Kömmerling®
TODAY FOR TOMORROW

PROCESSING GUIDELINES

PVC-U sheets in use

WORKING GUIDELINES FOR PVC-U SHEETS

KömaCel® KömaTex® KömaPrint® KömaDur®

When working with PVC-U sheets, there is a number of special guidelines and directions that must be complied with. The following data and values are provided for orientation purposes. Although they have been obtained by conducting a great variety of trials and tests, they cannot be assumed to be binding for every type of application.

Almost all tools and machine tools used to work metal and wood can also be used to work our KömaCel®, KömaTex®, KömaPrint® and KömaDur® PVC-U sheets. The cutting speeds are high, the feed rate low and the cutting depth also low. In most cases, there is no need to cool either the cutting tools or the cuts themselves, provided that the cutting edges of the tools are kept sharp and the heat that arises through the cutting process is dissipated by quickly removing the chips. If the depth of the cut is deeper, the cut will have to be cooled in order to prevent the material from “smearing”: this can be done using compressed air or water (cooling medium). Furthermore, the existing safety instructions also require that chips and dust be properly extracted.

Please note that whichever method is chosen to work the material, deep grooves and sharp edges must be avoided as they would lead to early breakage of the material due to the known notching effect when put under strain. Smooth surfaces at the edges can be obtained by finishing them with buffing wheels made of felt, unbleached calico or sisal weave, or with felt tapes. Grinding or polishing pastes can also be used. Uneven edges that arise during sawing, drilling or milling can be given a clean finish using flat scrapers (grinding angle 15°).

Guideline values regarding the cutting conditions and shapes of cuts and sections in connection with the working processes described below can be found in the table on page 22; for further details, see VDI Specifications.

CONTENT

KömaCel® Areas of application

ADVERTISING SECTOR

- Signs
- Inscription panels
- Displays
- Shop window decorations
- Large lettering
- Exhibition and showroom stands

BUILDING SECTOR

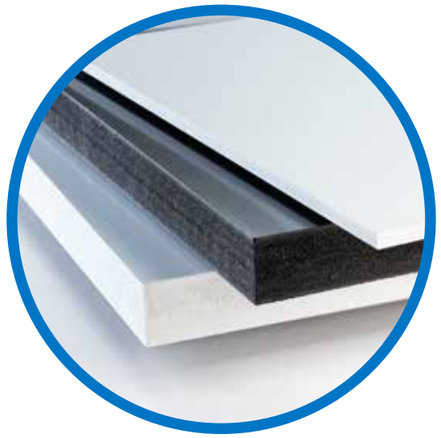
- Shop and interior finishing
- Wet rooms
- Cladding
- Roller shutter boxes
- Opaque panel infills
- Door and window elements

ANTIBACTERIAL

- Professional kitchens and canteens
- Laundries
- Healthcare pools and sports school pools
- Hospitals and retirement and nursing homes
- Operating rooms
- Cold stores
- Clean rooms

OTHER

- Model building
- Furniture industry
- Structured parts
- Photo lamination



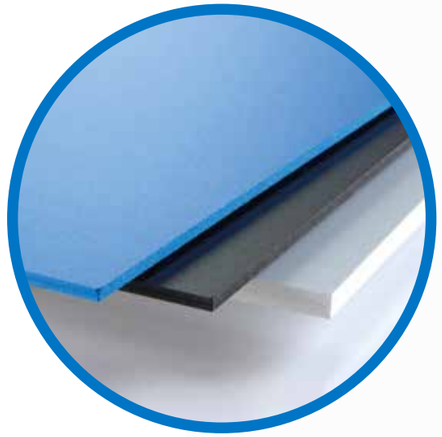
- Traffic signs for construction sites
- Chemical and laboratory areas
- Ship, container, and vehicule interior fittings

Features

- Solid, closed, smooth outer cover
- Fine-celled foam structure, moulded-in colour
- With glossy or matt surface
- Simple processing
- Very good bonding
- Good printing qualities
- Good for laminating
- Good for painting
- Good acoustic insulation
- Good sound insulation
- Low thermal conductivity
- Very good flexural strength
- Flame resistant *up to 10 mm thickness*
- Chemical and corrosion resistant
- Low water absorption
- Weatherproof and weather resistant
- No swelling
- 100% recyclable
- Active and long antibacterial protection
- Elimination of microbes

KömaTex®

Areas of application



ADVERTISING SECTOR

- Signs
- Banners
- Inscription panels
- Displays
- Shop window decorations
- Exhibition and showroom stands
- Digital printing
- Photo lamination

BUILDING SECTOR

- Shop design
- Interior finishing
- Model building
- Traffic signs for construction sites

Features

- Uniformly and finely structured surface
- Fine-celled foam structure
- Good surface strength
- Excellent printing quality
- Good for laminating
- Very good for bonding
- Ideal for punching work
- Simple processing
- Lightweight
- Flame resistant
- Thermoformable
- Chemical and corrosion resistant
- Weatherproof and weather resistant (colour White 662)
- Low water absorption
- Low thermal conductivity
- 100 % recyclable

KömaPrint®

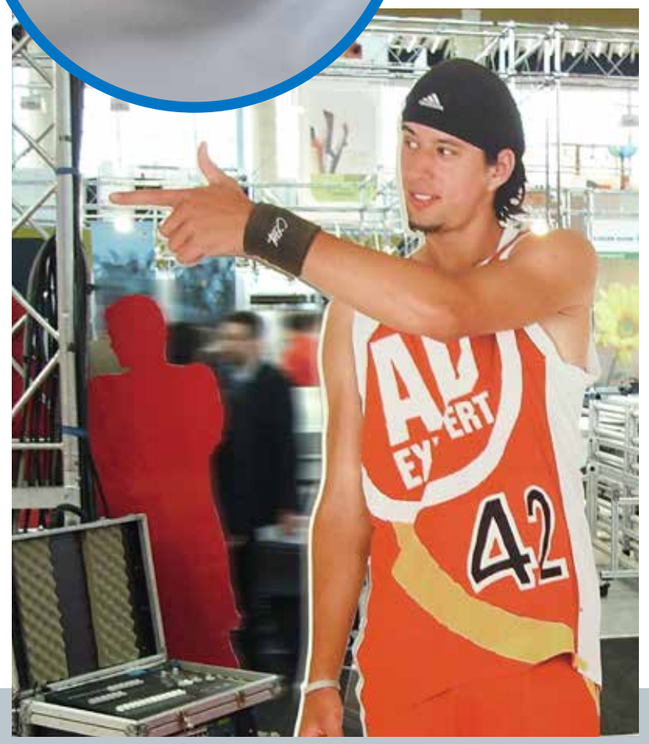
Areas of application

ADVERTISING SECTOR

- Digital printing
- Screen printing
- Photo lamination
- Signs
- Displays
- Banners
- Lettering
- Promotion
- Shop window decorations

OTHER

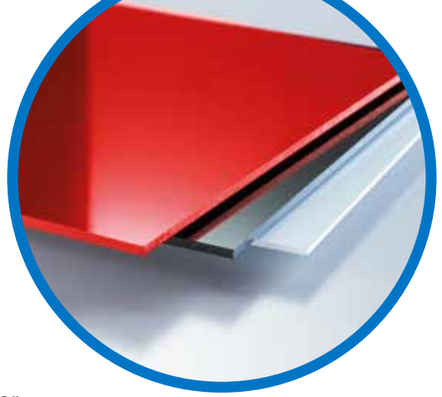
- Presentations
- Exhibitions
- Puzzles
- Decorations



Features

- Uniformly and finely structured surface
- Ideal for cutting, trimming, and sawing
- Ideal for punching work
- Fine-celled foam structure
- Excellent printing qualities
- Moisture resistant
- Colour 667 bright white
- For reliable printing processes
- Flame resistant
- Lightweight
- Good for laminating
- For internal and external applications
- Simple processing
- Very good for bonding
- 100 % recyclable

KömaDur®



Areas of application

ADVERTISING SECTOR

- Signs
- Displays
- Banners
- Inscription panels
- Exhibition and showroom stands
- Shop window decorations
- Digital printing

OTHER

- Deep drawn parts
- Machine building
- Apparatus and tank construction
- Electroplating technology
- Chemical and laboratory engineering
- Accumulators
- Photo industry

BUILDING SECTOR

- Shop and interior finishing
- Zone of high humidity
- Air conditioning and ventilation elements
- Sandwich elements for wall and door panelling
- Cladding and panelling

ANTIBACTERIAL

- Professional kitchens and canteens
- Laundries
- Healthcare pools and sports school pools
- Hospitals and retirement and nursing homes
- Operating rooms
- Cold stores
- Clean rooms

Features

- Surface smooth glossy or matt on one side
- Very good for printing *KömaDur D*
- Protective film on one side
- Various white hues and colours as well as dark and light grey
- Good for laminating *KömaDur D*
- 100 % recyclable
- Normal to increased impact resistance
- Very good for bonding
- Active and long antibacterial protection
- Deep drawing properties
- Flame resistant
- Elimination of microbes
- Suitable for welding
- Chemical and corrosion resistant
- Food harmless
- Grooved and embossed
- Weatherproof and weather resistant

MACHINING

Sawing

High-speed bandsaws and circular saws with a cutting speed of up to 3000 m/min are recommended. Depending on the thickness of the sheets, saw blades with a tooth pitch of between 5 and 10 mm are used. For circular saws, it is normally recommended to use blades with a tooth geometry that alternates between flat teeth, trapezoidal teeth and carbide-tipped teeth.

The saw blade diameter (Ø) and the number of teeth (t) must be coordinated to match the material to be machined, the machine type and the machine speed (e.g. KömaCel Ø 300 mm, t 96, speed 4000–5000 rpm, horizontal or vertical panel saw).

- In order to obtain clean edges to cuts and to avoid cracking, always clamp the sheet material in the work holding fixture in such a way that it does not vibrate.
- This is especially important for thin sheets with a thickness of 1–3 mm, not only when machining them singly but also in a stack.
- Use guillotine shears to cut a thickness of 1 mm.
- In the case of jigsaws, use only sharpened, unset saw blades (plastics, PVC-U). The feed (manual) must be at a slow, constant speed.
- In particular cases, it may be advisable to make use of the consulting service offered by the saw-blade manufacturer.

Information about the cutting geometry of the machining processes can be found in the table on page 22. The information and instructions given by the respective machine manufacturer must of course be observed.

Drilling

All PVC-U sheets in question can be drilled using the sort of twist drills familiar from drilling metals (DIN 1412 twist drills) whose angle of twist is approx. 30°. The point (or nose) angle can be up to approx. 110°, while the lip relief angle should be no smaller than 12–16°.

The cutting and feed speeds depend on the depth of the hole to be drilled: the thicker the sheet, the slower the speed. For holes larger than 20 mm in diameter, two-flute cutters with pilots are used. Holes larger than 40 mm in diameter are cut using circular cutters (e.g. quick helix drills).

Turning

When rough turning, it is advisable to combine a slow feed rate with a greater cutting depth and to use a cutting tip with a radius of at least 0.5 mm in order to obtain a groove-free surface. The cutting depth should be max. 2 mm for fine turning. If a faster feed rate is selected, cracking of the material can be avoided by setting a slower cutting speed.

Milling

The milling tools have to be ground so that they are suitable for working the plastic material. They must also provide enough space for an adequate volume of chips. Working with a fast forward feed rate along with moderate cutting speed and deep cuts will lead to good results. 3-D milling can also be performed without any problem with KömaCel®, KömaTex®, KömaPrint® and KömaDur®. For this purpose, the plotter system is equipped with a special ballnose end mill and linked with suitable computer software.

Cutting, punching, perforating

KömaDur® sheets up to 3 mm thick can be cut with guillotine (sheet) shears. The cut must be made swiftly and without interruption. The sheets should have room temperature, i.e. at least 20 °C. Thicker sheets (> 3 mm) should be cut using a saw.

KömaTex®, KömaPrint® and KömaDur® sheets up to 3 mm thick can be punched and perforated with profiling knives or two-piece tools. Also recommended are punching tools (made of strip steel) with facet cut (bevelled edge) on both sides. Heating the PVC-U material to 30 to 40 °C is useful and aids the working process.

Laser cutting

Due to the heat that is transferred to the material during laser cutting, this process is unsuitable for rigid foam sheets.

Water-jet cutting

An alternative cutting technology (cold-cutting process) is water-jet cutting. This cutting method is especially suitable for KömaCel®, KömaTex®, KömaPrint® and KömaDur® when complex contours are to be cut out.

Up to a sheet thickness of 3 mm, cutting can be performed using a pure water jet. For thicknesses of 4 mm and more, however, an abrasive agent (e.g. silica sand) should be added to the cutting water.

Different cutting speeds can be used depending on the type and thickness of the sheet and the type and quality of the cutting unit. The cutting speed depends mainly on the quality of the cutting surface wanted and should perhaps be discussed and agreed upon with the customer.

At the beginning of every series, therefore, we advise you to first of all determine the correct cutting speed with respect to the quality of the cutting surface.

FORMING (NON-CUTTING SHAPING)

KömaTex® KömaDur®

KömaTex® and KömaDur® PVC-U sheets can be formed, i.e. worked or shaped without cutting, by means of a number of different processes: by folding, bending, compression moulding, upsetting, stretch forming and thermoforming.

Usually, the sheets are formed during the elastic-plastic phase of the material, in which maximum degrees of expansion/elongation are reached and the forces required for forming can be kept low. In order to prevent damage to their structure, KömaTex® and KömaDur® sheets must not be formed at and below the softening temperature, i.e. at temperatures below 90 °C. The most favourable temperature range for each of the various hot-working processes depends on the sheet material and application (cf. table on page 12).

Good forming is possible only when the sheet material is thoroughly and homogeneously heated. The sheets are preferably heated using infrared heaters, but heating ovens or circulating-air ovens can also be used. During folding processes, for example, the sheets require localised heating, for which heating elements can be used.

Furthermore, we recommend sheets 3 mm thick and more be heated on both sides in order to avoid damage to the one surface through overheating and to shorten the heating time.

Thermoforming and stretch forming

KömaDur® and KömaTex® sheets can be thermoformed or stretch-formed on all commercially available forming machines. The only proviso is that the machines are protected against draughts on all sides.

Fast working cycle times can be achieved if the tools used for these forming processes are cooled. In the case of vacuum forming, sand-blasted surfaces have the advantage that the air can be completely extracted without leaving any air pockets. The diameter of the vacuum bores should not exceed 0.8 mm in order to prevent deformation of the drill holes. The edges should generally be rounded with a radius that is no more than between one and three times the thickness of the sheet.

In the case of KömaDur® and KömaTex® sheets, male moulds must be sufficiently conical: approx. 5°C. Female moulds do not need to be conical as the thermoformed parts separate from the mould as they cool down.

Cooling is generally carried out using compressed air. Compressed air combined with sprayed water, however, must not be used until the surfaces have hardened. Of the various thermo and stretch-forming processes, particular mention should be made of the air-slip processes in which the heated

sheets are prestretched pneumatically, i.e. by air. These processes are the ones that generally produce thermoformed parts with the most uniform material thickness.

In this connection, it is important to mention that the forming process of the material stops wherever the PVC-U sheet touches something (the mould). Thermoformed parts will for the most part not warp if the forming temperature is high, the parts are cooled down slowly, the moulds are opened at rather low temperatures and the rims are trimmed immediately after the parts have been removed from the moulds. For the forming process itself and the design of the moulds, the shrinkage of sheets has to be taken into account. KömaTex® and KömaDur® sheets can shrink by up to 0.5%, particularly in the direction of extrusion.

KömaCel® in the thicknesses 4, 5 and 6 mm can also be thermoformed. Due to their characteristics, however, the ability of the thicker KömaCel® sheets to be thermoformed is restricted. Deformations under thermal impact are possible to a limited degree (e.g. bending, folding with notch, etc.).

Folding, bending, compression moulding

Folding and bending of the PVC-U sheets must only be performed on suitable equipment. The bending radius must never be smaller than two to three times the thickness of the sheet. The heated zone should have a width of at least five times the thickness of the sheet.

After cooling, linear heating of the material will lead to stresses developing within the PVC-U, which cause warping when folding short lengths.

Sides with a length 20 times the thickness of the sheet will not warp. For this reason, we recommend you heat up the entire section in order to prevent short sides from warping.

Folds with a relatively small radius can be made by notching (V-notch) the inner side.

Hot-folding of sheets

To prevent the cell structure from being stretched to too great a degree, a minimum bending radius of approximately twice the thickness of the sheet must be observed. In the case of PVC sheets 8 mm or thicker, please remove the excess material by milling a V-shaped groove along the inside of the bending edge before bending. You can then carefully heat up the outside of the bending edge, bend up a fold and bond the joint created. However, a remaining thickness of 1 to 2 mm must be left in the rigid foam sheets. When milling, make sure that the V-shaped groove is 1° larger than the desired bending angle, i.e. 91° in the case of a 90° angle.

Cold-bending of sheets

The minimum bending radius when cold-bending rigid foam sheets is roughly 100 times the thickness of the sheet, that is, 200 mm for a 2 mm-thick sheet. To coldbend thick sheets, use a bench saw to saw around ten parallel grooves into the sheet with a clearance between them the width of the saw blade, leaving a remaining thickness of 1 to 2 mm. You can also use this method to bend thick sheets to any desired angle without heating them.

Embossing

Impressions such as letters, characters, numbers and ciphers are embossed with tools familiar from sheet-metal working and the cardboard and leather industries. The tools must be preheated: for working KömaCel®, KömaTex® and KömaDur®, temperatures up to around 100–130 °C are recommended. The actual embossing process generally does not require the sheet material to be heated.

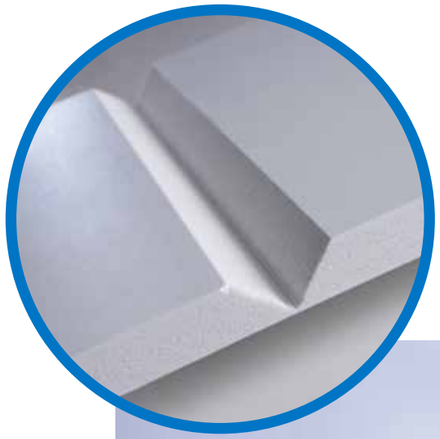
Further information and useful advice on forming PVC-U sheets can be found in VDI specifications.

Hot-working processes

Standard hot-working temperatures for forming (non-cutting shaping).

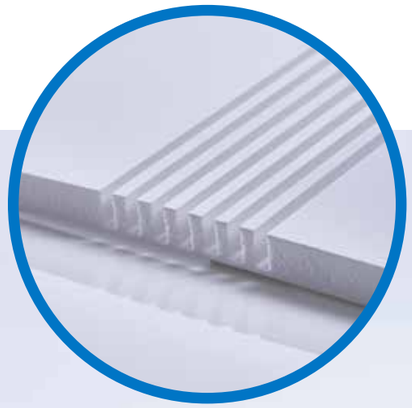
Material	Abkanten, Biegen und Pressform	Tiefziehen
KömaCel®	approx. 100 °C	with restrictions
KömaTex®	approx. 130 °C	120–150 °C
KömaDur® M, ES/D, H, WA	120–140 °C	135–180 °C

NB: If the material is heated above 180 °C, it initially leads to discoloration and then to thermal damage. Avoid forming rigid foam sheets at temperatures below 120 °C in order not to damage the cell structure.



Milling edge technology

By milling a V-groove, the panel thickness is reduced, which thus also determines the edge radius. With this technique it is also possible to bend thicker panels at the required angle.



Slot bending technology

By using the so-called slot bending technique, even thicker sheets can be cold bent and, compared to conventional „cold bending“, components with relatively small bending angles can be produced.

WELDING

KömaCel® KömaTex® KömaDur®

KömaCel®, KömaTex® and KömaDur® are made of thermoplastic materials. The sheets can be welded by means of familiar welding processes, such as hot-gas welding, heated-tool welding, folding and welding and friction welding, and using all pieces of equipment commonly available on the market.

Please always make sure before welding that the sheets in the welding zone have been properly cleaned with a cleaning agent or, better still, by machining.

After the welding process and depending upon the kind of product and application, you have to decide whether the weld seams need finishing or not. Filing,planing, grinding or smoothing are suitable methods to finish the weld seams. In all cases, it is important to work with care in order to avoid notching.

Please take great care with KömaCel and KömaTex sheets so that the foam structure does not collapse.

Good welding factors also require that the welding wire is not stretched with constant pressure and constant speed. pressure and constant speed. Before each new layer of welding rod, the joint must be scrape out; thermally damaged areas must be must be removed.

Hot-gas welding (with welding rod)

When hot-gas welding with a welding tip, the sheet material and the welding rod are plasticised at the weld by means of heated gas (max. 0.3 bar, low-pressure blowers, e.g. from Leister, Wegener, Zinser, Forsthoff) and preferably oil and water-free compressed air, and are then joined under pressure.

The necessary welding rods are part of our production range; they are available as coils or as pieces in different lengths and with different profiles. Both manual welding and machine welding are possible. The market offers a wide range of different welding equipment and welding tips. In particular, high-speed nozzles have proven themselves, enabling high welding speeds and producing good and reliable weld seams by evenly heating up the sheet and welding rod. Semi-automatic welding units with mechanical feed are particularly suitable for series production runs. The most frequent welds are the fillet weld, the single V and the double-V butt weld (see DIN 16930 and 16932).

Thin sheets are joined by single-V butt welds, thick sheets by double-V butt welds. The latter should be produced by welding on both sides alternately in order to avoid warping and buckling. The standard values for the temperature of heated gas (measured in the nozzle) as shown in the following table should be complied with in order to achieve weld seams with good welding factors.

Standard values for hot-gas welding

Temperatures inside the welding nozzle		
Material	**Circular nozzle**	**High-speed nozzle**
KömaCel® /KömaTex®	240 – 270 °C	270 – 290 °C
KömaDur® M, ES/D, H, WA	300 – 330 °C	220 – 350 °C

These standard values depend on the rate of hot-air flow (40–60 l/min), the welding speed, the type of welding rod, the temperature induction period, etc.
Circular nozzle 15–20 cm/min

Heated-tool welding (butt welding)

Another method of welding KömaCel®, KömaTex® and KömaDur® PVC-U sheets is the heated-tool welding procedure, in which tools of different shapes (circular, sword-shaped) are used. The perfectly smoothed-out and cleaned surfaces of the parts to be welded are heated up slightly by pressing them against the heated tool until they are plasticised. They are then pressed together.

This welding process is simple and time-saving and produces joints that are almost free of stress.

As long as the welding conditions, which depend on the material (temperature of the heated tools, contact pressure against the tool, contact pressure when joining and immediate joining after plasticising), are adhered to, the strength of the welding seams is almost equal to the strength of the basic material itself.

Standard values heated-tool welding

	Surface temperature of heated tool	Contact pressure (MPa)	
Material		**for heating**	**for joining**
KömaCel® /KömaTex®	210 – 230 °C	0.05	0.1 – 0.2
KömaDur® M, ES/D, H, WA	220 – 250 °C	0.05 (contact press.)	0.3 – 0.5

These standard values depend on the sheet thickness, heating time, etc. Circular nozzle 30–70 cm/min

Folding and welding

The folding and welding process is a modification of the butt welding process. The sheet is resting on an even surface. The heated tool is placed on the sheet along the bending (folding) line as a cutting edge until it melts into the material.

The edge of the bar has an angle of 60° for rectangular folding. The bar should penetrate the sheet by up to 2/3 of its thickness, before it is raised again. Immediately on removing the bar, the sheet is folded and welded along the plasticised line.

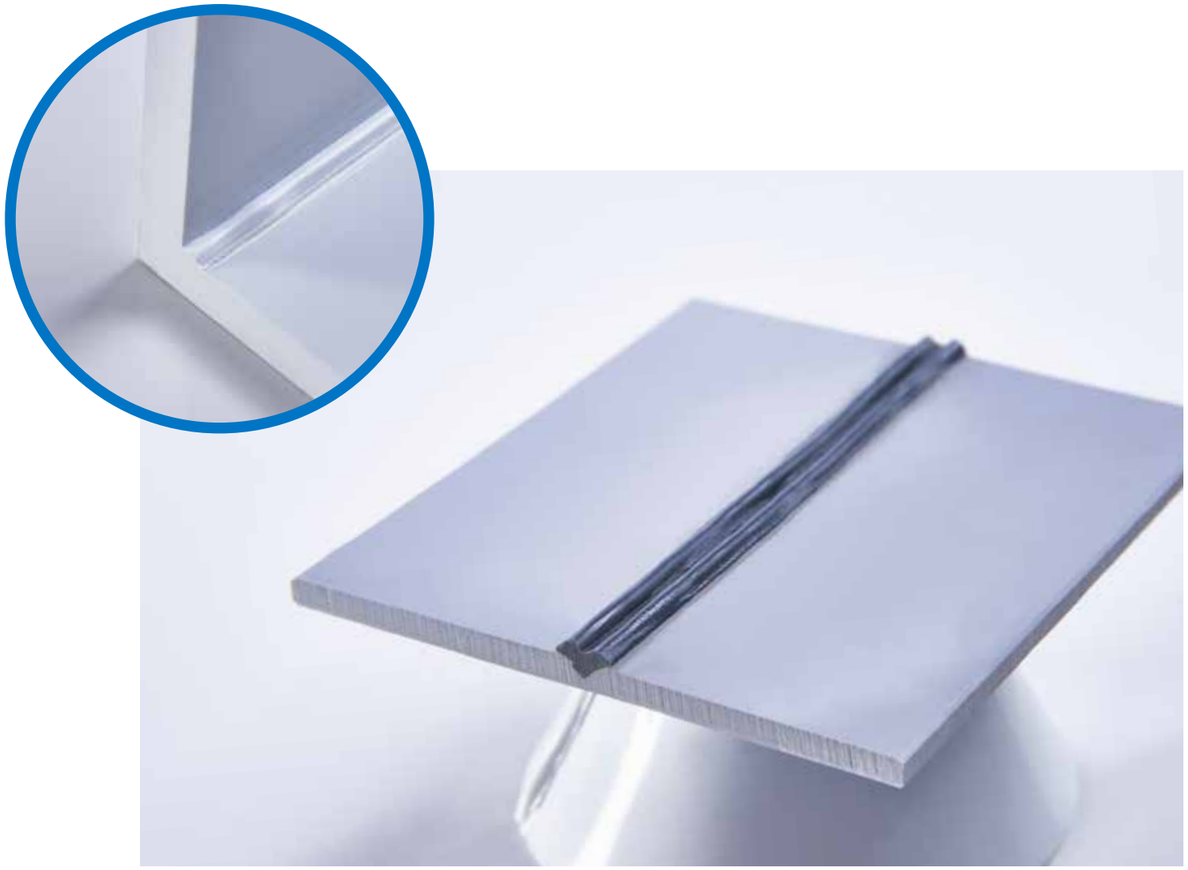
In order to produce the necessary pressure at the heated bar, the angle between the edges to be welded must be 15° to 20° smaller than the folding angle wanted. If thick sheets have to be folded, the heating time can be reduced by milling a wedge-shaped groove into the welding line before applying the heated bar.

The following parameters must be precisely adjusted and checked at regular intervals.

Heating should be stopped when this bead is 1–2 mm thick.

The contact pressure of the heated tool against the sheet must be set so low in order to avoid too much of the plasticised material being squeezed out of the plasticised zone.

Immediately after removing the heated tool from the sheet, the plasticised parts must be firmly pressed together until the material has hardened again.



BONDING

KömaCel®, KömaTex®, KömaPrint® and KömaDur® sheets, just like all other PVC-U materials, can be bonded both among one another and to other materials.

Different adhesive types may be used depending on the requirements and the specific use. For bonding KömaCel®, KömaTex®, KömaPrint® and KömaDur® sheets to one another, adhesives containing solvents (e.g. C 004) as well as solvent-free polyurethane adhesives (e.g. C 012) are suitable. C 004 is a PVC-U adhesive with colourless curing, which, because of its joint-filling characteristics, is able to align small uneven areas on the bonding surfaces. It cures extremely fast and should only be used for bonding rather small surfaces (such as butt joints). The stability characteristics of the cured bonding seams lie within the material stability range of the sheets themselves.

The PUR adhesives C 012 are solvent-free and resistant to moisture. They are suitable both for PVC-U sheets among one another and for bonding to other materials such as metals, stoneware, concrete, wood, many rigid plastics and rigid foam (polystyrene, PU, etc.). If using adhesives and adhesive systems that do not adhere with solvents, it will be necessary for the surface to be bonded to be cleaned first with 80/110 cleaner's naphtha or white spirit.

PRINTING AND LACQUERING

Thanks to their smooth surface, KömaCel®, KömaTex®, KömaPrint® and KömaDur® sheets can be easily printed, painted and lacquered. Basically, they can be lacquered with all lacquer systems suitable for PVC. The following systems have proven themselves particularly suitable:

1. One and two-component lacquer systems based on acrylic
2. Two-component polyurethane lacquer systems ("DD lacquers")
3. Screen-printing inks for PVC (vehicle base acrylic resin/PVC copolymer)

The lacquer systems stated under 1. and 2. are good for spray application. The screen-printing inks cited under 3. (manufacturers: e.g. Diegel, Wiederhold, Marabu, Proll and Sericol) are primarily for use in the screen-printing process.

They can also be used for painting and lacquering. For this purpose, however, the inks must be set to the required viscosity. Please consult the ink manufacturers with regard to the ink types to be used. By the way, radiation-curing lacquers have recently started to be used. One disadvantage of these, however, is that the non-lacquered surface areas can suffer discoloration depending on the length of exposure to the radiation. The surface to be printed must, as with all other materials, be clean and grease-free. However, we do advise against lacquering large surface areas of sheets that will be exposed to direct sunlight with a dark lacquer, due to excessive increases in temperature.

If outdoor use and weathering properties have an important role to play, we strongly advise you to consult the ink manufacturers. The working guidelines and instructions given in the application data and information sheets published by the ink manufacturers must be adhered to and requested if not in your possession.

DIGITAL DIRECT PRINTING

KömaTex® KömaPrint®

General information on direct printing

KömaTex® and KömaPrint® sheets are being used more and more in digital direct printing. However, the sheets are just one of several factors that influence the print result. At least as important as the sheets themselves in respect of this printing process are factors such as protective films, the image structure, the press, printing ink, electrostatic charge, press operation and a variety of ambient conditions (humidity, temperatures, etc.). Whenever working with the digital direct printing process, always wear cotton gloves.

Antistatic treatment

KömaPrint® sheets are good electrical insulators. For this reason, static charges applied by handling or cleaning can only be removed again by artificial discharge. In addition to other physical methods, blowing off with ionised air has proven effective.

Wiping with liquid antistatic agent prevents the build-up of new static charge over a certain period of time and thus the attraction of dirt particles. As this „protective film“ impairs the adhesion of paints and adhesives, it should only be applied at the end of all processing steps. Furthermore, it is essential to make sure that the printer manufacturer‘s specified values - for humidity and ambient temperature - are adhered to, as otherwise flow problems in the form of spotting and/or cloud formation may occur.

Staining due to humidity

If the ambient temperature in the storage area drops significantly overnight, the sheets will cool down. If the sheets are brought into the higher temperature printing area for printing the next day and there is a high level of humidity (e.g. if it has been raining), condensation can form between the protective film and the sheet surface. If the protective film is then removed immediately and the sheet surface is printed directly, stains or clouding may occur. For this reason, the boards must be conditioned for several hours before digital printing.

Furthermore, it is essential to ensure that the default values specified by the printer manufacturer - for humidity and ambient temperature - are adhered to, as otherwise this can lead to flow problems in the form of spotting and/or cloud formation.

Influence of protection films

Although protective films prevent soiling, they increase the static charge of the sheets when they are removed, which can lead to an uneven print image („cloud formation“).

Recommendation: For direct digital printing of light, single-colour print designs (e.g. background panels), use uncoated sheets.

Image and colour values

Light and transparent colours adhere to the substrate better than dark and opaque colours thanks to the different crosslinking characteristics. However, too high an ambient humidity level can also be a reason for ink adhering poorly. The quality of ink adhesion can only be reliably tested at the earliest 24 to 48 hours after printing.

Influence of UV lamps

The age, number and positioning of the UV lamps used to cure the printing ink also play an important role: too low a level of UV intensity, for instance, leads to inadequate crosslinking and the ink not adhering to the sheets properly. If the UV intensity is too high, the substrate can yellow, while the IR radiation also emitted by the lamps can cause the substrate to overheat and ultimately warp (dish).

LAMINATING

Kömmerling sheets can be laminated with photo lamination and labelling using standard self-adhesive films.

The choice of adhesive depends on the combination of materials and the requirements of the application. Depending on the type of laminating systems available (e.g. presses or roller application systems), 2-component PU adhesives or PUR hotmelt adhesives are used, for example. When selecting an adhesive, it is generally advisable to obtain technical application advice from the adhesive manufacturer. As materials with different physical properties are usually bonded when laminating, the sheets should always be laminated on both sides with the same material and in the same material thickness (backing) in order to rule out possible warping of the composite material. Always carry out preliminary tests before the actual production.

As with printing and painting, only materials in light colours should be laminated for outdoor applications, as dark colours can cause increased temperature absorption and warping of the sheets when exposed to sunlight.

USEFUL INFORMATION

Transport and storage

Store KömaCel®, KömaTex®, KömaPrint® and KömaDur® sheets in air-conditioned, constantly dry rooms at a temperature of around 15–20 °C and on a level base. Even while packed, the sheets must not be exposed to weather and sunlight.

- The sheets must not be exposed to weathering and sunlight in the packaging, especially in the case of sheets with protective film.
- Suitable forklift trucks or lifting equipment must be used for loading and unloading.
- When unloading, please check the sheet packaging directly for damage and note this on the delivery documents if necessary.
- Protective film-coated sheets should be processed within 6 months.
- Store pallets protected from rain and splash water.
- Protect from penetrating moisture.
- Avoid condensation (e.g. when transporting cold boards to warmer rooms).

CHEMICAL RESISTANCE OF PVC

Medium	Concentration (%)	Temperature	
		20 °C	60 °C
Organic chemicals			
Formic acid	10	++	++
Formic acid	100	++	+
Anillin	-	-	-
Ethanol	-	++	+
Petrol-benzene mixture (BV-Aral)	-	-	-
Benzene	-	-	-
Butanol	-	++	++
Cyclohexane	-	++	+
Cyclohexanol	-	++	++
Decalin	-	++	++
Diesel fuel	-	++	-
Diethyl ether	-	-	-
Glacial acetic acid	-	++	-
Acetic acid	10	++	++
Formalin	-	++	+
Glycol	-	++	++
Heating oil	-	++	N/A.
Heptane	-	++	-
Hexane	-	++	++
M-cresol	-	+	-
White spirit	-	++	O
Machine oil	-	++	++
Methanol	-	++	+
Olive oil	-	++	++
Petroleum ether	-	++	+
Turpentine oil	-	++	O
Toluene	-	-	-
Transformer oil	-	++	++
Xylene	-	-	-

Medium	Concentration (%)	Temperature	
		20 °C	60 °C
Inorganic chemicals			
Ammonia	24	++	-
Chromosulphuric acid	-	++	O
Caustic potash solution	10	++	++
Aqua regia	-	++	+
Sodium chlorite	40	++	++
Sodium hydrosulphite	10	++	++
Sodium hypochlorite	40	++	++
Caustic soda	10	++	++
Caustic soda	40	++	++
Phosphoric acid	10	++	++
Phosphoric acid	85	++	++
Nitric acid	10	++	++
Hydrochloric acid	10	++	++
Hydrochloric acid	35	++	++
Sulphuric acid	10	++	++
Sulphuric acid	96	++	++

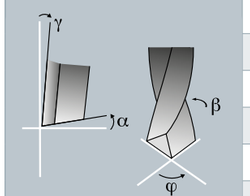
++ good resistance (Weight difference under 1%)
+ resistant (Weight difference 1–5%)
O partially resistant (Weight difference 5–10%)
– not resistant

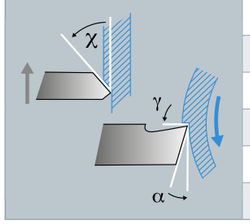
Other chemicals on request.

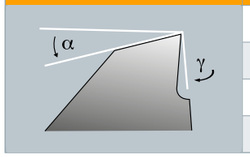
WORKING PROCESS CUTTING GEOMETRY

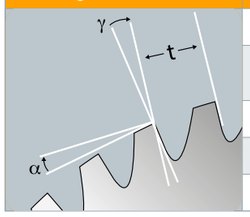
KömaCel® KömaTex® KömaPrint® KömaDur®

Standard values for machining KömaCel®, KömaTex®, KömaPrint® and KömaDur® PVC-U sheets

Drilling		Cutting geometry	Unit	Value
	α	Relief angle	Degree	8 – 10
	β	Angle of twist	Degree	30
	γ	Rake angle	Degree	3 – 5
	φ	Point angle	Degree	80 – 110
	s	Feed	mm / U	0.2 – 0.5
	v	Cutting speed	m / min	50 – 100

Turning / planing		Cutting geometry	Unit	Value
	α	Relief angle	Degree	15
	γ	Rake angle	Degree	0 – (-5)
	χ	Cutting-edge angle	Degree	45 – 60
	s	Feed	mm / U	0.1 – 0.3
	v	Cutting speed	m / min	200 – 500
	a	Cutting depth	mm	up to 6

Milling		Cutting geometry	Unit	Value
	α	Relief angle	Degree	5 – 10
	γ	Rake angle	Degree	0 – 15
	s	Feed	mm / U	0.3 – 0.5
	v	Cutting speed	m / min	up to 1000

Sawing		Cutting geometry	Unit	Value
	α	Relief angle	Degree	10 – 15 for carbide tips
	γ	Rake angle	Degree	0 – 5 for carbide tips 0 – 8 for band saws
	t	Pitch	mm	5 – 10 (8 – 10 for KömaCel)
	s	Feed	mm / UTeeth	0.1 – 0.3
	v	Cutting speed	m / min	up to 3000

USE OF PVC-U SHEETS UNDER SOLAR RADIATION

For many years now, PVC-U sheets, solid and foamed (expanded), have proven how suitable they are for outdoor applications such as signs, billboards, lettering boards and displays, under the most varied of weather and environmental conditions.

Intensity of solar radiation

The limits of application of the PVC-Usheets are determined by the natural extent of exposure to UV radiation. For KömaDur®, this is up to 120 kly/year and for KömaCel® and KömaTex® up to 140 kly/year (cf. table).

Climatic conditions in Europe:

City	Country	Global solar radition (kly/year)
Hamburg	Germany	80
Brussels	Belgium	80
Paris	France	90
Munich	Germany	100
Vienna	Austria	100
Bordeaux	France	100
Venice	Italy	110
Marseilles	France	120
Rome	Italy	130
Barcelona	Spain	140
Lisbon	Portugal	140
Madrid	Spain	140
Athens	Greece	140
Ankara	Turkey	140
Palermo	Sicily / Italy	140
Las Palmas	Spain	150
Tunis	Tunisia	160
Casablanca	Morocco	160

Weathering resistance

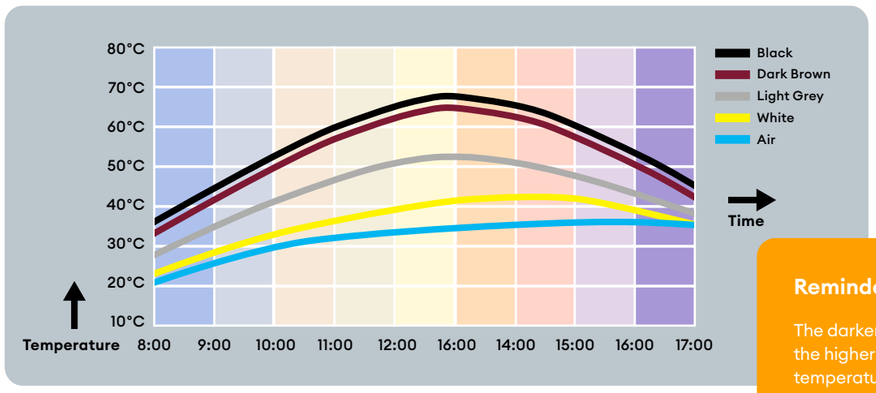
KömaCel®, KömaTex®, KömaPrint and KömaDur® are weather and moisture-resistant and consequently highly suitable for outdoor use. This means these materials will undergo no changes to their physical properties over periods of many years. White sheet types are colour fast, while coloured sheets (red, green, blue, etc.) may suffer a change in colour (become brighter) due to the higher degree to which they absorb solar radiation.

Surface colouring

Sheets used outdoors (e.g. signs) should–apart from the signature/logo–always have light-coloured surfaces (white, light grey, etc.). Large-surface, darkcoloured signs should not be used as they, like any dark-coloured object, absorb solar radiation to a far greater extent and can suffer damage as a result.

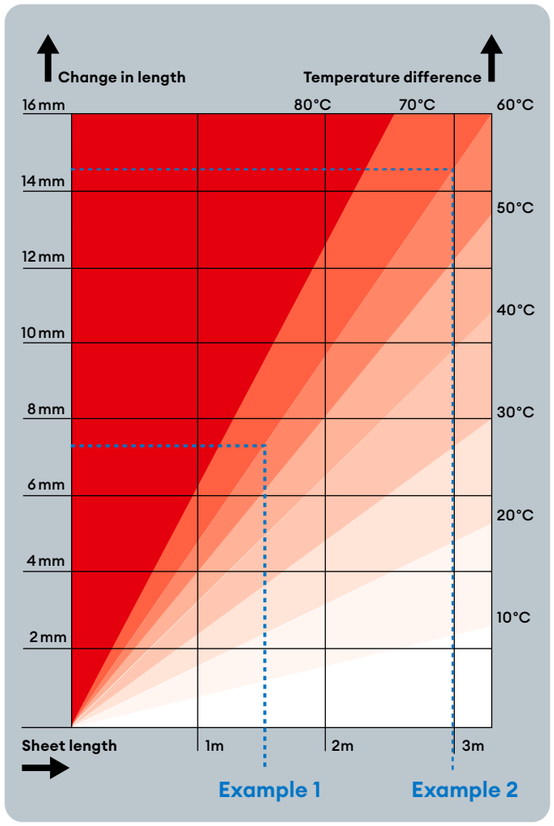
Surface temperatures of sheets in various colours

Temperature curve of PVC-U sheet surfaces at a maximum air temperature of 36 °C



Reminder

The darker the colour and the higher the surface temperature, the greater is the resulting change in length.



Length change of the sheets with temperature change

Change in length as a factor of the difference in temperature, the length of the sheet and the coefficient of expansion (α= 0.08 mm/m · °C)

Example 1

l = 1.5 x 0.08 x 60 = 7.2 mm

That is, the change in length for a 1.5 m long white sheet and a difference in temperature of 60 °C is 7.2 mm.

Example 2

l = 3.0 x 0.08 x 60 = 14.4 mm

That is, the change in length for a 3 m long white sheet and a difference in temperature of 60 °C is 14.4 mm.

USE OF PVC-U SHEETS FOR OUTDOOR APPLICATIONS

Information on fixing sheets outdoors

When used as outdoor advertising signs, PVC-U sheets are subjected to considerable fluctuations in temperature. As in the case of all other plastics, the coefficient of linear thermal expansion for the change in length under the influence of heat is applicable and must be taken into consideration: coefficient of linear thermal expansion α = 0.08 mm/m · °C.

PVC-U sheets from Kömmerling are moisture-resistant. As a consequence, any change in length can be predicted with precision, which is not the case with products from other manufacturers made of different materials, in which additional moisture-dependent movement occurs.

This change depends primarily on the maximum expected surface temperature and the length of sheet used. On the basis of the coefficient of thermal expansion (α) and the colour of the surface (white in our example), the difference in length can be computed as follows:

$\Delta l = l \cdot \alpha \cdot \Delta t$ (mm)

Δl = change in length (mm)

l = sheet length (m)

Δt = temperature difference (°K or °C)

α = coefficient of thermal expansion (mm/m · °C)

The basic temperature to be taken for computing this figure is always the installation temperature. An increase in temperature results in expansion, a decrease in temperature results in contraction (shortening). Sheet contraction is based on the lowest outside temperature according to the climatic zone map (for Germany, this on average is –15 °C). The change in length can be found by referring to the following diagrams (from –15 °C outside temperature to +45 °C surface temperature*, with white being used in the example).

* Cf. diagram on page 24.

Fixing information

When dimensioning the mounting system, always factor temperature changes and wind loads – that is, push and pull – in the equation. If you mount thin sheets in a frame to give them greater rigidity, you must still allow for expansion. Furthermore, all fixing elements should be made of stainless steel in order to prevent the sheets from becoming soiled with rust stains.

SHEETS ON CONTINUOUS WALL SURFACES

When fixing sheets to continuous wall surfaces, care must be taken to ensure there is sufficient ventilation, with the sheet being mounted with a minimum ventilation space between it and the wall of 2–4 cm. The gap left must allow air to circulate, e.g. with the aid of a lath construction.

LARGE-SCALE SIGNS

When constructing large-scale signs, the inherent stability of the structure must be guaranteed. KömaCel® 10 or even better KömaCel® 19 mm sheets are highly suitable for this purpose. In special cases, such as perimeter advertising boards at sports grounds, where the structure has to withstand impacts and jarring, KömaCel® 19 mm should be used.

FREE-STANDING SIGNS

When constructing large-sized, free-standing advertising signs, the structure chosen must be capable of withstanding the heavy wind loads that will arise (additional reinforcement etc.).

Screwed fixing

The natural change in length of PVC-U sheets used outdoors (e.g. advertising signs) requires a mounting system that permits the sheets to expand and contract when subjected to considerable changes in temperature.

One such mounting method is to fix the sheets with screws. In this case, holes or elongated slots are drilled, with care being taken to ensu-re there is suffi cient space (play) between the screw shank and the side of the hole.

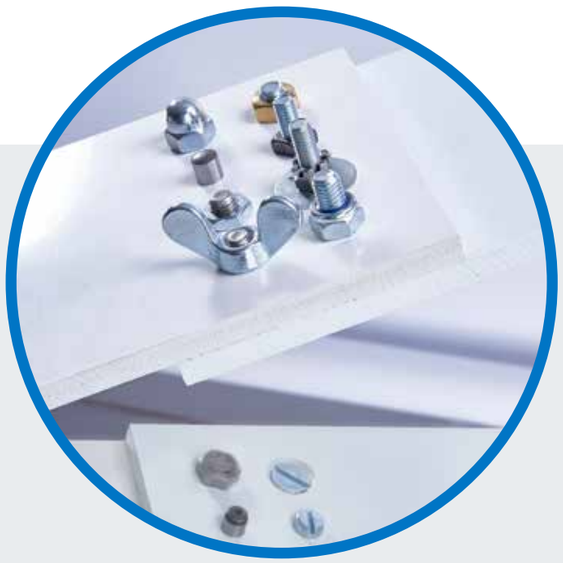
We recommend using half-round or round-head screws according to DIN 96. N.B.: do not use screws with a tapered section at the top of the shank due to the risk of the screws sinking into the holes and limiting movement caused by expansion/contraction of the sheet.

Care is also to be taken to ensure the screws are tightened such that the sheet has suffi-cient play between the holes.

Large washers should be used to cover the holes or elongated slots. They also prevent the screw head from sinking in the hole. Elon-gated slots should be drilled when mounting sheets that exceed 1.5 m in length. When mounting PVC-U sheets inside buildings, where there are as a rule only slight tempe-rature fluctuations, the hole diameter needs to be only 1–2 mm larger than the diameter of the screw shank.

Suspended boards

Typical slight stresses in sheets resulting from the extrusion process can be countered by stabilising at least the upper peripheral zones of the sheets by using, e.g. metal U-sections.



Substructure with rear ventilation

Pitch between the screwed fixing points as a factor of the sheet thickness:

Sheet thickness	Pitch between the screwed fixing points
2 mm	approx. 200 mm
3 mm	approx. 300 mm
4 mm	approx. 400 mm
5 mm	approx. 400 mm
6 mm	approx. 450 mm
10 mm	approx. 500 mm
19 mm (24/30)	approx. 500 mm

Example I

An advertising sign made of KömaCel® 654 (white), measuring 1500 x 1000 x 10 mm, is to be mounted outdoors to a ventilated substructure using screws. The screw shank diameter should be a minimum of 5 mm.

Determining the change in length and the hole diameter to be drilled:

Min. surface temp. –15 °C
Max. surface temp. +45 °C (white)
Temperature difference 60 °C

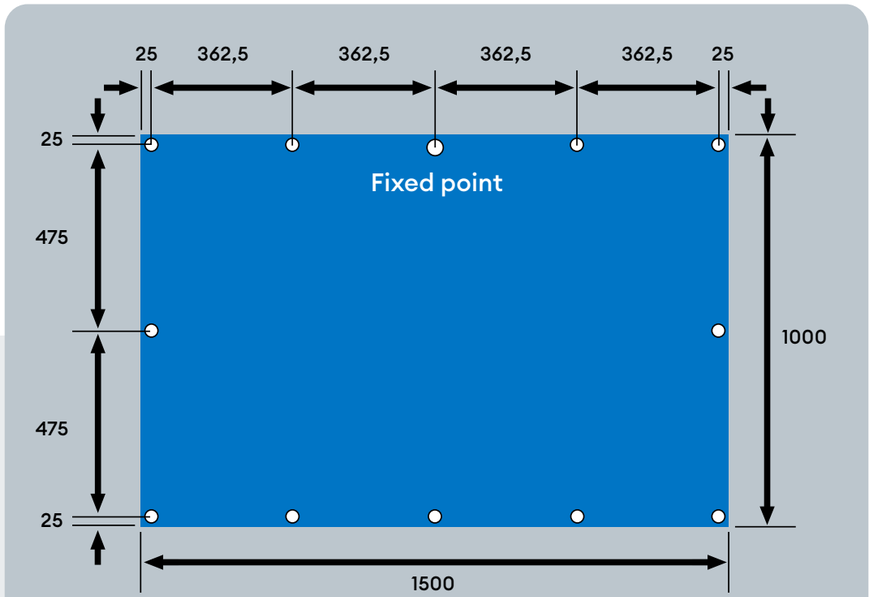
Solution: round hole

Overall change in length = 7.2 mm
Hole anchoring point (O)
= screw shank diameter + 2 mm = 7 mm

Due to the fact that the change in length is reduced by half in each direction from the anchoring point, the following hole diameter is required:

Holes allowing for movement (O) =
7.2 mm + 5 mm = 8.6 mm

Hole diameter = 9 mm



Dimensions in mm

Furthermore, the hole centre distance from the edge of the sheet should be at least 2.5 times larger than the drilled hole.

Example II

As in example I, but using KömaCel® with the dimensions 3000 x 1000 x 10 mm and screws with a shank diameter of 5 mm.

The dimensioning of the anchoring points is to be computed on the basis of the main direction of movement (direction of extrusion).

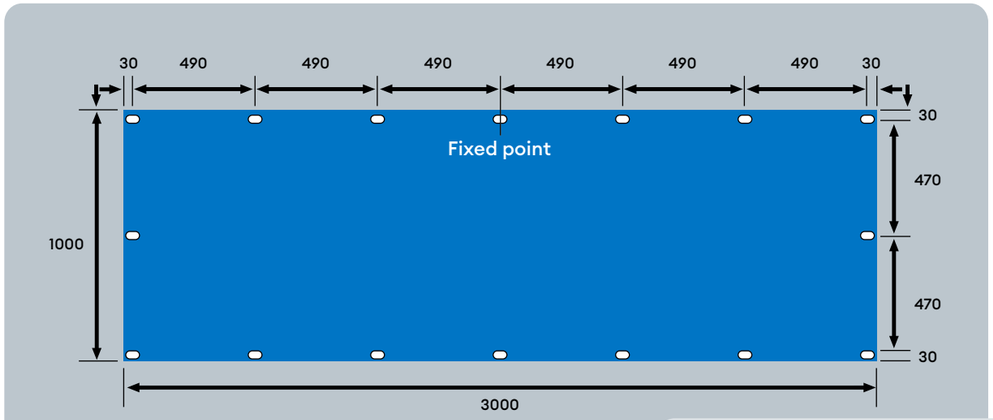
Movement at right angles to the direction of extrusion is less pronounced and the required tolerance for a sheet 1 m wide can be assumed to be approx. 4.8 mm.

Solution: elongated hole

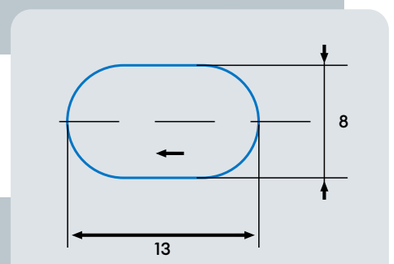
Overall change in length = 14.4 mm

Hole diameter of anchoring point (O) = screw shank Ø + 2 mm = 7 mm

Elongated holes allowing for movement = 14.4 mm / 2 + 5 mm = 12.2 mm



Dimensions in mm



Frame fixing

Another possibility for mounting sheets outdoors is frame mounting using metal U-section rails, which are particularly suitable for large sign façades. Movement of the sheets due to temperature changes (expansion and contraction) is to be taken into account here as well. U-sections with unequal sides have proven to be the most suitable for this purpose. Care must be taken to ensure the substructure is sufficiently ventilated (lath construction). The size of the expansion joints required to permit movement must be calculated as described in the above example and the diagram on page 24.

Example III

Large sign façade consisting of several Köma-Cel® 654 sheets (white), measuring 3000 x 1000 x 10 mm (19 mm), mounted in a U-section frame.

The following expansion joints have to be defined

1. H-section between the sheets
2. At the beginning of the frame
3. At the top side of the frame

The following temperature conditions are to be assumed, as in example I:

Min. surface temp. –15 °C
Max. surface temp. +45 °C (white)
Temperature difference 60 °C
Installation temperature +20 °C

Solution:

Change in length (l) for a sheet with a total length of 3 m
l = 14.4 mm

Change in width (b) for a sheet with a total width of 1 m
l = 4.8 mm

N.B.:

Assuming an installation temperature of 20 °C, the total movement, i.e. expansion/ contraction, of the individual sheet elements is as follows:

Expansion (Δt = 25 °C)
l = + 6.0 mm
b = + 2.0 mm

Contraction (Δt = 35 °C)
l = – 8.4 mm
b = – 2.8 mm

Change in length over the entire temperature range:
l_{total} = 14.4 mm
b_{total} = 4.8 mm

The temperature prevailing during installation is, therefore, to be taken into account and the dimensions and positioning of the expansion joints to be determined accordingly.

UNCOMPROMISING QUALITY FROM START TO FINISH

Certified to DIN ISO 9001

Systematic research and development work and decades of experience with plastics are the basis for the generally recognised high quality of our products.

We carry out tests at all stages – starting with the raw materials on delivery through to final inspection of the finished products.

Regular examinations and analyses conducted by independent testing institutes confirm the high degree of care we take during the production process. Our quality assurance system is certified to DIN ISO 9001.

SHEETS ARE OUR CRAFT, SUSTAINABILITY OUR MISSION

With a good conscience – recycling and reuse

For us, sustainability is not just an empty word, but a lived reality. At Kömmerling, we demonstrate this commitment every day. Through our product portfolio, our technologies, our working environment. We think and act holistically. Or to put it another way: We consider the ecological, social AND economic aspects of everything we do.

Our products and manufacturing methods are designed to help protect the environment. For instance, by reducing emissions, making careful and efficient use of resources and adopting a targeted approach to recycling.

There are no toxic or harmful substances in KömaCel®, KömaTex®, KömaPrint® and KömaDur® that can be given off over the long term. KömaCel®, KömaTex®, KömaPrint® and KömaDur® are free from formaldehyde, asbestos, lindane, PCB, PCP and CFCs. What's more, they are cadmium and lead-free and are also made without any monomers, biocides or plasticisers.

This is why KömaCel®, KömaTex®, KömaPrint® and KömaDur® pose absolutely no hazard to people or the environment, neither during their manufacture, while in use, nor during the recycling process. Old sheets no longer in use or leftover sections of sheets can be recycled without any problem: they are ground up in shredders and cutting machines before being returned to the production process to make new sheets. This closed material cycle is not only economical, but ecological, too.

CARE AND CLEANING

Kömmerling PVC-U sheets do not require any special care. However, as with other materials, regular cleaning is recommended to maintain their visual value in the long term. This applies in particular to outdoor applications.

Normal soiling can usually be easily removed with warm water or soapy water. Only clean, non-abrasive sponges or cloths should be used for washing and drying.

Cleaning agents with abrasive / scouring components or cleaners containing solvents should not be used, as these can irreparably damage the surface of the panel or change the material properties.

The use of residue-free cleaning agents such as isopropanol is recommended for preparatory cleaning of surfaces, such as is necessary before gluing, painting, etc. Many other cleaning agents, e.g. „plastic cleaners", leave behind or form - sometimes intentionally - invisible surface films, which can impair the adhesion of adhesives, lacquers etc. to the panel surface.

Cleaning agents labelled with the general term „plastic cleaner" should only be used if their suitability for PVC is explicitly stated by the manufacturer.

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