Reduced hazard potential for high-performance lasers

Risk of injury due to unintentional radiation from fiber-coupled high-power lasers is high. A new special fiber interrupts the power supply of the laser in case of fiber breakage or disconnection.

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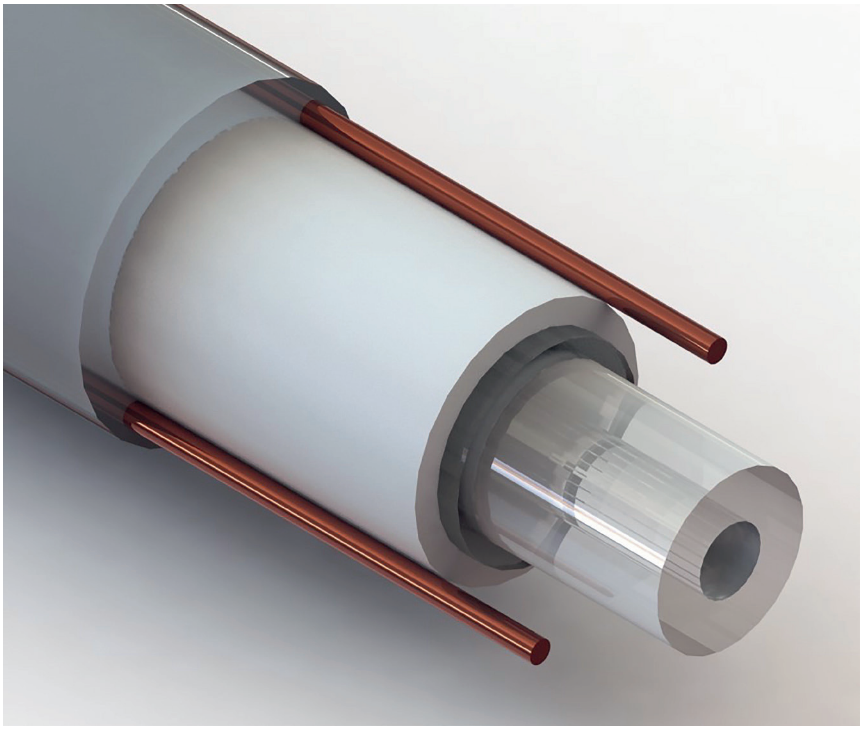
The widespread use of laser technology in industrial metalworking also means that a new source of hazard has also entered factory halls and application laboratories: due to their intensity, the radiation from industrial lasers is highly dangerous and can cause serious injuries.

According to DIN EN 60825-1 (2015), high-power lasers are all assigned to laser class 4 and thus to the class with the highest risk potential. This means that they may even cause fires or explosions. Even aside from those extremes, however, the risk is not to be underestimated: with class 4 lasers, the energy output is so intense that damage is inevitably to be expected as soon as the human body is exposed to radiation.

Radiation exposure

This type of critical radiation exposure happens much faster in practice than some users might suspect. After all, a person does not have to move directly into the focal area of a multikilowatt laser in order to suffer physical damage: even with mere scattering radiation, the consequences can be fatal. In addition to severe skin burns, with potential subsequent diseases such as skin cancer, irreversible eye damage poses a risk, as unfiltered high-intensity retinal irradiation leads to blindness within a very short time. One serious problem is that laser radiation is not always noticed immediately, that means as the vast majority of industrial laser systems operate in the infrared range, their radiation is therefore invisible to the human eye.

The color-intensive images that adorn many reports on welding and coating applications are all too easily misleading. What can be seen there are the melted powder streams and stirred up workpiece surfaces, but not the laser beam itself. The same applies in the factory hall, which is what makes the laser so dangerous: unlike a welding flash, it does not necessarily trigger the blink reflex. Affected persons often realize only belatedly that their eyes were exposed to scattered radiation through pain and a subsequent loss of vision, which can also lead to blindness. Such accidents were not uncommon, especially in the early days of industrial laser applications, where, according to a frequently quoted US statistic, during the first three decades since the advent of industrial lasers, eye injuries accounted for 69 % of all accidental damage.



Safety fibers prevent the leakage of scattered radiation

Image: Ceramoptec

Protection rules

In view of the enormous hazard potential of laser technology, legislators require nowadays comprehensive preventive measures in many industrialized countries. In Germany, for example, the Occupational Safety and Health Ordinance on Artificial Optical Radiation (OStrV), which entered into force in 2010, requires compliance with set exposure limits and the implementation of numerous protective and training measures. Organizations that produce or use high-power lasers are required to appoint a qualified laser protection officer who assists them in the assessment of hazards, the implementation of protective devices and the enactment of safe laser operation. Protective goggles and suits, shielding screens and walls are indispensable in many applications. Detailed briefings and regular training, regarding the safe handling of the beam sources, as well as the risk assessments of the protection officer must be documented.

Summary

Radiation discharges caused by fiber breaks or detachment of the fiber from the beam source are among the greatest hazards when using high-performance fiber-coupled lasers. A new fiber concept for the first time enables automatic laser shutdown in the event of damage. The relatively straightforward principle is based on thin copper wires, which are integrated into the polyamide jacket and connected to the circuit of the laser source. If the optical fiber is damaged, the copper wire conductors are destroyed and the power supply to the laser immediately interrupted. The risk of a radiation leak is therefore greatly reduced and occupational safety is improved in the long term.

The statutory health and safety regulations are however, not limited to clothing specifications and the separation of hazardous areas, but also include technical safety measures at the beam sources and laser systems themselves. Even the best information and protective measures can be pointless if radiation scatter emerges unexpectedly and the leak is not noticed immediately. The biggest risk factors in that regard are fiber breaks and loose fiber connections at the beam source. As a matter of fact, the vast majority of current high-performance industrial lasers are fiber-coupled: the laser beam is routed from the beam source to the workpiece via special fiber-optic cables, where it is directed towards the work area using focusing optics. During those processes, the fibers are often subjected to a variety of associated movements, for example by pivoting and rotating robot arms, on which the focusing optics as well as other components such as wide-beam nozzles are mounted. The optical cable is thus constantly affected by tensile and bending forces, which can lead in the long term to cable breaks due to material fatigue or the detachment of cables from the beam source. At the breakage or detachment points, light can then be emitted, and thus dangerous radiation scattering ensues.

If the optical cable of a laser breaks or detaches from the beam source, the entire laser system must be switched off immediately for obvious safety reasons. In the past, that usually required the active intervention of the operator, since damage or detachment of the conduction cable did not automatically lead to the shutdown of the system. That always left an undefined time window between the occurrence and discovery of the defect, during which leaking laser radiation could cause dangerous, possibly irreversible damage.

Safety fibers

A newly developed technology from Ceramoptec now makes it possible to close this window almost completely. For the first time, a new type of fiber configuration can trigger an automatic laser shutdown when the optical conductor is broken or detached. Thanks to these safety fibers, the critical response time after damage occurs is close to zero.

The new fiber concept is basically surprisingly simple, but therefore all the more effective: two wafer-thin copper wire conductors are integrated in the polyamide jacket that traditionally envelops the beam-carrying fibers. The wires are connected via the common fiber couplings into the circuit of the beam source. The optical cable and the laser system are therefore also connected electrically. If the cable breaks, the copper wire conductors are also destroyed. This interrupts the circuit of the laser system and immediately shuts off the beam generation. The same circuit interruption is generated when the fiber optic cable detaches from the power source. In the event of a breakage or detachment of the light guide, no radiation that represents a health hazard can escape within a few milliseconds – representing an enormous gain in the safety margin compared to the previous situation.

Since the two copper wire conductors are installed together with the usual polyamide sheathing immediately following the completion of the fiber drawing process, the newly developed fiber configuration is not limited to certain fiber types. All-round fibers such as the Optran UV/WF are available as 'safety' fibers as well the homogenizing Optran-NCC fibers with polygonal core geometries. In addition, the fiber configuration can be adapted to a wide variety of process conditions. In order to cover all bending radii and temperature zones, the copper wire conductors are available in standard configurations with cross-sections of 50, 100 and 150 µm as well as in customer specific versions. For applications where the fiber-optic cable is ex-

Safety fibers can be adapted to a wide variety of application conditions

posed to a variety of bends, thinner conductors are advantageous, while stronger conductors are available for high-temperature applications. Applications that combine both requirements can be manufactured, for example by utilizing conductors with special cross-sections and alloys.

Applications

Due to their high degree of flexibility in terms of fiber type and configuration, the safety fibers can be used in all fiber-dependent industrial laser applications. They are especially valuable in areas where unforeseen radiation leakage represents an above-average process risk – for example when using lasers in hazardous areas (EX/Atex). The inclusion of active protective devices, which automatically switch off the laser in the event of a cable breakage or detachment of the optical fiber from the beam source, is particularly advisable in these areas. mg ■

Web service

Further details on optical fibers from Ceramoptec

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