solid-state lasers – rod, disk or fibre?

For their laser-active medium, solid-state lasers use synthetic YAG crystals (YAG = yttrium-aluminium-garnet). Besides the rod configuration which has been in use for a long time already, the disk configuration is also now starting to be used.

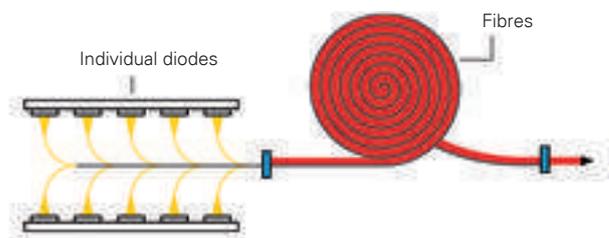


Rod laser



Disk laser

The laser beam is generated without the need for operating gases. Process gases such as shielding gases have a significant effect on the welding process. Due to the short wavelength of just 1.06 μm, the laser light can be transmitted through fibre optic cables. This makes it easier to implement automation solutions using articulated robots, for example. Fibre lasers that have recently been expanded into the kilowatt range have a significantly smaller beam diameter than CO₂ or Nd:YAG lasers. This permits them to achieve greater precision when cutting materials. Fibre lasers are also the perfect solution for micro-welding operations. When processing a material with a fibre laser, the heat input is very low. That's why it is preferred for welding with a higher power beam.

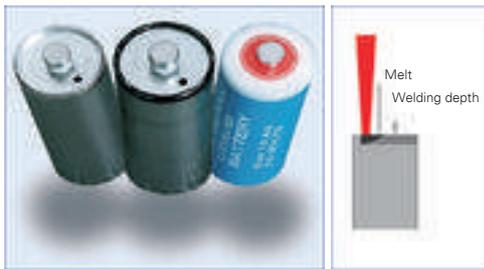


Fibre laser

Laser welding and soldering – four efficient options

As has already been the case in cutting technology, the use of lasers is also becoming increasingly prevalent in welding and brazing applications. Four variants are possible: heat conduction welding, deep penetration welding,

laser brazing and hybrid welding. The welding process can be carried out with or without filler material. It is also possible to weld dissimilar types of metals and alloys, such as aluminium/steel or black/white.



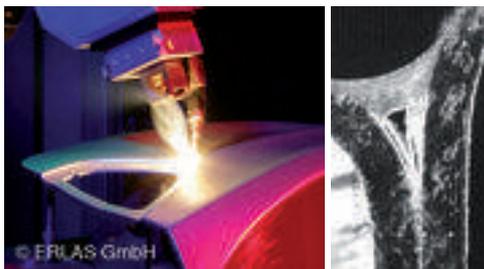
Heat conduction welding

Heat conduction welding does not require high power levels. The energy of the laser is converted to heat at the surface of the component, so that a melt pool forms, which passes along the heat energy through convection. As with arc welding, this convection can be influenced by shielding gases and the penetration profile can be adapted to the specific welding requirements.



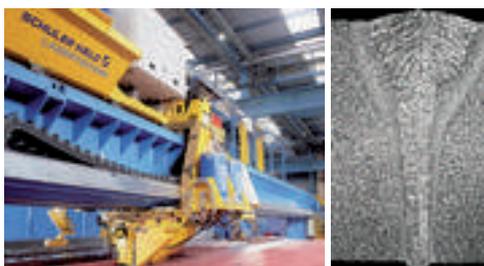
Deep penetration welding

Deep penetration welding requires higher power levels, as the metal is not merely melted but also vaporised. In this way, the laser penetrates deep into the workpiece and forms a so-called "keyhole". A column of plasma is created in this keyhole, which absorbs the energy of the laser and transfers it to the material. The result is a continuous welding process. The plasma cloud emerging from the vapour channel has to be blown away with a shielding gas, otherwise it would absorb the laser energy and disable it from contributing to the welding process.



Laser brazing

Laser brazing is similar to heat conduction welding. The energy required by the solder here must be taken into consideration. Laser brazing is now widely used, particularly in the automotive industry. Along with advantages such as low heat input and distortion, the corrosion resistance of the solder and the easier processability are also major factors here. The reliability of joints and long service life also make laser brazing a good alternative.



Hybrid welding

The hybrid process is a combination of multiple methods. In the case of laser welding, the combination with MAG welding is especially useful. This pairing combines the cost-effectiveness of laser welding with the high deposition rate of the MAG process and is suitable for use on thicker plates and sheets.

Gases and gas supply – reliable and application-based



Gases are needed at several points in the process. Depending on the system, they perform the following functions:

- **Gases used as operating gases to generate the laser beam (CO₂ laser)**
- **Cross jet**
- **Purge gas**
- **Shielding gas**

Laser (operating and) process gases

Laser or operating gases are required in order to operate the resonator. Process gases are fed into the laser beam in the workspace, e.g. as shielding gas or cutting gas. The purity, quality and mixing consistency of the operating gases for CO₂ lasers are subject to the highest standards – and for good reason:

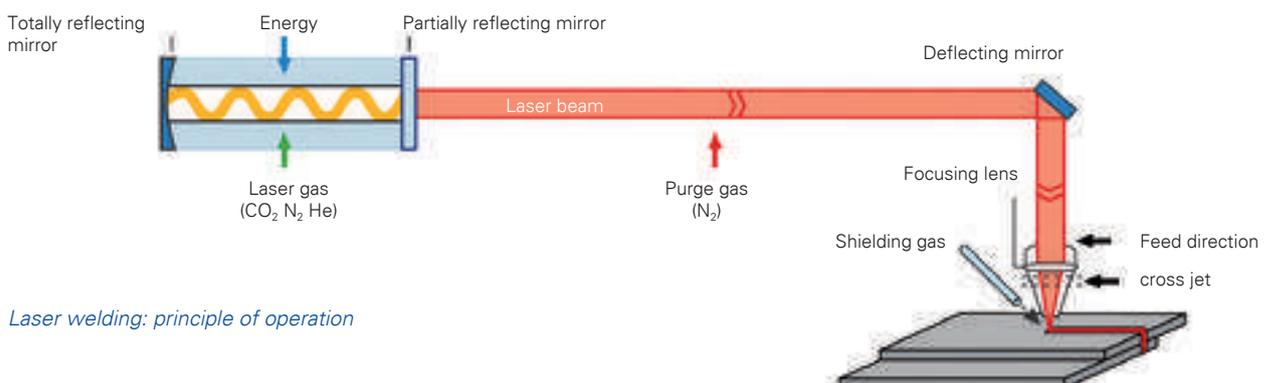
- Even traces of moisture or hydrocarbons can impair operation.
- Hydrocarbons can damage sensitive and expensive optical components.

- Moisture disturbs the excitation discharge and disables the laser from achieving its full efficiency.
- The formation of acid molecules can lead to corrosion damage.
- Dust particles can scatter the laser light, thereby disrupting the process.

For perfect laser operation, therefore, it is absolutely essential that the gases used are extremely pure and free of disruptive contaminants. These gases are either supplied in pre-mixed form or their separate components are mixed in the laser unit. And the gas supply system must also satisfy the purity requirements as well.

Shielding gases

In welding, the shielding gas performs several functions. One of the main roles is to protect the hot material, as contact with the atmosphere can cause surfaces to absorb nitrogen or moisture or to oxidize.



Laser welding: principle of operation

Gases and gas supply – reliable and application-based



The shielding gas also continuously removes the plasma cloud over the workpiece. The addition of CO₂, oxygen, helium, nitrogen or hydrogen makes it possible to affect the welding process thermally or metallurgically.

Originally, pure helium was used for welding. Today the shielding gases used in laser welding tend to be more like those used in gas metal arc welding. The reasons for this are different laser sources with different wave lengths, as well as the metallurgical effect of CO₂ and oxygen, the thermal effect of helium and hydrogen and the cost-reducing effect of argon. This led to the use of typical gas mixture combinations such as argon/helium, argon/oxygen and argon/hydrogen. Messer has developed its own product range under the name Megalax®. It is based on extensive welding tests and reflects both experience in the market and the results of research and development work.

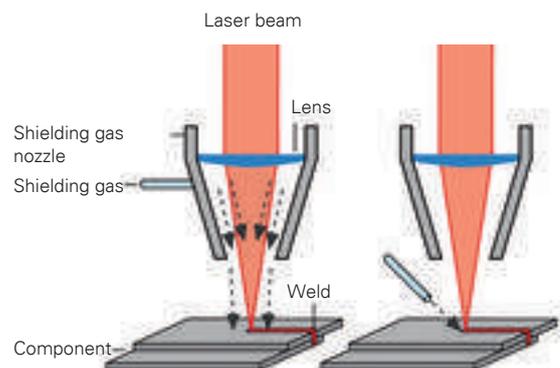
Welding without shielding gas

Particularly in applications using solid-state lasers, welding is often performed without shielding gas. It creates a welded joint with a correct appearance – but that alone is not the deciding factor. Without shielding gas, the weld metal can absorb nitrogen, oxygen and moisture, which can eventually lead to pore formation and hydrogen cracking. Especially in plain and low-alloy steels, nitrogen causes premature ageing and embrittlement. In most cases, the effects become visible only after the component has been subjected to the relevant stresses for several years.

Gas injection and shielding gas supply

When applying gas to the weld or solder point, laminar flow is a prerequisite for proper shielding gas coverage. High shielding gas velocity causes turbulence which entrains atmospheric air with the gas flow.

Material	Products
Un- and low-alloyed steels	Megalax X4
High-alloyed, austenitic steels	Megalax H7
Duplex steels	Megalax He30 X1 Megalax He68 H2
Aluminium and its alloys	Megalax He70 N
Un- and low-alloyed steels	Megalax He50



Shielding gas supply in laser welding: coaxial or lateral



Different shielding gas mixtures also affect the laser beam. Different nozzle arrangements can be used to provide shielding gas coverage in laser beam welding: coaxial, lateral or peripheral and annular nozzles.

In coaxial shielding gas supply, the entire beam area between the nozzle outlet and the lens is blanketed with shielding gas. In this case, a plasma column can cause damage. The lateral supply of shielding gases often forms an injector which causes air to be drawn into the welding area. As a result, the welding process takes place under a shielding gas/air mixture, which leads to pores, annealing colors and other welding defects. With annular nozzles, it is helpful to use an additional assist gas for purging (e.g. nitrogen). This prevents the shielding gas from reaching the laser optics. The annular nozzle ensures that the melt pool is uniformly covered by shielding gas.

Gas supply

Depending on the quantity needed and on the intended use, Messer offers various supply concepts which have proven themselves in practice. Smaller quantities such as in the supply of laser gases (operating gases) are handled with gas cylinders. Individual 10-litre or 50-litre cylinders are most commonly used. For welding, all shielding gases and gas mixtures can be supplied in separate cylinders or in bundles.

Installation

For optimal gas supply, gases have to be transported to their destination without becoming contaminated. This requires proper installation of the hardware, appropriate selection of gas fittings and a need-based supply of gases in the purity needed. The installation of a particle filter provides additional security. The supply of gas to the resonator also demands extremely high purity, both in the resonator gases themselves and also for the pipes and hoses used as supply lines.

The degree of purity of the gases is indicated in percent – a figure given to several decimal places. In order to simplify labelling, an international index system has been established. The indices consist of a digit, a point and a second digit. The first digit indicates the number of nines, and the digit to the right of the point represents the last digit of the complete value. Example:

2.5 ^ 99,5 %
3.5 ^ 99,95 %
4.6 ^ 99,996 %
5.0 ^ 99,9990 %

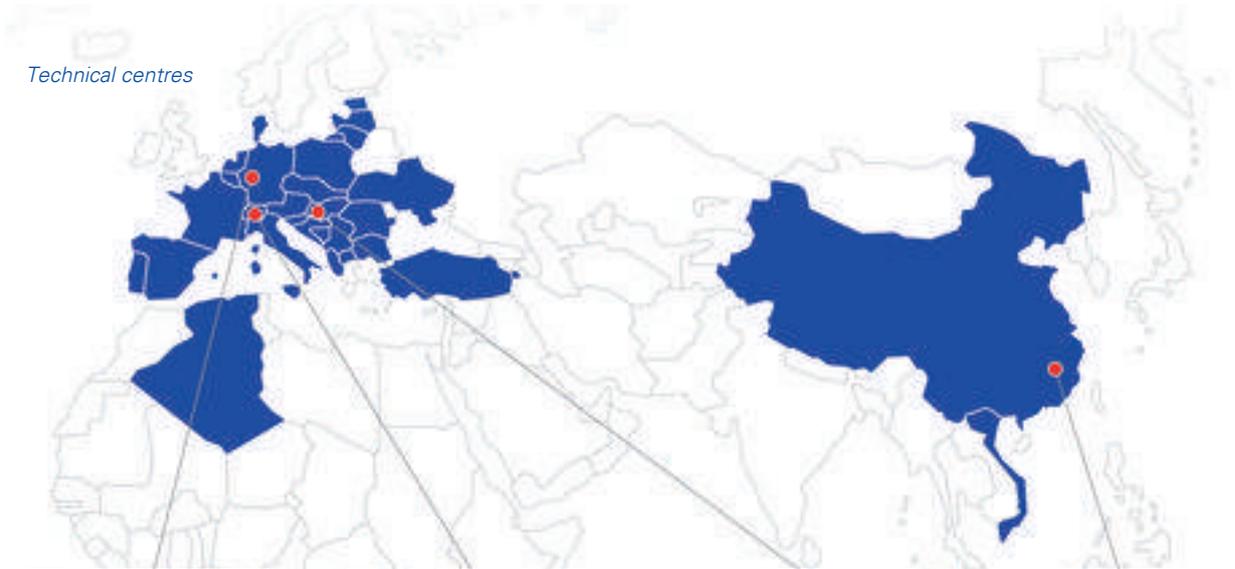
For the supply lines in the fixed part of the equipment, pipes made of copper or CrNi steel are ideal. Hoses always carry the risk that nitrogen, oxygen and especially moisture will diffuse into them. The use of special materials can minimise this problem.

Safety – without compromise

Equipment used in the laser processing of materials requires consideration of several special work safety aspects which are typical of lasers-based processes. First and foremost, there is the laser beam itself: its potential risks differ depending on the type of laser, and so the protective measures also differ accordingly. Moreover, emissions generated during welding or cutting must be appropriately extracted and filtered. For the safe use of laser systems and their peripheral equipment, the applicable guidelines and regulations have to be followed.

Advice, Delivery, Service

Technical centres



Krefeld



Dällikon



Budapest



Shanghai

Technical centres – sources for innovation

For the development of new technologies in the field of welding and cutting, Messer operates technical centres in Germany, Switzerland, Hungary and China. These facilities provide ideal conditions for innovative projects as well as customer presentations and training courses.

Portfolio of gases – comprehensive and clear

Messer offers a spectrum of gases that extends well beyond the standard fare: it ranges from just the right gas for each application, and clear, application-oriented product designations to the continuous introduction of new gas mixtures designed to address current trends.

Specialised on-site consulting – right where you need it

Specifically in the context of your particular application, we can show you how to optimise the efficiency and quality of your processes. Along with process development, we support you with troubleshooting and process development.

Cost analyses – fast and efficient

We will be glad to analyze your existing processes, develop optimisation proposals, support process modifications and compare the results with the original conditions – because your success is also our success.

Training courses – always up to date

For the optimal handling of our gases, we can train you on processes and how to use them. Our training courses illustrate the use of various shielding gases for welding and explain how to handle them safely. This also includes the storage of the gases and the safe transport of small quantities. Information and training materials for your plant are also part of the service, of course.

You can also download this brochure and many others from the Internet as a PDF file:
www.messergroup.com



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