Epoxy resins in boatbuilding

Practical tips

HP-Textiles

About us

Since the company was founded in 2004, HP-Textiles GmbH has stood for the development and distribution of fiber composites. In addition to a wide range of fiber reinforcement materials and specially formulated epoxy resins, DeinTeich.de and bredderpox® were created as additional strategic business areas were created. As a result, in addition to the composites industry, users from the pool construction and surface protection systems sectors are also among our satisfied customers.our satisfied customers.

Our business areas:

Composite materials	GRP coatings	Building Chemistry
www.hp-textiles.com/shop	www.deinteich.de	breddermann-kunstharze.de

In order to guarantee our business partners a continuously high quality of our services as well as optimal process reliability, the quality management of HP-Textiles was certified according to DIN EN ISO 9001 in 2011. Through the enthusiasm and passion for scientific research, coupled with the understanding of our customers‘ wishes, we guarantee optimal product properties also in the future.

Together with strong partners from science and industry, we also offer custom synthesis and manufacturing of a wide variety of products. The establishment of a networked, development allows us to respond to customer requirements even at short notice. Variable batch sizes enable us to supply large industrial customers as well as small quantities for project developments.

Our young qualified team, a arge warehouse as well as reliable logistic partners guarantee a ast processing of your order.

The continuous further development of our product range should also be a basic requirement in the future in order to guarantee optimum component properties at economical prices!

Your team from
HP-Textiles GmbH

Contents

Basics Epoxy resin

Why Epoxy resin?

Epoxy resins are not only suitable for new builds, but are also particularly good for rebuilding or repairing existing hulls. Even if these are made of polyester resin were made. Where polyester resins often reach their performance limits or can only be permanently bonded after extensive pretreatment with adhesion promoters, epoxy resins are often the more effective solution.

Although many boats are still manufactured entirely with polyester resins, on closer inspection this is mainly for historical reasons. For example, at the beginning of the GRP construction method, many production processes were geared to construction with glass fiber mats and polyester resins.

What are the advantages of Epoxy resins?

- Very low material shrinkage
  The individual components of the epoxy resins react via a so-called addition reaction, whereby no reaction products are released. Therefore there is loss of volume is much lower than in the case of vinyl ester or polyester resins. polyester resins.
- Free from solvents
  Thus no odor nuisance due to solvents!
  In addition, e.g. sandwich foams are not attacked.
- Very good adhesion properties
  Due to its high adhesive strength, it can also be used on existing substrates (polyester-laminate, wood or many metals).
- Suitable for processing high performance fibers (aramid, carbon,...)
  Process high quality fibers with high quality resins!
- Permanently high mechanical strength (low fatigue behavior)
  Compared to conventional polyester laminates, composites with epoxy resins have significatly higher resistances.
- Very low water absorption / pronounced osmosis protection
  Epoxy resins are characterized by a very high water vapor density!
  In addition, relatively high film thicknesses can be achieved with only a few coats.

Looking at the aerospace, wind power and automotive industries, one trend becomes clear-high-performance fibers in combination with epoxy resins are predominantly used in demanding applications!

With so much sun, there is always a little shade. Thus, to date, there is no 100% UV- and light-stable epoxy resin system on the market. For durable, high-quality coloration in the overwater area this reason, additional varnishes are usually applied for durable, high-quality coloration in the.

What should be considered when editing?

Dosing

Always observe the specified mixing ratio exactly!

Background: One part each of the hardener and resin components react with each other and form the polymer chain. Over- or underdosing of the hardener component would always have a negative influence on the subsequent properties of the laminate! In the worst case, the laminate would simply not cure.

Processing temperature

Do not fall below the specified processing temperature!

Too cold: A certain temperature as kinetic energy is necessary so that the resin and hardener components can „find each other“ and react. The rule of thumb here is „10°C temperature increase doubles to triples the reaction speed“ - conversely, curing can even come to a standstill if the temperature is too low.

Rule of thumb: 10°C temperature increase = reaction speed x 2 - 3

Too warm: The curing reaction of most synthetic resins is exothermic, i.e. releases heat. This heat in turn accelerates the curing. To mitigate this effect at higher temperatures, the resins should be placed in a shallow container (e.g. a paint tray) after mixing. Epoxy resins should also be stored at moderate temperatures (approx. 15-20°C) before processing.

Post-curing / tempering

Improving the mechanical properties by temperature!

Epoxy resins should always be subjected to post-curing after curing. This significantly improves the mechanical properties and also the heat resistance.

Background: Subsequent heat applicaton results in a higher degree of crosslinking and therefore and thus also better strength and durability.

Further details can also be found in our instructions for annealing as well as the data sheets of the respective systems or in further instructions. These can be found as a free download in our online store under the menu item Downloads in the list above or in the the respective product description.

Terms

Priming: Application of a first layer (e.g. epoxy resin HP-E80FS) for a subsequent coating, or a subsequent laminate build-up. For better penetration into the substrate, primers are often low viscosity. By penetrating into porous substrates, a larger contact area is achieved for the bonding is achieved.

Filling: Smoothing the surface texture. In principle, a type of priming and smoothing on particularly rough surfaces. However, in contrast to primers, filling compounds are much more viscous to pasty. With the aid of a filler (e.g. HP-E30S or HP-E25KL or HP-E45KL with fillers) unevenness, holes or pores are closed.

Lamination: Impregnation of fibers with resin in layers. This produces a fiber composite material.

Gluing: Purely joining parts together. Example: A broken workpiece is glued back together.

Gelcoat: Application mainly in negative molds, therefore medium viscosity (more viscous). Finishing or fine layer with improved surface properties, also called also called top coat.

Topcoat: Topcoat / fine coating resins for use „on the top“, i.e. as a surface sealer (e.g. HP-E25D, HP-E40D). surface sealing (e.g. HP-E25D, HP-E40D).

Note: On existing / non-fresh substrates, the resin may be rejected (formation of „fish eyes“). In this case, the substrate must be roughly sanded after intensive cleaning. For „wet-on-dry“ work, it is better to use our HP-E45KL.

The different fields of application

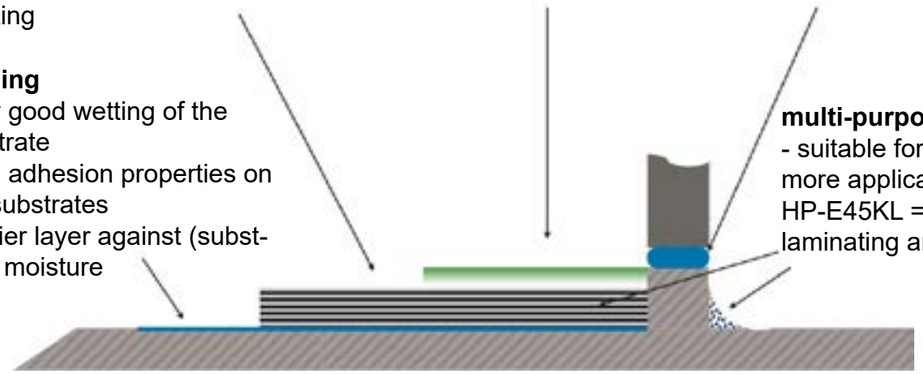
Laminating resins
- very good wetting of the reinforcing fibers
- distinct mechanical properties in the fiber composite
- high strengths
- medium to high degree of cross-linking

Top coat resins
- high surface quality
- improved UV stability
- increased scratch resistance
- high resistance to various chemicals
- osmosis protection

Adhesive resins
- very good adhesion properties
- durable residual flexibility (tough-hard)
- can be used on many materials

Priming
-very good wetting of the substrate
-high adhesion properties on div. substrates
-barrier layer against (substrate) moisture

multi-purpose resins
- suitable for two or more applications (e.g. HP-E45KL = bonding, laminating and sealing)



Selection guide for Epoxy resins

Application area	Product	Information
Bonding (pure joining of parts)	**HP-E5K** **HP-E60K** **HP-E120K**	Pot life approx. 5, 60 or 120 min. Pure adhesive resins form a tough, hard adhesive joint which should be protected from direct contact (water, fuel, etc.). Adhesive joints >1mm must be reinforced with fillers!
	HP-E25KL **HP-E45KL**	Multipurpose systems. Adhesive joints, chemical resistant.
Filling (repair work, coving, osmosis rehabilitation)	**HP-E30S**	Putty system.
Chemical and fuel resistance (coatings of fuel tanks, bilges,...)	**HP-E25KL** **HP-E45KL**	Multipurpose systems. Basic systems for enrichment with fillers. Chemical resistant, list of chemical chemical resistance available.
Primers	**HP-E80FS**	Metal, GRP, wood,... Pre-impregnation of porous / absorbent substrates. Pot life: approx. 35 min.
Top coats surface work on fresh substrates, Improved UV and light resistance	**HP-E25DM**	Gelcoat, colorless, medium viscosity, short pot life, processing also in negative molds
	HP-E25D **HP-E40D**	Topcoat, colorless, low viscosity, short or medium pot life
Top coats Surface work on existing substrates	**HP-E25KL** **HP-E45KL**	Multipurpose system. Basic system for enrichment with fillers, Chemical resistant.
Laminating (i.e. fiber impregnation) e.g. for complete new buildings, hull construction, ... in negative molds	**HP-E28L** **HP-E55L** **HP-E110L**	Standard laminating resins with good mechanical properties. Pot life: approx. 25, 55 or 110 min.
	HP-E29L **HP-E56L** **HP-E111L**	High-load laminating resins with pronounced mechanical mechanical properties and improved physiological compatibility. Pot life: approx. 25, 55 or 110 min.
	HP-E25KL **HP-E45KL**	Multipurpose system. Medium viscosity.
Work in the **infusion process** (production of components in negative molds) increased temperature resistance, visible carbon components	**HP-E3000GL**	Extremely low viscosity, excellent fiber impregnation in the infusion process Pot life 15 to 300 min. (intermixable) Detailed information in separate instructions

Epoxy resin

Use of fillers

What are fillers used for?

Epoxy resins are not only used for pure lamination work. Often substrates also need to be filled or parts bonded.

To avoid having to stock a confusingly large range of epoxies, it is possible to adjust the properties of the resin to the particular application using a resin system and appropriate fillers.

Basic

First, resin and hardener should be thoroughly mixed before adding fillers. To avoid segregation or settling of the fillers, in many cases our thixotropic agent HP-PK22 can be added in many cases.

Fillers must be stored dry, in the original container and protected from moisture. The use of fillers may lead to changes in the reaction kinetics. For example, the curing time may be extended. We recommend carrying out preliminary tests.

Details can also be found in the individual technical data sheets of the fillers.

Thixotropy

In order to be able to work with laminating resin on inclines or steep surfaces, it must have a special consistency. On the one hand, it must not run off (i.e. it must not be too liquid) on the other hand, it must still slightly impregnate the fibers. In addition, there is the fact that the flow behavior is generally highly temperature-dependent. Thus, an epoxy resin that exhibits optimum properties at 15°C can be completely unsuitable for application temperatures of 25°C may be completely unsuitable. In order to be able to adjust the flow behavior individually, so-called thixotropic agents (e.g. HP-PK22) are added. The subsequent behavior is then similar to that of ketchup. This is liquid immediately after shaking/stirring, but then rapidly decreases in flowability and „stands still“.

Base resin for applications with fillers

Frequently used epoxy systems are our HP-E25KL (from 5°C) or the HP-E45KL (from 15°C). These can be used both as unfilled, medium-viscosity laminating resins, but also in combination with different fillers.

Selection aid fillers

	HP-PK22	HP-MB2	HP-BF1	HP-GS3 HP-GS6
Base	Silica	Glass hollow-balls	Cotton-flakes	Chopped Glass-fibres 3 / 6mm
Bulk density (approx.)	40 g/l	140-150 g/l	70-90 g/l	350-400 g/l
Dosage (approx. weight percent)	0,5 - 5 %	to 30 %	to 30 %	to 10 %
Thickening, flow behavior of superplasticizer, lamination on steep surfaces			**K**	
Avoid segregation Avoid settling of fillers				
Backfills Undercuts, infills	**K**			
Coupling layers for mold making	**K**			
Bonding Adhesive beads, reinforcement of bondings	**K**			
Coarse filler for rough fillings, closing holes or similar	**K**	**K**		
Light or fine putty Model making, car, boat building and industry	**K**		**K**	

= very well suited (++) *= suited (+)* *= not suited* *K = only in combination with +/++*

- All percentages are weight-related -

Notice:
The dosages are to be seen as possible guide values at approx. 20°C in combination with a laminating system. The exact values may vary. We always advise a trial mix under processing conditions.


HP-PK22


HP-MB2


HP-BF1


HP-GS3/GS6

Various reinforcing fibers

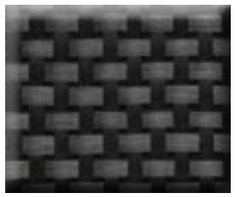
Reinforcing fibers provide the actual strength in the fiber composite.
Basically, the following criteria are therefore important for fiber selection:

- The orientation (alignment) of the fibers in the composite material
- The resin assumption, i.e. the interaction of resin and fibers at the interface
- The mechanical properties of the reinforcing fibers
- The subsequent proportion of the reinforcing fiber in the composite (fiber volume fraction)

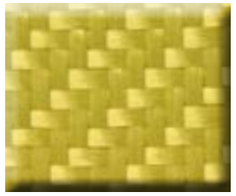
Different types of fibers

Glass fibers can be processed in the form of yarns and rovings into woven glass fibers can be processed in the form of yarns and rovings into fabrics or scrims, among other things, and represent the largest proportion of reinforcing fibers in terms of volume. They are convincing due to their high cost-effectiveness combined with good properties. In order to optimize adhesion to the resin matrix, they are available with different sizings.

Carbon fibers have versatile properties with a relatively low specific weight, they have high strength and high stiffness.They are chemically largely inert, electrically conductive, thermally stable, infusible, biocompatible and permeable to X-rays. This enables them to be used in a wide variety of applications.



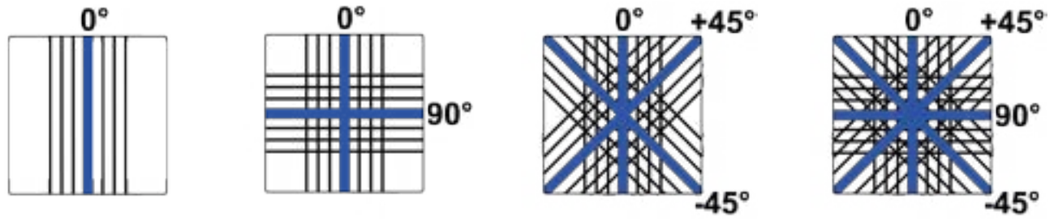
Aramid fibers are characterized by high toughness and particularly good impact and abrasion resistance. Further properties are good damping capacity, excellent chemical resistance and non-flammability. The processing of the raw fabric and the laminates is often very difficult and therefore only feasible with special tools.



Different types of construction

Gelege have been increasingly used for several years. These are non-woven textile woven textile fabrics whose fibers lie endlessly and parallel next to each other and are held in position by a sewing thread or heat setting. Since the individual threads are not deflected (as in the case of a woven fabric, for example), they achieve particularly high strengths.

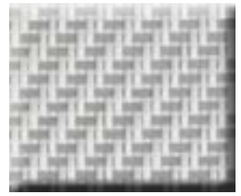
Alignments



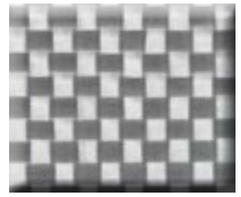
Unidirectional (fibers in one direction) | **Bidirectional (fibers in 2 directions)** | **Triaxial (fibers in 3 directions)** | **Quadraxial (fibers in 4 directions)**

Glass filament fabrics are webs of continuous E-glass produced by a weaving process. The basic mechanical properties (tensile strength, tensile elongation, E-modulus and elongation at break) are determined by the type of glass, the application properties, but above all by the sizing and the type of weave.

Comparison of coatings - glass filament fabric	
Silane	**Finish**
especially well suited for epoxy and polyester resin	
economic reinforcing fiber	very good processing & impregnation properties, Laminates with high transparency

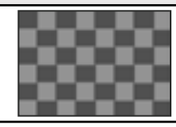
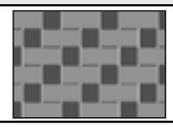


Glass roving fabrics are woven webs made of continuous E-glass roving yarns. The direct roving, unlike the filament yarn, is not provided with a protective twist. With roving fabrics, larger layer thicknesses can be produced with just a few plies. The fiber content and strength is much higher than with laminates made of glass fiber mats, but lower than with glass filament fabrics, or multiaxial glass fabrics. In addition, roving fabrics are often somewhat more „brettiger“ than comparable glass filament fabrics.

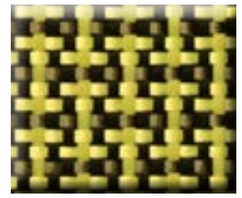


Different weaves

Fabrics with twill weaves are often easier to place around curves than, for example, products with plain weave. The same applies to carbon, aramid or hybrid fabrics.

	Plain	Twill	Satin
			
Drapeability	+	++	+++
Sliding strength	+++	++	+
Strength in laminate	+	++	+++
Surface smoothness	++	++	+++
	+++ very well suited	++ well suited	+ suited

Hybrid fabrics combine the good properties of different fiber e.g. carbon fabrics with those of aramid fabrics. The carbon fiber gives the fabric high stiffness and tensile strength. The aramid fibers provide impact strength, work past and wear resistance.



Selection Guide Reinforcing Fibers

Application areas	Selection of possible reinforcing fibers (types)	Constructions / Weights per unit area	Advantages / Disadvantages	Laminate thicknesses (guide values for 3 layers with HP-E55L)
Coating of small to medium surfaces **Hulls** in **canoe or kayak construction** (also wood), **„Stitch and Glue“ -** process	**Glass filament fabric silanes**	approx. 160 - 280g/m², twill weave	+ very good drapability	**HP-T163E:** approx. 1,5mm **HP-T275E:** approx.. 2 - 2,5mm
	Glass filament fabric with finish, when higher **transparency** is required	approx. 160 - 280g/m², twill weave	+ very good drapability + very high transparency + less dust formation during cutting	**HP-T163EF:** approx. 1,5mm **HP-T280EF:** approx. 2 - 2,5mm
Coating of larger areas, construction of new buildings (hulls / decks / complex superstructures) **Repairs on existing GRP** (polyester or epoxy resin)	Many different reinforcing fibers possible Depending on the geometry of the shape to be laminated (corners, radii,...) and desired laminate thickness **Glass filament fabric** **Glass roving fabric** **Glass fiber scrim**	**Glass filament fabric** from approx. 280g/m², twill, plain or satin weave	+ see above... - Relatively low laminate thicknesses	**HP-T275E:** approx. 2 - 2,5mm **HP-T385E:** approx. 2 - 2,5mm
		Glass roving fabric from approx. 300 - 600g/m², twill or plain weave	+ higher laminate thicknesses + less sensitive to displacements - less drapable than Glass filament fabric	**HP-P300E:** approx. 1,5 - 2mm **HP-P401E:** approx. 2 - 2,5mm **HP-T580E:** approx. 2,5 - 3mm
		Glass fiber lay-up from approx. 320 - 810g/m²	+ high strengths + specific fiber alignment possible + less fraying during cutting	**HP-B320E:** approx. 2mm **HP-B450E:** approx. 2 - 2,5mm **HP-B600E:** approx. 2,5mm **HP-B810E:** approx. 3 - 3,5mm
Surface finish	To ensure that the surface has as **smooth a structure as possible** should be finished with the finest possible reinforcing materials should be used to finish **Glass filament fabric with finish**	**Glass filament fabric with finish** from approx. 50g/m², twill or plain weave	+ very good impregnability + high transparency + low dust formation during cutting	**HP-P49EF, HP-P80EF, HP-T100EF:** approx. 1mm **HP-T163EF, HP-P200EF:** approx. 1,5 - 2mm
Laminates made from high-performance fibers (e.g. for new buildings in negative shapes or particularly stressed areas, high-quality yacht construction, construction of sports boats)	Load-directed use of **scrims and fabrics** made of **carbon, aramid** or **mixed fibers**	**Carbon fabric** from ca.160 - 420g/m², twill or plain weave **Carbon fabrics** from approx. 200 - 410gm² **Aramide fabric** from approx. 60 - 170g/m², twill or plain weave **Hybrid fabric** from approx. 180 - 205g/m², twill or plain weave	Carbon: + high load capacity in fiber direction Aramid: + „across“ the fiber loadable, increased abrasion resistance and impact strength	**HP-T160C, HP-T195C:** approx. 1,5 - 2mm **HP-B141C:** approx. 1,5 - 2mm **HP-B305C:** approx. 2,5 - 3mm
Narrow laminates, repair areas, rubbing strips, for reinforcing fillets	**Glass filament fabric tape - Silanes**	**Glass filament fabric tapes** in widths from approx. 2 - 20cm	+ Material is prefabricated (desired width) + load-directed use possible	**HP-P220/...E**: approx. 2mm
	Glass glazing tape	**Glass gel tape** Width approx. 9,5 - 30cm		**HP-B420E:** approx. 2 - 2,5mm **HP-B320/...E:** approx. 2mm

Tips:

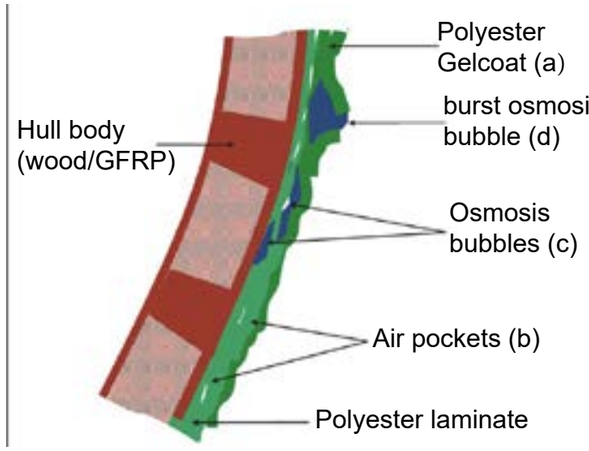
- Fabrics with a twill weave are often easier to drape, i.e. place around curves, than fabrics with a plain weave
- Lighter materials are often easier to drape and impregnate
- Heavy materials can save time as fewer layers are required
- Recommendation for experienced users: use lightweight fabrics and scrims in multiple layers for better impregnation and fewer air pockets

REINFORCING FIBERS

Osmose

How arises Osmose?

Osmosis is defined as the diffusion of a liquid through a semipermeable. (permeable on one side) It is therefore actually less a phenomenon than a scientific process! In order to better understand the damage caused by osmosis, it is important to know that top layers of unsaturated polyester resins are generally not 100% impermeable to water. Added to this is the fact that, even with careful small cavities (e.g. due to air inclusions) usually form in the laminate. Uncured components of the polyester resin now collect in these „chambers“ and react with water to form acid and alcohol. These are also strongly hygroscopic (water-attracting) and „suck“ the water into the small cavities in the form of water vapor. This process and the constant absorption of water increase the pressure in the cells, which can lead to cracks and ultimately to cracking of the gelcoat layer.



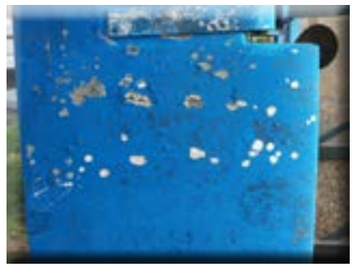
a) Top layer made of a polyester gelcoat
b) Small voids due to air pockets in the laminate
c) Uncured components are strongly water-attracting and suck the water into small cavities
d) This process leads to cracks and cracking of the gelcoat layer

How to recognize Osmose?

Not every bubble immediately indicates massive damage due to osmosis! Basically, surfaces should always be assessed as soon as the boats have been out hoisted of the water.
Already after the first drying time, the volume of osmosis bubbles can decrease significantly again, as they simply dry out. If bubbles then form in the water again, this is a fairly sure sign of possible damage by osmosis!

In addition to the optical characteristics, an osmosis attack can be recognized by a pungent (vinegar-like) odor.
In addition, the liquid escaping from the bubbles forms a greasy film. To have the damage professionally assessed and to coordinate further remediation measures, you should contact an (independent) expert.


Osmosis on a boat hull


Osmosis on a rudder

What influences Osmose?

Osmosis can have different causes. We have compiled the most important of the possible causes in the production of polyester components:

favors osmosis: ✗	**Reduces the risk of osmosis:** ✓
Improper deaeration / insufficient fiber impregnation / general craftsmanship errors	Laminates should definitely be carefully deaerated! Fewer air bubbles = fewer cavities for later osmotic reactions!
Glass fiber mats with emulsion binder (absorb moisture)	If glass fiber mats, then with powder connector, better still ECR glass mats o. C glass fleece
Polyester resins based on orthophthalic acid	Higher-grade polyester resins based on ISO/NPG or vinyl ester, ... Even better: **epoxy resins!**
Too thin surface layers	Only sufficient layer thicknesses offer appropriate protection.
no / insufficient annealing	Post-curing increases the degree of crosslinking and the durability of the laminate

How to restore osmosis damage?

Step 1: Grinding / sandblasting

Professional refurbishment naturally begins with the removal of the fine layer. Gelcoat and/or paint should be removed as completely as possible. This can be done by grinding, milling or blasting.

Mere sanding is usually not sufficient, as this does not expose the material for subsequent drying.


Gelcoat is removed


Boat hull after removing the top layer

Step 2: Clean and dry

After the removal of the fine layer, the surface is cleaned horoughly and in several working steps with plenty of fresh water. Careful cleaning is particularly important, otherwise remaining salts / impurities can cause problems again.

The next step is drying. Even the smallest cavities must not contain any residual moisture!

The hull is then masked off and prepared for the next step.

Hull is masked off for further work steps after drying

Step 3: Priming, filling and possibly laminating

Depending on the condition of the substrate, different steps are necessary to restore sufficient strength. If the surface has only minor defects, the application of a primer and a new epoxy fine coat (in several layers) may well be sufficient.

Massive damage incl. delamination, Area must be rebuilt with fiberglass fabric or scrims

Epoxy system / Condition of the Subsoil	priming	spatula	laminate	Fine layer
	HP-E80FS	HP-E30S HP-E45KL + Fillers, if necessary see S.8/9	Selection Laminating resins see S.7	HP-E45KL, (possibly also HP-E40D, HP-E25D or HP-E25DM)
small pores, laminate undamaged	✓	✓		✓
large holes, laminate undamaged	✓	✓	✓	✓
large holes, massive damages in the laminate structure	✓	✓	✓	✓

Subsidiaries

Why should substrates be pretreated?

In order to achieve the best possible adhesion to existing substrates, these should be pretreated accordingly. Old paints, varnishes, gel coats or other coatings should be at least roughly sanded before coating. Often a complete removal is advisable, especially in the case of old objects, since several different coatings have been applied. Direct coating on „old paint“ is not advisable, because these are repellent and thus a coating is often not applied coating can.

Gelcoat is removed

The pretreatment of different surfaces

1	The substrate must be dry and free of silicone or grease. First, the surface must be degreased with a suitable solvent (e.g. acetone HP-AC). The entire surface must then be sufficiently deaerated!		
2	**Wood**	Coating / varnishing (thin, optically demanding layers)	Sandpaper with grit 100-180 Sanding in the direction of the grain
		build up massively, bonding (thick layers)	Sandpaper with grit 60-120 Sanding against the grain (this increases the surface for gluing!)
		Types of wood with a high resin / oil content (e.g. teak) are difficult to bond. Here, the surface must be degreased particularly intensively and roughly sanded against the grain!	
	GRP	Sandpaper with grit 60-120	
	Metal	Blast or roughly grind with angle grinder. Any oxide layer must always be completely removed and the epoxy resin then applied within 2-3 hours.	
	Alu	Degrease and carefully grind. Anodized aluminum / aluminum alloys should be etched additionally if necessary!	
3	Remove the grinding dust with compressed air or a vacuum cleaner.		
4	Clean the surface again with a solvent and let everything flash off for a sufficiently long time!		

Tips:
Allow the surface to dry (flash off) longenough. In addition, the coating surface should be brought to „operating temperature“(Background: Surfaces that are too cold massively slow down the curing speed! There is also a risk of condensation forming.)

Repairs and damaged areas

Close holes and filler

For this purpose, fillers are added to the mixed epoxy resin (e.g. our HP-E45KL) or the HP-E30S is used. In this way, it can be individually adjusted for the respective requirements. The HP-E45KL is of medium viscosity and, with a pot life of approx. 45 offers a sufficient time window for mixing and filling work. To achieve the desired consistency, microballoons HP-MB2 (hollow glass spheres) and our Thixotropy-powder HP-PK22 can be added. By the addition of Microballoons HP-MB2, it is posible to produce pressure-resistant light puties. The HP-PK22 prevents run-off from steep surfaces and reduces segregation of resin and microballoons. Medium sized holes should be additionally be reinforced. For this purpose, cotton flocks (HP-BF1) or Chopped Glass-fibres (HP-GS3 or HP-GS6) can be mixed into the filler. Larger holes or damaged areas should be additionally repaired with fabric or scrim. Hardened putties are then sanded (grain size 80 - 120).

Cracks and holes in the gelcoat

Our epoxy systems HP-E25KL and HP-E45KL are suitable for many applications due to their formulations. For example, they can be used as medium-viscosity laminating resins, but can also be used (provided with fillers) as adhesive or filler systems. The systems are also resistant to many chemicals, so they can be used as topcoat systems even in critical areas.

Filling work

In order to enlarge the bonding surface, it should always be ground („shafted“) in the shape of a funnel in the case of larger holes. To do this, the damaged area is drilled or milled out. The bonding surface is then carefully degreased and cleaned.

Bonding of rigid foams with epoxy resin, Cotton flakes and Thixotropypowder

In the case of damaged sandwich structures, the core must first be renewed. In the following pictures, a rigid foam was cut to size and glued in place using epoxy resin and fillers glued in place.

Cutting the reinforcing fibers

The laminate layer is then rebuilt. For this purpose, the reinforcing fibers (e.g. fabric or scrim) are cut to different sizes and are applied in layers (if possible with alternating orientation of the fibers).

Laying out the reinforcement fibers on the surface

The dimensions of the fabric pieces should increase from the bottom to the top in accordance with the shank. A piece of peel ply can then simply placed on top.

Repairs with damp wood

Structures made of wood, or with wood cores are often good for surprises. Not infrequently initially planned „light repair work“ turns out to be extensive renovation projects after the wood has been exposed.

Mouldy wood can be easily removed from the laminate with a pointed object (peat cutting)

The causes for this are manifold. Often, wooden structures with too high residual airtight without the existing residual moisture being able to escape any further.

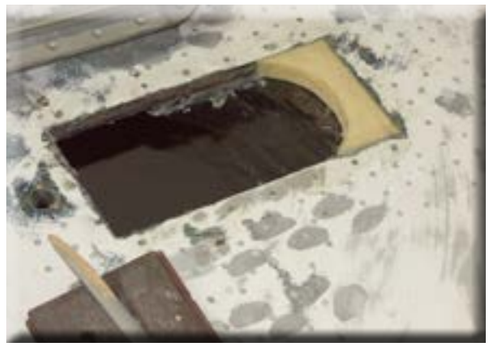
Another cause is possible leaks, i.e. the creeping ingress of moisture (water vapor, sea or bilge water,...) into the wood core.

In all cases, the wood begins to rot and the structure loses massive strength. To restore strength, the affected area should be opened and the soft wood removed. After sufficient drying time, the core material is replaced and the laminate is also rebuilt on the surface.

Yielding decking suggests damage to the laminate and this extent becomes after opening recognizable

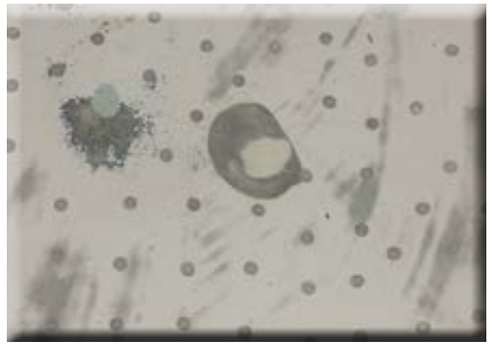
Injections with epoxy resin

Sandwich laminates usually consist of a core material (rigid foam, wood or honeycomb material) which is surrounded on both sides by a laminate. If the laminate detaches from the core, the structure loses significant strength. Dry, minor detachments in sandwich structures can be repaired by resin injection. This involves drilling into the top of the laminate and filling it with epoxy resin from above. The epoxy resin is filled into disposable syringes and injected through small drilled holes. Important: Only drill into the top laminate layer!



Injection sites on a boat deck

This method is not suitable for large delaminations with moisture damage. Here the entire surface should be opened, drained and rebuilt!



Sandwich structures are repaired. Here: The replacement of a complete sandwich structure and resin injection in combination

Infusion and injection

An epoxy system of the HP-E3000GL series is suitable for the infusion method (new construction) but also for injection techniques for the rehabilitation of damaged structures. It is very low viscosity and available with different pot life from 15 to 300 minutes.

Fillets

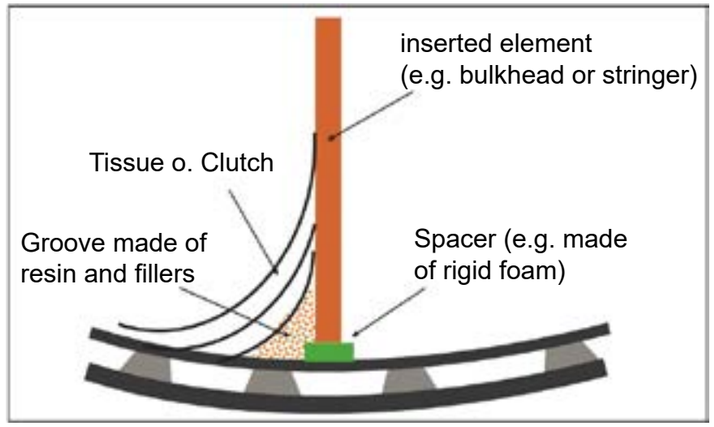
To ensure that forces can be absorbed or introduced as optimally as possible, angled joints should never be laminated at too sharp an angle. Faulty designsdefects such as fine cracks or even complete fractures or delaminations.

Cracks in the corners

Detachments after defective repair

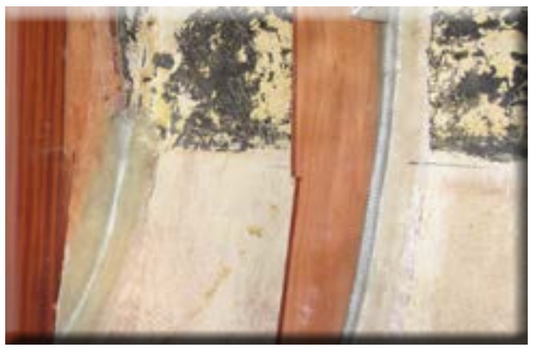
Angular connections (bulkheads on the hull, subsequently inserted stringers, stringers or other installations) must be reinforced by fillets.

Epoxy resin (e.g. HP-E45KL filled with HP-PK22 and HP-BF1 or HP-E30S) is first worked into the corner. On top of this still tacky compound, several layers of several strips of fabric or scrim are applied.
Here, of course fabric or fabric tape can also be used here. The fabric layers are then coated with resin until a smooth surface is obtained. Alternatively, peel ply fabrics can also be used.



Structure of fillets

Crack in transition main bulkhead to bilge



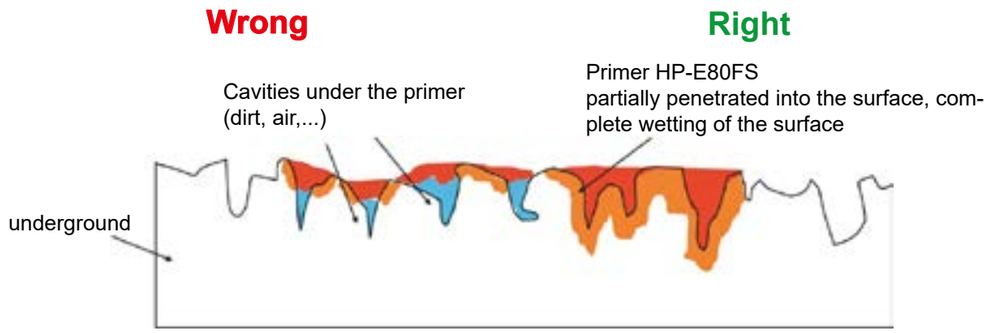
Subsequently reinforced internals

Priming

Advantages of a primer

A primer is characterized primarily by good impregnation behavior. This is why it is also referred to as „pre-soaking“. Background: When epoxy resin is completely absorbed into the pores of the substrate, a significantly larger surface area is available. This favors durable, high-quality adhesion.

A good primer is therefore often also a kind of adhesion promoter at the same time! For a durable bond, it is therefore particularly important that the primer is applied carefully and without defects.



Schematic representation of a substrate with small irregularities (grinding grooves, pores, ...)

Priming system HP-E80FS

Our epoxy system is low viscosity and with a high adhesive strength! The formulation allows a very good adhesion to mineral substrates, wood, metals, GRP and many other plastics. HP-E80FS has been used successfully in the offshore sector for a long time and defies the toughest conditions there! The consumption depends strongly on the substrate and varies between approx. 100 and 250g/m². The primer can be applied with a laminating roller or a brush.

As soon as the surface has gelled, the subsequent layer of epoxy resin can be applied. If the subsequent layer is not applied within 24 hours at 20°C, it is mandatory to sand the entire surface. Substrates unsuitable for bonding or laminating are, for example, PE, PP, soft PVC, PTFE and some other special plastics. In case of doubt, we recommend preliminary tests.

Note on priming on wood:

The reaction causes the surface temperature to rise. In individual cases there is a risk that air bubbles will escape from the substrate with a time delay and become trapped in the resin. Due to the brownish coloration, there may also be a slight change in color (especially with light wood types). Therefore, we particularly recommend preliminary tests for wood substrates!

Laminate

Mixing

The laminating resin is weighed out according to the respective specifications in the data sheet. The mixing ratio must be strictly observed and the batch size must be adjusted to the ambient temperatures and the curing behavior (details: see data sheet).

To counteract excessive temperature development, the laminating resin should be transferred to a flat vessel (paint tray) for processing.

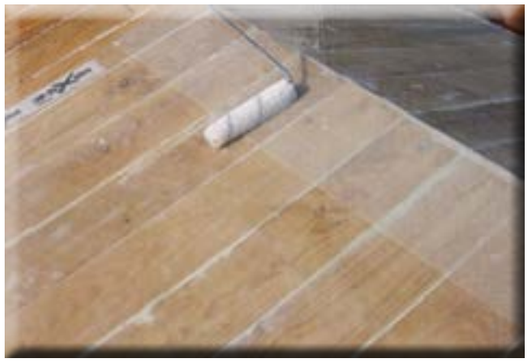
Epoxy laminating resins

Good fiber impregnation and excellent strengths are the main features of the epoxy laminating resin systems from HP-Textiles. They are available with different pot life from 25 to 100 minutes.

Impregnation of the reinforcing layers

At the beginning of the lamination work, some mixed laminating resin is first applied to a part of the surface. The cut-to-size reinforcing layer (fabric, fleece,...) is now applied to this, (fabric, scrim, fleece, etc.) and carefully soaked with resin. Sufficiently impregnated material will become more translucent after a short time.

Recommendation: Work „wet-on-wet“.
Thus you achieve high interlayer adhesion with low resin consumption!



Laminating on previously primed wood

Tips:

- All reinforcing materials should be stored in the processing area for at least 24 hours before starting work in order to avoid moisture precipitation on the surface.
- To reduce air bubbles already during mixing, the HP-BEL51 deaerator can be used. The last air bubbles can be minimized by blending. If some air bubbles still appear, they can be removed with the aid of a (hot air) dryer. To do this, you only need to go briefly over the freshly applied resin, otherwise there is a risk of premature curing.
- At the beginning of the lamination work, you can apply a little mixed epoxy resin to a piece of cardboard or wood. In this way, you can check the curing state at any time without having to repeatedly touch the coating surface.

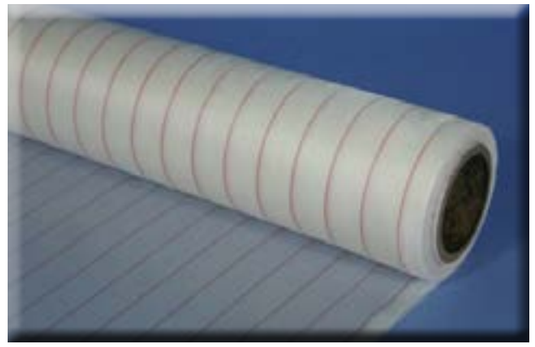
Venting

In order to avoid air pockets in the laminate, it is advisable to use deaeration rollers in addition to the conventionalvelor and polyamide rollers (HP-L1015 - HP-L1017), deaeration rollers should also be used. These are available as cross, longitudinal or spiked rollers.

Cross grooves vent roller

Peel ply fabrics

To minimize time-consuming grinding work, so-called peel ply fabrics are used. These are highly tear-resistant polyamide fabrics which are placed on the still moist resin surface and lightly rolled. After complete curing, the peel ply fabrics can be „peeled off“ at an acute angle. What remains is a uniformly roughened surface, which provides an optimum substrate for bonding or the subsequent surface finish.



Peel ply fabrics with red identification threads

Tips:
If the work is to be continued with a time delay, the peel ply fabrics can also remain on the component until the on the component until further processing, thus preventing soiling of the surface. In any case, it must be completely removed before further processing and must not be incorporated into the laminate.

Peel ply fabrics are available in twill weave (HP-T105P) or plain weave (HP-P83P) as well as in widths between 3 and 150 cm. As with the reinforcing fibers, the twill weave is more suitable for more complex / curved geometries and the plain weave for flat, planar structures. Peel ply fabrics are equipped with identifying threads so that they stand out visually from the laminate.

Peel ply fabrics on the fresh surface

Surface after tearing off the fabric

Apply top coat

Barrier primer

A top coat (also known as a fine coat or barrier coat) must be applied before the actual coating. This layer of unfilled epoxy resin protects the laminate against external from external influences and forms the basis for the subsequent coating (with a boat paint). Top coats consist of at least two to three layers of resin.

Apply as thin layers as possible to avoid run-off. Also, each layer should be applied in different painting directions (cross-coat).

To achieve optimum adhesion, you should always work „wet-on-wet“ here. If the lower layer has cured and no longer comes off, the next layer can be applied.

If, however, the lower layer has hardened too much, it must be sanded before the next coat ibefore the next coat (120 or 240 grit) and degreased with acetone.

Epoxy laminating resins serve as the basis for the later finish (the fine layer). The medium-viscosity epoxy system HP-E45KL (also thixotroped with HP-PK22) is used as abarrier primer on existing substrates, i.e. „wet-on-dry“.

Surface finish

Before the boat paint can be applied, the surface must be as smooth as possible. For this purpose, the last layers of epoxy resin (i.e. the barrier primer) are „smoothed“ after each pass. This involves carefully working over the freshly applied epoxy resin again in several steps using a suitable tool (a deaeration roller, a velour roller or a brush) to obtain an even, bubble-free surface.

Final coatings and boat paints

Selection

Due to their limited light and UV resistance, epoxy resins are rarely used as a colored finishing coat in surface applications. This is where our two components PUR coating HP-PUR is used. This provides an optimum gloss and improves the weather resistance.

Available in almost all RAL colors, also transparent!

Application 2 components PUR Paint HP-PUR / HP-PUR-PLUS

Preparation and mixing

Before application, the surface should be carefully finished with increasingly fine sandpaper. Start with a grit size of approx. 320 up to a finer grit size (e.g. 800). Then clean the surface again with solvents and degrease.

Carefully mix the resin and hardener in the specified ratio. Bubble-free using a suitable stirrer. Allow the mixture to stand for 10 minutes before processing to allow any bubbles that may have formed can escape.

	HP-PUR		HP-PUR-PLUS		HP-IMC-X - PUR Thinner -
	resin	harder	resin	harder	
Mixing ratio (parts)	100	25	100	50	10 - 20%
Pot life (at 20°C)	approx. 3 hours		approx. 3 - 5 hours		
Permanent water resistant	No		yes		
Processing temperature (optimal)	18 - 25 °C				

Then process within the pot life. Spray application is recommended for high is recommended.

Processing

Application with flocked foam roller and subsequent coating is possible. We recommend a paint test with subsequent adhesion test!

The coating must only be applied in a dry, well ventilated environment.

Avoid condensation moisture. Painted surfaces must be protected from moisture for at least 24 hours, as this may interfere with curing and reduce the gloss.

Painting the revised deck

Available in almost all RAL colors

Diameter of spray nozzle: approx. 1.2 - 1.4mm, HVLP approx. 1.3 - 1.4mm

Spray pressure: approx. 4bar, HVLP approx. 2 - 2,5bar

Spray passes: 2 - 3 (recommended)
Recommended film thickness: 40 - 50µm (per coat)

Yield: 1 liter mixture approx. 7m² at 50µm

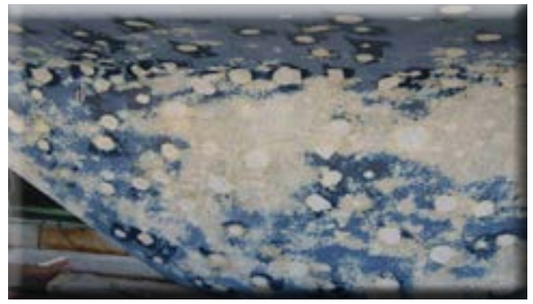
Customer projects

Wooden kayak in „stitch and glue“ construction method

All bonds were made with HP-E45KL, including Thixotropypowder. HP-PK22 and Cotton flocks HP-BF1. Afterwards, the glass fabric tape HP-T280/050E (also with HP-E45KL) has been laminated on for reinforcement.

The kayak was sealed with HP-E40D using flocked foam rollers (HP-L1018 / HP-L1019).

Osmosis rehabilitation sailboat (type: „Firling“)



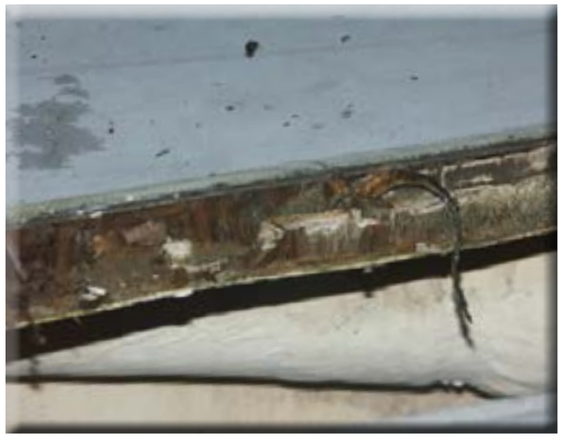
First, the underwater hull was cleaned, degreased and sanded.

It was then treated with HP-E45KL,Thixotropypowder HP-PK22 and Microballoons HP-MB2. To increase the strength and durability. a Glass Fabric „Silane“ (HP-VJ50C) was laminated with HP-E45KL.

Finally, a fine coat, consisting of HP-E45KL, Thixotropypowder HP-PK22 and color pigments was applied.

Refit J-41 racing yacht

Condition before refit



Products used:

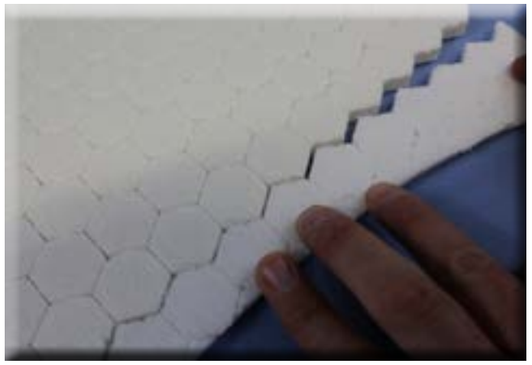
<u>Bonding, filling, laminating:</u>	
Multipurpose Epoxy System	HP-E45KL
<u>Fillers:</u>	
Cotton flakes	HP-BF1
Thixotropypowder	HP-PK22
Microballoons	HP-MB2
<u>Glass fabric:</u>	
166g/m², twill weave	HP-T163E
<u>Glass scrim:</u>	
450g/m², biax +/-45°	HP-B450E

During the repair work

3D|CORE™ as sandwich material

3D|CORE™ is a structure-reinforcing foam core (SVS), which consists of hexagonal foam honeycombs, which are connected to each other by fine webs. The honeycomb construction gives the board tremendous flexibility, which provides excellent drapability of the foam core and thus follows a contour.

By simplifying processing, 3D|CORE™ improves production workflows, making it ideal for the IMC/MTI® process, among others. Not only time but also material is saved.



The 3DCORE can be easily cut and placed together

The 3D|CORE™ during infusion

CUSTOMER PROJECTS

GRP repair kit for boat building

With our GRP repair set, nothing stands in the way of renovation. It is suitable for small holes, repairing holes and repairing components affected by osmosis. The set offers a comprehensive range of materials for processing small to medium damage and also serves as an initial identification aid for large projects.

The set offers an optimal introduction to GRP repair. It contains a suitable epoxy resin, thinner, matching fabric, peel ply, mixing cup, various rollers, gloves, stirring rods, cotton flakes and Thixotropypowder.

The complete set can be found in our online store (www.shop.hp-textiles.com) under the article number.

Item number in the online store: HP-KS-GFK01

Frequently asked questions

Do I have to pay attention to a certain occupational safety during processing?

- Keep out of the reach of children
- Avoid inhalation of vapors and product contact with skin
- Wear suitable protective gloves and goggles
- Do not eat, drink or smoke during application

Where can I find detailed information about the products?

- Information about the products can be found in the online store at www.shop.hp-textiles.com
- Further information can be found in the technical data sheet

What is the best way to store the products?

- Epoxy resins are best stored in a cool place (approx. 15°C)
- Shelf life at least 12 months with optimum storage

What do I have to consider when disposing of the products?

- Do not allow to enter drains, watercourses or the ground
- Uncured products are hazardous waste
- The cured system is construction site waste / household waste

How can I clean the tools?

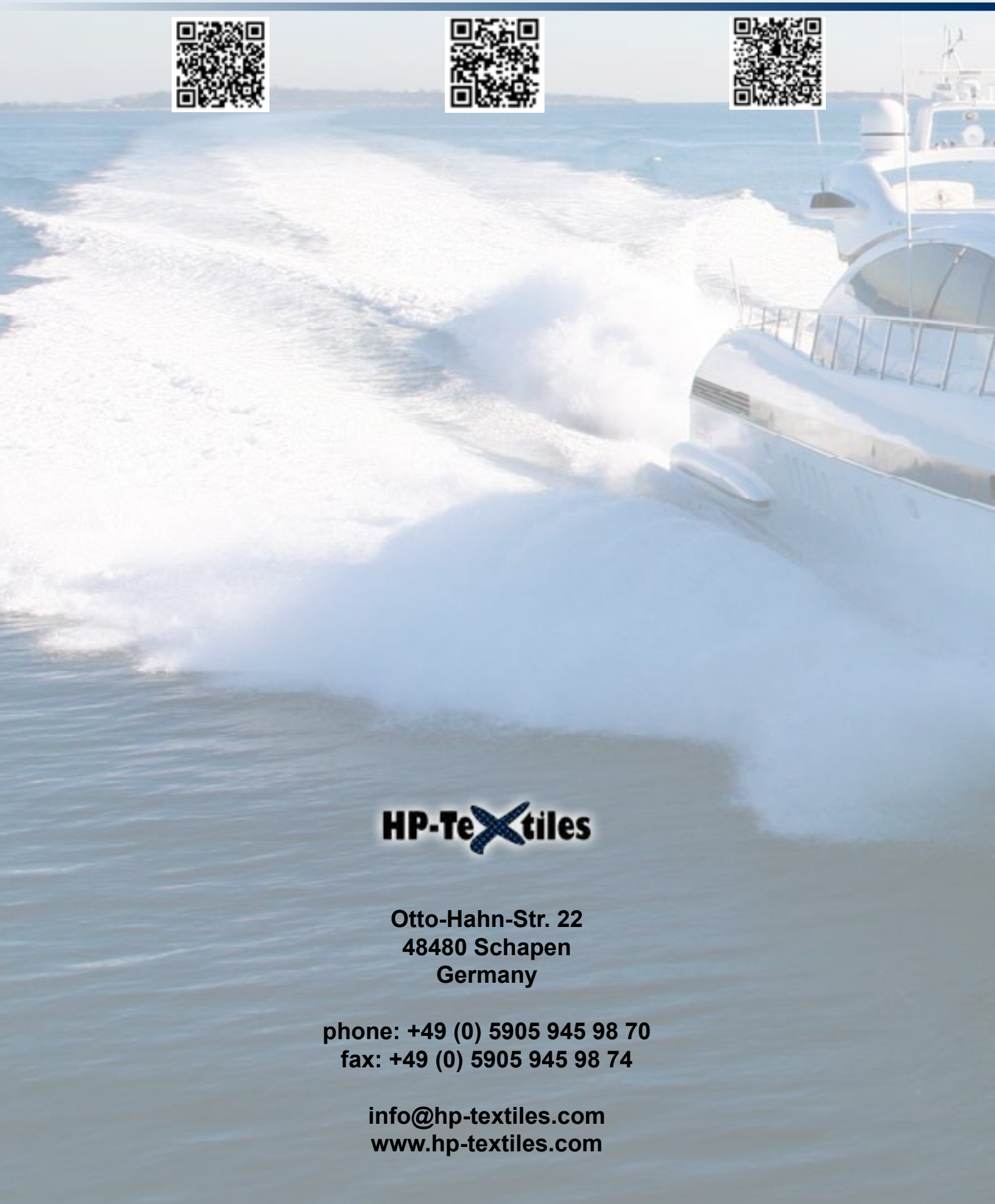
- Remove uncured product residues from tools with acetone or Thinner XB
- Allow to air thoroughly after washing out with solvents
- Cured product residues can only be removed mechanically (e.g. by grinding)

Our business areas:

HP-Textiles
Composite Materials

DeinTeich.de
Teich Pool Dach
GRP Coatings

bredderpox®
Building Chemistry



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