

Optical radiation protection in the BAuA

The BAuA is involved in many different ways in the field of optical radiation protection. Alongside the work on protection against laser radiation, the following main topics are dealt with:

- **Protection of eyes during welding**
Working comfort and occupational safety can be enhanced by improved electro-optical welder protection filters.
- **Laser protection filters for the ns and fs ranges**
The protective effect of laser filters may be impaired by non-linear light-material interactions, such as induced transmission.
- **Participation in the nationwide UV measuring network for the determination of the UV Index**
The UV Index is a simple measure of UV radiation which causes sunburn and can be obtained by anyone at the present time on the Internet (www.bfs.de).
- **Drawing up of specifications relating to the solar UV exposure of workers working in the open**
Using personal dosimetry information is obtained on the load experienced by certain occupational groups and the influence of work and leisure behaviour.
- **Protection of eyes from dazzle due to power LEDs**
The BAuA is involved in developing specifications for the measurement and risk assessment of different radiation sources and types.

Healthy, safe and competitive

The Federal Institute for Occupational Safety and Health (BAuA), as a knowledge provider in matters of safety and health at work, offers advice and practical assistance to the general public, the social partners and policy-makers. We research, analyse, inform, publish, co-ordinate, develop, train and advice for a human world of work with safe, healthy and competitive workplaces.

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Hand-held lasers to work materials

What protective equipment really protects?



It's having the right protective equipment that counts

The use of hand-held lasers to work materials is on the increase. Not only in research, but also in industry and the craft sector there is increasing reliance on the great efficiency and precision of lasers. Hand-held lasers are used in machine and plant engineering, as well as in the automobile industry, in shipbuilding and in the restoration of historic monuments. At the goldsmith's workplace and in the dental laboratory hand-held lasers are now part of the standard manual tool inventory.

Many of these devices have technical protective facilities which, it must be said, cannot provide adequate protection in every case. Personal protective equipment is therefore absolutely essential when using hand-held lasers. But what characteristics do materials need to have in order to give real protection? The BAuA studied in a research project what materials are suitable in protective clothing.

There have as yet been no testing methods or application recommendations with respect to the material of personal protective equipment as worn when operating material-working, hand-held lasers. The aim of the research project was to verify testing methods and the suitability of personal protective equipment (protective clothing, face, hand and foot protection). For this purpose various commercially available and new materials were examined with lasers typical for this particular application (CO₂, Nd-YAG, diode lasers), the aim being to check they were fit for purpose.

For manufacturers and users a basis has thus been worked out for the safe and practice-based selection of personal protective equipment.

With the results it is possible to establish safety provisions for typical applications in the standards and to formulate a set of model operating instructions according to the German ordinance on the use of personal protective equipment ('PSA-Benutzungsverordnung').



Practical instructions for manufacturers Personal protective equipment (PPE)

PPE manufacturers of protective equipment for the operation of hand-held lasers should take the following steps to determine the exposure conditions and to select PPE:

1. The foreseeable maximum radiation of the body part concerned or the side of the protective system towards the beam must be estimated as accurately as possible, specifically with respect to
 - intended operation
 - foreseeable cases of misuse
2. To ensure adequate protective effect the correct materials must be selected according to the following criteria:

Degree of transmission of the protective system

- high mass by area (tight weave) and
- laminated, coated, metallised fabric

Properties which effectively prevent failure of the protective system, such as the formation of holes or penetration by laser rays

- optical properties: diffuse reflection of the laser rays on functional layers
- thermo-mechanical behaviour: high destruction threshold and flame-retardant equipment

Properties which prevent heat transfer from the protective system to the skin (within the tolerance time, i.e. the time between the heat input and the occurrence of second-degree burns)

- low heat input into the skin
- high mass by area
- type of bonding (material structure): e.g. honeycomb weave (through insulating effect)

What protective equipment protects? The results of the research project

1. Commercially available cotton clothing (T shirt, shirt, jacket, glove)

Mass by area < 250 g/m², high transmission, quick failure, quick inflammability, quasi no tolerance time

▶ hardly offers any protection against laser radiation ($E > 5 \times 10^4 \text{ W/m}^2$)

2. Protective equipment of cotton/main constituent cotton according to DIN EN 531, DIN EN 470-1, equipped to be flame-retardant, mass by area $\geq 300 \text{ g/m}^2$

low transmission, longer time to failure, partial inflammability; tolerance time short ($E > 1 \times 10^5 \text{ W/m}^2$)

▶ provides limited protection against laser rays where there are high radiation intensities

3. Protective equipment of aramide-aluminised, metal-lines, laminated according to DIN EN 531, DIN EN 470-1

very low transmission, substantially longer times to failure, no inflammability, substantially longer tolerance times where there are higher radiation intensities ($E > 1 \times 10^5 \text{ W/m}^2$), fabric very stiff, limited comfort when worn

▶ suitable for aprons, gloves, limited areas of clothing, provides the best protection against laser rays as compared to other possibilities

4. Commercially available protective gloves of leather (welders' protective gloves) according to DIN EN 12477

low transmission, longer time to failure, no inflammability with higher radiation intensities (especially in the case of CO₂ laser radiation), major shrinkage in leather; very difficult or impossible to remove gloves, a certain storage of input thermal energy and delayed discharge to the skin, danger of delayed burning

▶ limited suitability as PPE against laser rays, heat-treated leather (fire-brigade protective gloves) more beneficial

