

Dear customers,

Our company would like to take this opportunity to present itself.

We are providing services for our customers dealing with composites all over the Europe since the 2000. We deliver practically whole range of materials for various segments of composite industry and we also offer our own products, services and technical consultancy.

In the interest of high quality service provision for our customers abroad we established new foreign trade department close cooperating with our branch offices abroad in Poland and Ukraine. News and another information concerning composite materials and technologies you can find in website www.havel-composites.com where, among others, you can directly order chosen goods in our e-shop.

At present our customers are active in airplane, automotive and boat industry as well in others sectors of polymer composites.

We are proud of the fact that lot of our materials were successfully used in many very interesting products of our clients.

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POLYESTER RESINS AND GELCOATS



POLYESTER RESINS AND GELCOATS

Polyester resins are most widely used resin systems, particularly in boat industry.

There are the basic kinds of unsaturated polyester resins (UP) as follows:

orthophthalic	- lowest price
isophthalic	- more expensive and higher quality, better chemical and thermal resistance
fumaric	- good chemical and thermal stability
chlorophthalic	- fire retardant, lower mechanical properties
terephthalic	- very good chemical and thermal resistance

Unmodified unsaturated polyester resins have relatively high shrinkage during the course of curing (7 – 8%). They are brittle and under the loading they create microcracks easily. Electrical properties (non-conductivity, value of relative permeability) are good as well as UV resistivity. UP resins wet well glass fibres, bond strength depends on the surface treatment of fibres.

By processing there is necessary to add another substances, generally catalyst, accelerator, if needed additives – thixotropic agents, pigments, fillers, fire retardants etc. Catalyst and accelerator should be dosed in well measured amounts to influence polymerization reaction and to obtain the best material properties. Excess of catalyst brings too quick reaction and too short working time, on the contrary the lack of catalyst causes incomplete curing. Fillers are added up to 50% by weight, but some of them can reduce flexural and tensile strength.

Vinylester resins are similar regarding molecular structure but they have located reactive groups only at the end of their macromolecules. Vinylester chains are more tough and rigid and therefore the resins are more resistant against impacts. Vinylester resins offer better water resistance, thermal stability and very high corrosion resistivity against many chemicals, therefore they are applied to pipes, storage and transport tanks and other chemical equipments. Vinylester resins cures slower than orthophthalic ones and they are more expensive.

►**NEWS**◄ DCPD polyester resins (dicyclopentadien) – DCPD resins with minimum 66% non volatile matters are characterised by lower styrene content resulting in smaller emission and smell, lower shrinkage then orthophthalic types. Manufacturer of composites can meet strict legal regulations concerning styrene immission using DCPD resins. Reduction of styrene emission has no negative influence to interlaminar strength of composites. Other advantages: better wetting of glass fibres, quick curing with rapid start of reaction which allows increase of production capacity by quicker mould exploitation, there is possible to reduce post curing time. DCPD resins can reach thermal stability (HDT) 95° C, thanks to lower shrinkage there is reduced print-through effect on the composite parts surface. DCPD resins have usually darker colour and little bit different smell.

Polyester resins

Type	Description
HAVELpol. 1	Basic orthophthalic resin, accelerated. Recommended peroxides:Butanox M 50, Peroxide K 1, mixing ratio 100:2
HAVELpol. 2	Standard orthophthalic resin, accelerated, low emission, thixotropic
HAVELpol. 3	Very low emission orthophthalic resin (25% less styrene), accelerated
HAVELpol. 4	Clear, UV stabilized, non-accelerated (Co accelerator should be ordered jointly, dosage 1-2%)
HAVELpol. 5	Non-accelerated!! Suitable for heavy mechanical loaded parts. Accelerator should be ordered jointly, ratio 100:1-2
HAVELpol. 6	Standard orthophthal resin, pre-accelerated, low price. Suitable for the production of plain fiberglass components, where the main criterion is price.
HAVELpol. H 834	DCPD polyester resin H 834 is medium reactive, accelerated, with controlled exotherm and low shrinkage. H 834 is suitable for boat and other composite parts by hand lay-up as well spray-up. Resin has high HDT 95°C and excellent hydrolytic stability, i.e.water resistance. Approved by Lloyd's Register. H 834 can be delivered in 30W or 40W versions (working time 30 or 40 min. using 1.5% Butanox M50) and also in versions 20C or 30C - 20 or 30 min. working time, lower viscosity, suitable during winter.
Transparent casting	Colorless orthophthalic casting resin, suitable for the creation of decorative castings, potting of table tops, etc. UV stabilized, water-clear.

Polyester gelcoats

Type	Description
Havelgel 65	Pre-accelerated isophthalic gelcoat designed for mold application. It was designed for brush application. It is designed for use in the marine, construction and transportation industries. It is also suitable for normal use. It excels in resistance to water and weathering. To activate, use Butanox M50 in an addition of 1-3%. Clear and white version.
Havelgelcoat 97	Pre-accelerated isophthalic gelcoat designed for mold application. It has excellent adhesion to epoxy resins and pre-pregs. Suitable for brush application, Havelgelcoat 97 can be available in a wide range of colors. The processing technique does not differ from color to color. Application Havelgelcoat 97 is designed for both manual lamination and vacuum injection systems.
Vorgelat T30 MGS	Clear and white version. Accelerated with cobalt, without paraffines. For colouring it is possible to use pigment pastes for polyesters. For the best results it is recommended to use original peroxides and diluents, for instance diluent SF up to 10 parts by weight
Vorgelat T35 MGS	High quality white gelcoat. Suitable for ready to use parts which will not be additionally surface treated. Proved in boat and airplane industry. It is recommended to use original peroxides and diluents. Gelcoats T30 and T35 have excellent adhesion also to epoxy laminates
Norpol GS 2000 H	Suitable and cheaper alternative to T30 and T35. No surface treatment after demoulding is necessary. High quality gelcoat for hand application. It cures by using all suitable peroxides, ratio 100 : 0,8 – 3 parts by weight. Recommended thickness 0,5 – 0,8 mm.
Norpol GS 100 S	Clear gelcoat, suitable alternative to T30 and T35. Application by spraying, mixing ratio with peroxides 100 : 0,8-3 parts.Recommended thickness 0,5 – 0,8 mm.
Norpol GM 60014 H	Green tooling gelcoat for manufacturing of composite moulds used for polyester resins. Gelcoat exactly copy the model surface. It is possible to sand and polish it, easily repairable.

►NEWS◄ We offer the possibility of delivery coloured gelcoats pigmented according RALcolour card, also in metallic grades. Only by order!

Peroxides, accelerators, diluents

Type	Description
Peroxid K1	Quality approved peroxide for curing of polyester resins, recommended mixing ratio 100 : 0,8 – 3% in dependence on laminate thickness and ambient temperature.
Butanox M50	Favourite peroxide for curing of polyester resins, mostly used type of Butanox
Peroxid SF 10 MGS	Peroxide recommended for curing MGS gelcoats T30, T35 and T3 PU
Perkadox	Accelerator for curing polyester and vinyl ester resins, 1% or 4%
Cobalt	Accelerator for curing polyester and vinylester resins. 1% or 4% solution
Styrene	Styrene is one of basic raw materials used for production of polyester and vinylester resins and gelcoats. Separately it is used as diluent of these materials if needed.
Diluent for T30, T35 and T 3PU MGS	Diluent specified by manufacturer for adjustment of viscosity MGS polyester gelcoats T 30, T 35 and T 3PU.

Mechanical/physical properties of cured (non-reinforced) resins

Resin	Tensile strength	Tensile modulus [GPa]	Flexural strength [MPa]	Flexural modulus [GPa]	Compressive strength	Heat distortion temperature HDT [°C]
orthophtalic	55	3.45	80	3.45	-	80
isophtalic	75	3.38	130	3.59	120	90
isophtalic	80	3.59	140	3.72	-	100

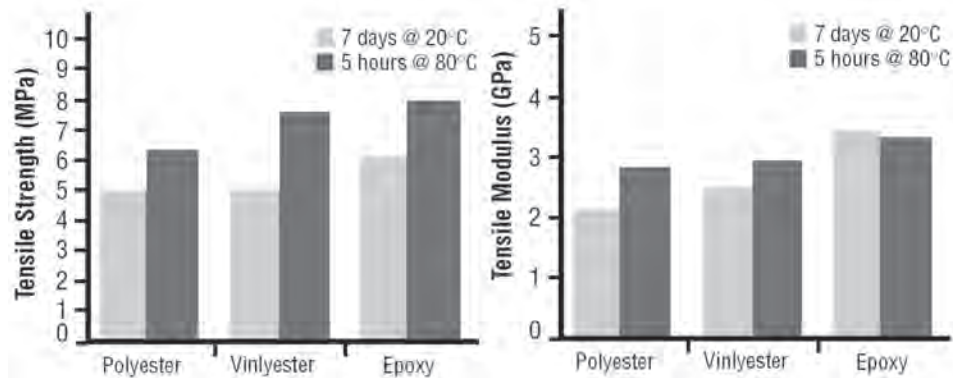
Effect of glass content to mechanical properties of composite Glass reinforcement/polyester resin

Resin	Glass content [weight %]	Tensile strengt [MPa]	Tensile modulus [GPa]	Flexural strength [MPa]	Flexural modulus [GPa]	Compressive strength [MPa]
orthophtalic	30	140	4.8	170	5.5	-
	40	150	5.5	220	6.9	-
isophtalic	30	150	8.27	190	5.5	-
	40	190	11.7	240	7.58	210
vinylester	25	86.2	6.96	110	5.4	180
	35	153.4	10.8	260	9.52	230
	40	160	11.0	220	8.89	210

Effect of glass content and type of reinforcement to mechanical properties of composite

Material	Glass content weight %]	Tensile strength [MPa]	Tensile modulus [GPa]	Flexural strength [MPa]	Flexural modulus [GPa]	Compressive strength [MPa]
neat cured resin	0		5.40	88	3.90	156
glass fibre mat	30	117	10.80	197	9.78	147
	50	288	16.70	197	14.49	160
glass fabric	60	314	19.50	317	15.00	192
classic fabric	70	331	25.86	403	17.38	280
unidirectional glass fabric	70	611	32.54	403	29.44	216

There are two basic mechanical properties of any polyester resin system: tensile strength and modulus. Graphs below show the results of commercially available polyester, vinylester and epoxy resins systems cured for various time at 20°C and 80°C .



HAVELcell P1 – polyester foam for sandwich manufacturing

Reinforced white foam based on orthophthalic polyester resin, high viscosity close to putty, foam is not sagging even applied in 5 mm thickness. Foam is suitable for sandwich structure creating directly in the mould. 1 kg of foam has volume approx. 2 litres. Thanks to this the weight of your product can be reduced up to 50%. Using this foam can be reduced also the cost of your products as the price for litre is lower then the price of litre of resin and production with this foam is faster by 40% compared to classic laminating laying glass mat or fabric layers. Another advantage is lower consumption of peroxide and also styrene evaporation is reduced. The pressure generated by impregnation should be adequate to applied layer of the foam so that it is not squeezed from the mould. In the case of application by spray gun it is possible to let cure, the thickness of foam can be easily adjust after application of the last layer by spreader. Optimum is when resin used for impregnation of covering mat or fabric cures later then foam layer. Volume weight of the foam is 650 – 750 kg/m³. HAVELcell P1 has thanks to its structure excellent thermal and sound insulating properties.

HAVELcell P UltraLight

It is similar foam as P1, but with lower volume weight which was developed to bring down density as possible and in the same time to increase flexibility and toughness of sandwich. It was realized within the resin price. Sandwich foam of this type is successfully used from the year 2006 in company HAVEL COMPOSITES by production of sea kayaks for export. Volume weight of this foam is 450-550 kg/m³ and it can be processed by hand or by spray-up. The best way for application is spraying by the gun with greater nozzle diameter 4 mm and more. As with other foam types the viscosity can be adjusted by polyester resin or styrene. It is also possible to apply this foam by brush or spatulae in thinner layers. As with other sandwich materials it is necessary that the foam must be overcoated by laminate on both sides to reach the real sandwich effect. One of the main advantages of this technology is the elimination of complicated vacuum process which is necessary by production of sandwich structures. For sandwich materials it is necessary that the foam must be overcoated by laminate on both sides to reach the real sandwich effect. One of the main advantages of this technology is the elimination of complicated vacuum process which is necessary by production of sandwich structures.





EPOXY RESINS AND GELCOATS

Epoxy resins (EP) “overcome” most of another resins from the point of view mechanical properties and weather resistance and that is why they are most used in of industry. They are also ideal resins for boat and ship building. Epoxies are widely used in primary structures of ships and secondary structures of aircrafts.

Epoxy resins can be easily and fast cured within the temperature range 5 – 150°C according to selection of hardener eventually accelerator. One of the competitive properties of epoxy resins is their lower shrinkage during cure process which causes decrease of internal stress and minimises the print through effect. Other advantages of EP are high adhesion properties, electro - isolating properties and good chemical resistance.

Epoxy resins are used as adhesives, sealing materials, casting resins, paints and as a matrix for composites in wide range of application fields.

Epoxy resin structure consists of many long-chain macromolecules similar to vinylesters where reactive groups are located at the ends of every chain. Reactive sites are created from epoxy groups instead of polyester ones. Absence of polyester groups makes exceptionally good resistance against aqueous media.

Epoxy resins differ in curing chemistry, instead of catalyst the cured by means of hardeners.

Various amines are often used as hardener, in this case curing is an addition reaction.

Curing of epoxy resins is possible to speed up by application of heat, i.e. the higher the temperature the quicker complete curing occurs. Using of higher temperatures is very effective as some EP systems cure several hours, even days by room temperature. According to elemental rule the increase of curing temperature on 10°C causes doubling of reactive speed, i.e. if the gel time of system is 25 min. at 20°C it gels in 12 min. at 30°C with only slight enhance of exotherm. Postcuring of epoxies close to their HDT brings also other advantages: better mechanical properties and higher thermal stability.

Compared to polyester and vinylester resins epoxies have better fatigue resistance and it is also one of many advantages why EP are used in aero and space applications, transportation and wind energy.

Advantages: High mechanical properties
Excellent water resistance
Longer open time
Thermal stability up to 160°C
Low shrinkage by curing

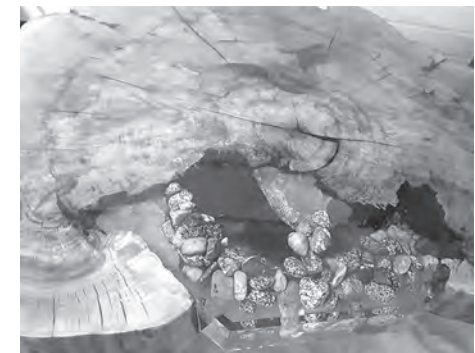
Disadvantages: Higher price
Mixing ratios should be kept precisely
Amine hardeners are corrosive

Epoxy resins of Havel Composites company

<i>Epoxy resin</i>	<i>Description</i>
LH 145	Very low viscosity, resistance against crystallization. Suitable for boat production, sporting goods and car parts. Hardeners: H 146, H 147, H 10, 133 – 138, 500 - 502
LH 160	Standard laminating resin, low viscosity, high hardness and chemical resistance of products. Certificated by Germanische Lloyd. Production of boats and accessories, sporting goods, models, moulds and castings. More sensitive to crystallization by lower temperatures. Hardeners: H 505-H512, H 10, H 146, H 147, 285-287, 133-138, 500-502
LH 260	Clear resin resistant to crystallization, higher viscosity then LH 160. Similar application as LH 160. Available in 3 another modifications: LH260 with UV sabilizer (contains carbon microparticles – better strength and UV stability). LH 260 with defoamer (more rapid putting away microbubbles). Retardexo LH 260 (reduced flammability) Hardeners: H 505-512, 285-287, 133-138, 500-502
LH 288	Special epoxy resin with extremely low viscosity. Suitable for infusion technologies. Products are very hard. Hardeners: H 281-H284
LH 289	It creates smooth and glossy surface. Used as surface lacquer and glazing of artificial stone. Recommender hardener: H 289
LH 300	Higher viscosity. High thermal stability (up to 150°C). Very important to keep precise the technology (see technical data sheet). Recommended hardener: H 513
LH 385	An alternative to L285 MGS is characterized by low viscosity. It offers high quality application properties such as high mechanical properties, good chemical resistance, excellent temperature properties, etc. It is a low viscosity resin based on bisphenol A. Viscosity: 400-800 mPas / 25 ° C. Crystallization does not occur at normal storage temperatures. The advantage of the mixture of resin and recommended hardener is its clarity. Special properties: The resin is clear even at a temperature of 0 - 10 ° C, The resin with a hardener creates a low-viscosity system before lamination, which allows good wetting while pushing bubbles out of the laminated surface. Workability time / so-called pot life / from approx. 15 min. within about 5 hours depending on the hardener used. Ideal hardeners are H 285, H 286, H 287, H 146, H 512, H 535-538.

Another epoxy resins

<i>Epoxy resin</i>	<i>Description</i>
L 285 MGS	Very high quality resin certified for aircraft industry and for model production. Very high viscosity, good wettability resulting in low weight products with high utility value. Hardener: 285-287, 500
C	Epoxy resin with outstanding chemical resistance. Used for tanks, pipes,
L	Good adhesion to wood, steel, plastic, ceramics, foamed polystyrene etc. Hardener: L
L 20	Similar to type L, it is possible to use other types of hardener: VE 2723, VE 2778, VE 3261
Rivertable WWA+WWB	Epoxy casting system designed for casting table tops, the so-called Rivertable. It excels in its transparency and, thanks to the reduced exotherm, the possibility to cast a layer of up to 9 cm at a time. After curing, the product is colorless, firm, sandable and polishable.



Offer of hardeners for epoxy resins

Hardener	Hardener
133 MGS	Hardener for curing of epoxy resins: L 160, L, LR, LR 100, LH 130, LH 145, LH 160, LH 260. Mixing ratio 100:35 by weight or 100:40 by volume. Gel time 100 g/20°C is 10-15 min.
135 MGS	Hardener for curing of epoxy resins: L 160, L, LR, LR 100, LH 130, LH 145, LH 160, LH 260. Mixing ratio 100:35 by weight or 100:40 by volume. Gel time 100 g/20°C is 25-30 min.
136 MGS	Hardener for curing of epoxy resins: L 160, L, LR, LR 100, LH 130, LH 145, LH 160, LH 260. Mixing ratio 100:35 by weight or 100:40 by volume. Gel time 100 g/20°C is 1-2 h.
285 MGS	Hardener primarily for curing of epoxy resin 285. However it is possible to use it for resins L, LR, LR 100, LH 160, LH 260. Mixing ratio 100:40 by weight or 100:50 by volume. Gel time 100 g/20°C is 50 min.
286 MGS	Hardener primarily for curing of epoxy resin 285. However it is possible to use it for resins L, LR, LR 100, LH 160, LH 260. Mixing ratio 100:40 by weight or 100:50 by volume. Gel time 100 g/20°C is 2 h.
287 MGS	Hardener primarily for curing of epoxy resin 285. However it is possible to use it for resins L, LR, LR 100, LH 160, LH 260. Mixing ratio 100:40 by weight or 100:50 by volume. Gel time 100 g/20°C is 4 h.
386 MGS	Hardener for epoxy resin L 385. Mixing ratio 100:35 by weight or 100:40 by volume. Gelltime 5-6 hours at 25°C, 80-120 min. at 40-45°C.
500 MGS	Very rapid hardener for epoxy resins L 285, L 160, L, LR, LR 100, LH 130, LH 145, LH 160, LH 260. Mixing ratio 100:40 by weight or 100:50 by volume. Gel time 100 g/20°C is 10-15 min.
H 285	Hardener alternative 285 MGS, mixing ratio 100:40, workability time 50 min.
H 286	Hardener alternative 286 MGS, mixing ratio 100:40, workability time 2 hours.
H 287	Hardener alternative 287 MGS, mixing ratio 100:40, workability time 4 hours.
H 505	Hardener for epoxy resins LH 130, LH 160, LH 260. The mixing ratio is 100: 27. Workability time is 15 - 30 minutes.
H 507	Hardener for epoxy resins LH 130, LH 160, LH 260. The mixing ratio is 100: 28. Workability time is about 40 minutes.
H 508	Hardener for epoxy resins LH 130, LH 160, LH 260. Mixing ratio 100:28. Gel time is cca 60 min.
H 509	Hardener for epoxy resins LH 130, LH 160, LH 260. Mixing ratio 100:26. Gel time is 70-90 min.

H 510	Hardener for epoxy resins LH 130, LH 160, LH 260. Mixing ratio 100:24. Gel time is 80-100 min.
H 511	Hardener for epoxy resins LH 130, LH 160, LH 260. Mixing ratio 100:19 Gel time is 90-120 min.
H 512	Hardener for epoxy resins LH 130, LH 160, LH 260. Mixing ratio 100:23. Gel time is 150-180 min.
H 513	Hardener for epoxy resins LH 300 and LH 301 for high thermal stability. Mixing ratio 100:23 by weight. It is important to keep precise technology, please ask technical data sheet..
H 146	High quality hardener for curing of epoxy resins LH 160, LH 145 and LH 130. Mixing ratio 100:30 by weight. Gel time is 50-60 min. Minimal curing temperature is 25°C, but recommended curing temperature is 30°C and higher.
H 147	Top quality hardener for curing of epoxy resins LH 160, LH 145 and LH 130. Mixing ratio 100:25 by weight, slow hardener with gel time 90 min.
H 10	Special hardener for curing of epoxy resins LH 130, LH 145 and LH 160. This hardener is suitable namely for those applications where clarity of laminate is a priority (for instance face parts). Mixing ratio 100:45-50 by weight, ratio 100:50 is suitable mainly for thinner layers and need of short gel time. Gel time on ratio 100:45 by weight is 20-25 min. and on ratio 100:50 by weight 15-20 min. at 20°C
H 282	Hardener for epoxy LH 288. Mixing ratio 100:23, gel time 40-50 min.
H 283	Hardener for epoxy LH 288. Mixing ratio 100:19, gel time cca 40 min.
H 284	Hardener for epoxy LH 288. Mixing ratio 100:23, gel time 150-180 min.
H 289	Hardener for epoxy LH 289. Mixing ratio 100:33, gel time 30 – 60 min..
C	Hardener for epoxy resin C. Mixing ratio 100:60 by weight, gel time 50 min..
L	Hardener for epoxy resin L. Mixing ratio 100:40 by weight, gel time 40 min.
VE 3261 (EPH 161)	Hardener for curing of epoxy resin L 20. Mixing ratio 100:25 by weight. Gel time is 90 min. It is necessary to keep curing recipe, please see data sheet.

Note: *Mixing ratios by hardeners which can be used for more epoxy resin types could be slightly different, but not more than within ±2. For sure please ask the technical data sheets.*

Epoxy gelcoats

Gelcoat	Description
EG 100 - T	Clear spray gelcoat for thin layers. For curing use hardener H 100 in ratio 100:40 by weight. Recommended gelcoat thickness 0,05 – 0,2 mm. In case of thicker layer gelcoat is soft, cures hardly and slowly. This gelcoat can be used as topcoat – coating for closure back side of laminate and also for water-resisting paint of wood. It is possible to dilute it by special thinners for gelcoat EG 100-T and EG 100 – W..
EG 100 - W	White (RAL 9003) spray gelcoat for thin layers. For curing use hardener H 100 in ratio 100:40 by weight. Recommended gelcoat thickness 0,05 – 0,2 mm. It is possible to dilute it by special thinners for gelcoat EG 100-T and EG 100 – W.
EP 100 - T	Very durable thixotropic professional epoxy gelcoat. Hardener 100 T - mixing ratio 100:50 by weight, working time 40-50 min., gel time 4-5 h. Hardener 120 T – mixing ratio 100:40 by weight, working time 10-15 min., gel time 1-2 h.
F 200	Epoxy gelcoat for moulds manufacturing. High hardness of edges and surface ensure very long service life. Unfortunately it is not possible to polish the mould surface and hence also it is not possible to repair mould without possibility to polish repaired location. Hardener F 16, mixing ratio 100:10 by weight, working time 15-20 min., gel time 1-2 h. by 1 mm thickness. Hardener F 16 is suitable for production of moulds with higher thermal stability cca 60-100°C, but it is necessary to temper the mould. Hardener F 260, mixing ratio 100:10 by weight, working time 25-30 min., gel time 2-3 h. by 1 mm thickness. Hardener F 260 can be used for production of moulds not requiring higher thermal stability..
Araldite SW 18	Epoxy gelcoat for moulds manufacturing. Hardener Araldit HY 5159, mixing ratio 100:18.
Araldite SW 404	High quality epoxy gelcoat for moulds manufacturing, blue colour, high chemical resistance. Insuperable in strength and durability, it is not possible to polish it. Hardener Araldit HY 2404, mixing ratio 100:10. Working time 25-30 min.
RENGEL SW 56	Epoxy gelcoat for mould production. Recommended hardener HY 5159, mixing ratio 100:10 by weight, geltime 25-30 min. After gradual postcuring thermal stability 120°C. Using hardener HY 2404 in ratio 100:13 geltime 10-15 min., thermal stability up to 100 °C.
Gelcoat P	Epoxy gelcoat for mould production. It creates hard surface and edges of moulds, black colour. Recommended hardeners VE 3261 and VE 2723, see hardeners for epoxy resins..

Epoxy foam for sandwich manufacturing HAVELcell E1

Epoxy foam HAVELcell is structured epoxy resin with density cca 550 kg/m³. Thanks to low weight you can create your sandwich structure of your products. This material can reduce working time and the production costs. A part which is produced from this foam 1,5 mm of thickness and with both side skins of glass tissue 200 g/m² impregnated with epoxy resin is lighter then water and that is why this material is suitable also for boat production. Foam HAVELcell E1 consists from 2 components. Component A is epoxy resin and component B hardener for curing of this foam. Mixing ratio A : B is 100:35 by weight.







ROVINGS

Rovings are assembled strands without twist or with low number of twists (less than 40/m) for production of pultruded profiles, filament winding and weaving of roving fabrics (woven rovings). Various lubrication/ sizing agents are used for achieving of required properties, eventually individual strands are divided into more fine ones. Various types of rovings are designated for spray-up technology, continuous sheet production, filament wound tubes and vessels, pultrusion, centrifugal casting, for production of prepregs for press moulding technologies (SMC, hot press and vacuum moulding), manufacturing of chopped strand mats (CSM) and woven roving fabrics. Rovings can be used also for reinforcing of mould and composite part edges, plugs and bonded shaped elements etc. Rovings are supplied in form of cylindrical bobbins (cheeses) weighing cca 15 kg, with or without cardboard spool (for external or internal pulling away - tow). Tenuity of rovings is given in tex number or denier.

Example: 1200 tex (tex number indicate what is the weight of 1000 m of a given fibre - roving in grams).
 1 running meter weights 1,2 g, 10 m = 12 g, 100 m = 120 g, 1000 m = 1,2 kg.

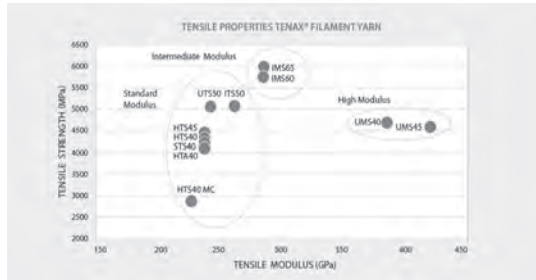
Carbon rovings

Type of carbon roving	Tex
Tenax HTA 40 E13 3K	200tex
Tenax HTA 40 E13 6K	400tex
Tenax HTA 40 E13 12K	800tex
Tenax HTS 40 F13 24K	1600tex
Tenax STS 40 F13 24K	1600tex
IMS65 E23 24K	830tex
Tenax UMS 45 Y13 12K	385tex
Tenax UMS 40 F23 24K	800tex
Carbon roving 50K	3700tex

** UMS type rovings require an approval process*



Carbon fibres are manufactured from various raw materials – precursors. One of the most important are special polyacrylonitril fibres which are first of all stretched under tensile loading to aligned the macromolecules, followed by oxidation process again under tension and as a final step there is carbonization in inert atmosphere. Other type of precursor is pitch from distillation of coal or crude oil which is processed to gain fibre form. Carbon fibres are mostly classified for practical reasons by the value of tensile modulus and tensile strength. Precursor fibres carbonized at 900- 1500°C have higher tensile strength are called “high strength” (HS). These fibres are cheaper than high modulus ones. By carbonization at higher temperatures at 2000 – 2800°C are gained graphite fibres which have lower tensile strength, but they are greater at higher tensile modulus. Such fibres are called “high modulus” (HM).

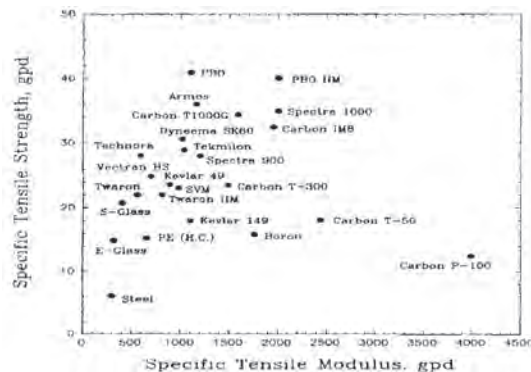


Comparison of mechanical properties of various types of carbon rovings (dependence of tensile strength vs. tensile modulus)

Properties of TENAX carbon rovings

	HTA	HTS	STS 5631	UTS 5631	UTS 7731	IMS 3131	IMS 5131	UMS 2526	UMS 3536
Density /g/cm ³ /	1,76	1,76	1,77	1,79	1,79	1,76	1,8	1,79	1,81
Tensile strength /MPa	3950	4300	4000	4800	5000	4120	5600	4560	4500
Tensile modulus / GPa/	238	238	240	240	245	295	290	395	430
Elongation %/	1,7	1,8	1,5	2	2,1	1,4	1,9	1,1	1,1

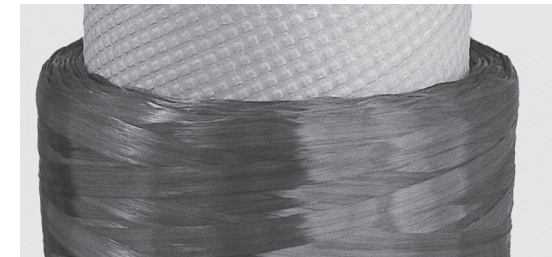
Comparison of mechanical properties of reinforcing fibres (tensile strength vs. modulus)



Glass rovings

Glass rovings AEROGLOSS	
Aeroglass 200 tex – without spool	
Aeroglass 300 tex – without spool	
Aeroglass 600 tex – without spool	
Aeroglass 1200 tex – without spool	
Aeroglass 2400 tex – without spool	
Aeroglass 600 tex – with spool	

Aeroglass 1200 tex – with spool
Aeroglass 2400 tex – with spool
Another glass rovings
Glass roving for edges – higher volume T 5000 tex
Cutted glass roving 5 – 10 cm

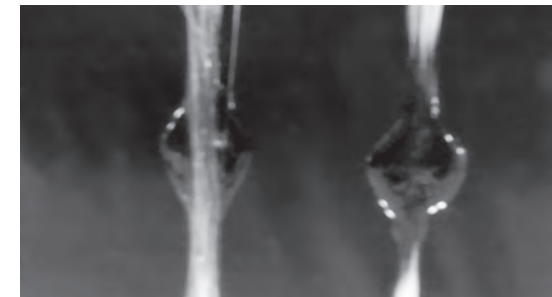


As well as AEROGLOSS fabrics also AEROGLOSS rovings are manufactured from E-glass and they are primarily used with epoxy resins, but they are also suitable for other commonly used resins. AEROGLOSS rovings is suitable namely for weaving, filament winding and pultrusion.

Test:

On the right there is glass roving AEROGLOSS 2400 tex, on the left general purpose roving 2400 tex.

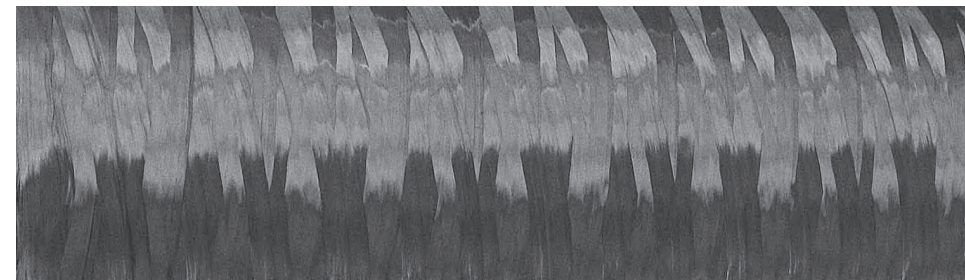
From the photo there is clearly visible the advantage of AEROGLOSS roving after 1 min. of application of epoxy resin LH 160 compared to commercially used rovings.



Aramid rovings

We offer also aramid rovings. Aramid fibres are used as a reinforcement of composite parts where high toughness and abrasion resistance is required.

In our supply there is only one most favourite type: **Aramid roving - type 2200 - 1610 dtex f1000**





GLASS REINFORCEMENTS



GLASS REINFORCEMENTS

Glass fibres for composites are manufactured mainly from glass marked as glass type E (II. hydrolytic class – electro grade). E-Glass is a low alkali glass with a typical nominal composition of SiO₂ 54wt%, Al₂O₃ 14wt%, CaO+MgO 22wt%, B₂O₃ 10wt% and Na₂O+K₂O less than 2wt%. Production is continuous, starting from finely ground raw materials from selected quarries which are molten in special furnaces at around 1550°C. The glass leaving furnace at a very high temperature is used to feed bushing (block pierced with hundreds of small holes) of platinum/iridium alloy. The basic strand is made by forming. Forming is achieved by drawing the molten glass flowing from the holes of the bushing at high speed. This forms to between 50 to several thousands monofilaments. These filaments are defined by their diameters: from 5 to 24 microns (1µm = 1/1000 mm).

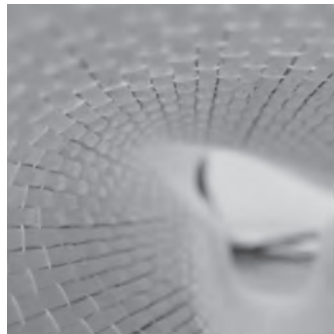
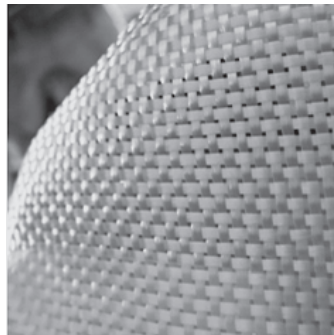
The individual filaments receive a coating of size at the forming stage, immediately after leave the bushing. The size, made up of organic product dispersed in water, is designed to give the glass strand certain characteristics necessary for final processing (lubrication effect) and to improve adhesion to different matrix type. It usually contains a silane type chemical "coupling agent" which also contributes to enhancing the mechanical properties of composites and particularly their resistance to ageing.

Aeroglass - Fabrics made of glass yarn based on type E. This yarn has sizing suitable for most of the resins used. Since the sizing does not contain wax these fabrics are namely suitable for epoxy resins. Those yarns where the sizing contain wax are good for weaving (fibres slides better one another and filaments do not stammer) are not much suitable for composite production, they can be used only for resins containing styrene (polyesters and vinylesters), however even in this case the wax diluted in the resin causes the adhesion between fibres and matrix and between individual layers. The special sizing which is used by AEROGLASS fabric production envelopes individual fibres immediately after being towed from furnace so that they are resistant against air humidity. This sizing is diluted up to resin impregnation and thanks to this the fibres are protected until laminate creation. The fabrics made of such sized yarn are worse for weaving because absence of wax in the sizing. The weaving process is markedly slower and from time to time the fabric can imply tiny defects, however they do not influence neither the utility value nor the strength of final product.

Aeroglass glass fabrics are suitable for production of aircrafts, boats, car parts, sporting goods, industrial applications and covers, but also for manufacturing of more expensive epoxy moulds requiring great rigidity and service life.



Type	Specification	Structure
AEROGLOSS 17	17g/m ²	plain
AEROGLOSS 25	25g/m ²	plain
AEROGLOSS 48	20x20/cm	plain, style1080
AEROGLOSS 80	12x12/cm	twill 2/2, plain
AEROGLOSS 110	16x15/cm	twill 2/2, plain
AEROGLOSS 130	10x10/cm	twill 2/2, plain
AEROGLOSS 140	8x7/cm	plain
AEROGLOSS 163	12x12/cm	twill 2/2, plain
AEROGLOSS 200	16x13/cm	twill 2/2
AEROGLOSS 200	8x7/cm	plain
AEROGLOSS 220	6x4,5/cm	plain
AEROGLOSS 280	8x7/cm	twill 2/2, plain
AEROGLOSS 390	8x7/cm	twill 2/2, plain
AEROGLOSS 390	6x6/cm	twill 2/2



Aeroglass 110

Popular glass fabric 102 g/m² for model manufacturing. Suitable for smaller and medium size parts. It is rather more dense fabric with lower throughput, however it impregnates well. Available in plain and twill 2/2 structure.

Aeroglass 130

Finer glass fabric 130 g/m² widely used for production of smaller and medium size parts. It belongs to more open, less dense fabrics and that is why it is suitable for inner layers. Quick impregnation. Delivered as plain and twill 2/2.

Aeroglass 140

Glass fabric 148 g/m² often used as a first layer of medium size parts. It belongs to more open fabric which impregnates quickly and it is laid up simply to the mould. It can be also successfully used for lamination of wood combined with finer fabric when thinner layer is required. Production of surfboards and car bonnets are often application field for this fabric.

Aeroglass 163

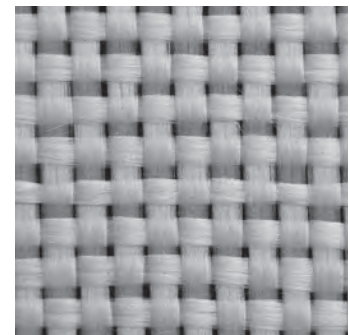
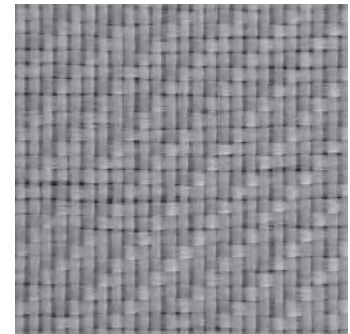
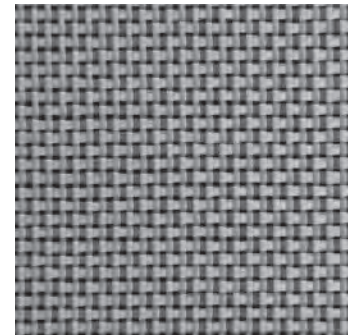
Glass fabric 158 g/m², popular namely for production of composite parts for aircrafts of various category. It is suitable as a first and last layer, but also for structural inner layers. It is mostly used in combination with fabrics 280-390 g/m². Regarding high quality size it impregnates very quickly. Standard deliveries in plain and twill 2/2 structure.

Aeroglass 200

Medium dense glass fabric 198 g/m², general purpose type. It is often used as a first and last layer of medium size composite parts, but suitable also as structural fabric. Thanks to its structure it does not fray out and loose fibres do not come out. It is resistive to the defects by handling and placement to the mould. Well trimmed even in diagonal direction. Available in plain and twill structure.

Aeroglass 220

Glass fabric 208 g/m² is less dense one made of 198 tex yarn. It's favourite especially for easy impregnation even when high viscosity resin is used. This fabric is suitable for all cases when higher resin content is required. It is also suitable for bonding with plastics and subsequent impregnation. Because of its structure is also proper type for RTM and other infusion technologies. Delivered in plain structure.



AeroGlass®

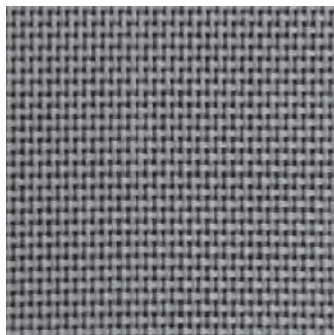
Glass fabrics Aeroglass

Aeroglass 48

Finer glass fabric 48 g/m² suitable as a first laminate layer. It is suitable for production of models and small parts with lower thickness. It can be also used as a last layer to close rough structure of heavier fabrics and mats. It is produced plain weaved.

Aeroglass 80

Favourite glass fabric 79 g/m² for model manufacturing. Thanks to its low price it is one of the most used fine glass fabric also for production of another small and medium size parts. It is ranked among more porous fabrics and thanks to this the impregnation is very fast. It is delivered both plain weaved and twill 2/2.

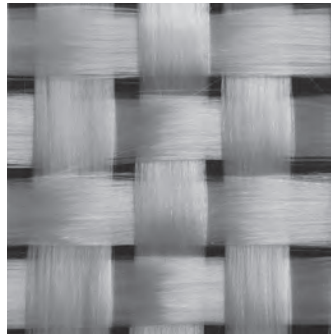
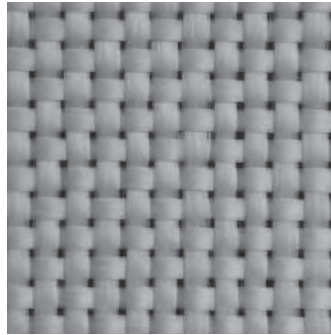


Aeroglass 280

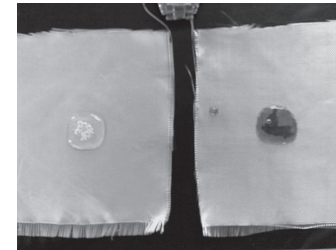
Glass fabric 297 g/m². Favourite structural fabric namely for ultra-lights and sailplanes and also for car parts and sporting goods. It exceeds in good drapability and easy impregnation. Available in plain or twill 2/2 .

Aeroglass 390

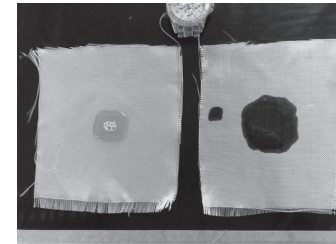
Glass fabric 396 g/m². Favourite fabric for composite parts of ultralights and sailplanes, but suitable also as a structural one for other parts. Though it is relatively heavier fabric it had good drapability and impregnates well. Rather often it is used for manufacturing of quality moulds. Available in plain and twill 2/2 .



Impregnation test: Comparison of Aeroglass fabrics with generally used one in dependence of time and resin type

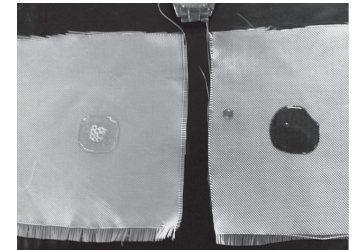


1 minute after application of 2 g LH 160

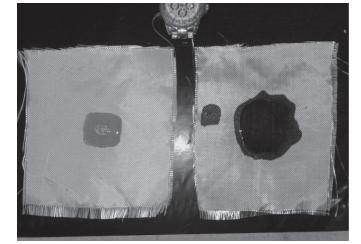


3 minutes after application of 2 g LH 160

For the test purpose it was taken commonly available glass fabric 163 g/m² plain structure (left) and AEROGLOSS fabric 163 g/m² (right). Epoxy resin LH 160 (certified by Germanische L'loyds) was used for impregnation.



2 minutes after application of 2 g LH 160



4 minutes after application of 2 g LH 160

Immediately after application the dissolving of sizing and quick impregnation takes place while the left side is without change. As early as after 2 minutes the fabric absorbs excess of resin drawing it into fibres around.

After 3 minutes AEROGLOSS fabric shows 3 times greater impregnated area compared to standard one, where impregnation did not occur. 4 minutes after application the impregnated area is 4 time large. The sample on the left side is all the time not impregnated.

Industryglass is trademark of mats from chopped glass strands and fabrics made of roving based on E glass. These fabrics and mats are suitable particularly for resins containing styrene. Industryglass materials are convenient for production of tanks, covers, moulds and such products where there are not high requirements for weight and strength.

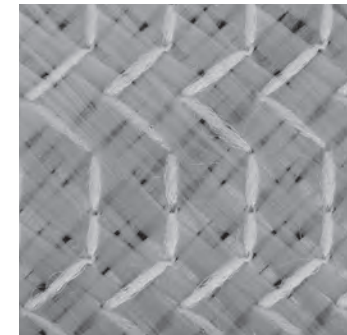


emulsion / powder	Type
Glass mat , width 125 cm, 30g/m ²	emulsion
Glass mat , width 125 cm, 100g/m ²	emulsion
Glass mat , width 125 cm, 150g/m ²	powder
Glass mat , width 125 cm, 225g/m ²	emulsion / powder
Glass mat , width 125 cm, 300g/m ²	emulsion / powder
Glass mat , width 125 cm, 450g/m ²	emulsion / powder
Glass mat , width 125 cm, 600g/m ²	emulsion / powder

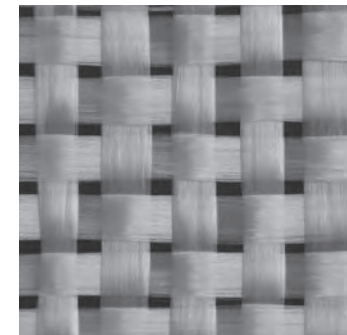
Offer of another glass reinforcements:

UNIDIRECTIONAL GLASS FABRICS (UD)
UD glass yarns connected by net 200g/m ²
UD glass yarns connected by net 220 g/m ²
UD glass yarns connected by net 250 g/m ²
UD glass yarns connected by net 300 g/m ²
UD glass yarns connected by net 500 g/m ²

BIAXIAL GLASS FABRICS
Biaxial glass fabric 300 g/m ² , ± 45°, width 127cm
Biaxial glass fabric 450 g/m ² , ± 45°, width 127 cm
Biaxial glass fabric 600 g/m ² , ± 45°, width 1250 mm



ROVING GLASS FABRICS
Glass fabric RT 350 (348 g/m ²) - plain
Glass fabric RT 450 (446 g/m ²) - plain
Glass fabric RT 1000 (1000 g/m ²) - plain
<i>Available in various widths 100, 125 cm</i>



Glass fabrics INTERGLASS <i>(certified for aircraft industry)</i>
Interglas 02034 (24,5 g/m ²), width 110cm - plain
Interglas 02037 (47,5 g/m ²), width 127 cm - plain
Interglas 90070 (81 g/m ²), width 100 cm - plain
Interglas 91111 (105 g/m ²), width 100cm - satin
Interglas 92110 (163 g/m ²), width 100 cm - twill
Interglas 92145 (220 g/m ²), width 100 cm - UD
Interglas 92125 (280 g/m ²), width 100 cm - twill
Interglas 92140 (390 g/m ²), width 100cm - twill





CARBON REINFORCEMENT

Carbon fibres (C fibres) combine high strength and modulus and thermostability with light weight (low density). Current carbon fibres have 60 time higher specific tensile strength then steel.

Carbon fibres are produced of visciose or polyacrylonitrile (PAN) fibres and from anisotropic pitch spinned from the melt. For production of C fibres having the highest modulus is used just pitch – rest from distillation of crude oil or black coal. The highest modulus of commercially available C fibres have those made of interphase pitch (with contain liquid crystals), the value of modulus reached is up to 965 GPa. Today are C fibres made also of novoloid fibres based on phenol-formaldehyde.

Basic types of carbon fibres:

Carbonized fibres – medium modulus and good tensile strength. They are considered to be standard C fibres (HS – high strength, AS – average strength, HT or HTA – high tenacity)

High modulus graphitized fibres – (HM - high modulus)

High tensile fibres – with medium modulus (IM – intermediate modulus)

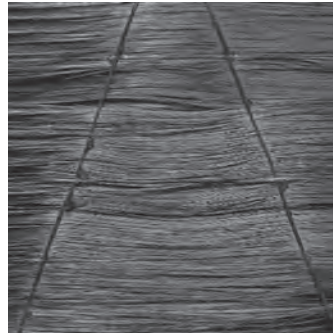
Fibres with very high modulus – (VHM – very high modulus, UHM – ultra high modulus)

Offer of carbon fabrics:

Carbon UD non-woven inlay reinforcement:

Carbon unidirectional fibres, width 50 cm, 50K
Carbon unidirectional fibres connected with net 50 g/m ²
Carbon unidirectional fibres connected with net 80 g/m ²
Carbon unidirectional fibres connected with net100 g/m ²
Carbon unidirectional fibres connected with net 125 g/m ²
Carbon unidirectional fibres connected with net150 g/m ²
Carbon unidirectional fibres connected with net 200 g/m ²
Carbon unidirectional fibres connected with net 300 g/m ²
Carbon unidirectional fibres connected with net 400 g/m ²

Carbon unidirectional fibres, width 30 or 60 cm, 12K
Carbon unidirectional fibres connected with net 80 g/m ²
Carbon unidirectional fibres connected with net 100 g/m ²
Carbon unidirectional fibres connected with net 125 g/m ²
Carbon unidirectional fibres connected with net 150 g/m ²
Carbon unidirectional fibres connected with net 200 g/m ²
Carbon unidirectional fibres connected with net 250 g/m ²
Carbon unidirectional fibres connected with net 300 g/m ²



Here are listed the most used, classically wound carbon fabrics, however we are able to deliver also fabric with other weights, various thickness and weaving structures.

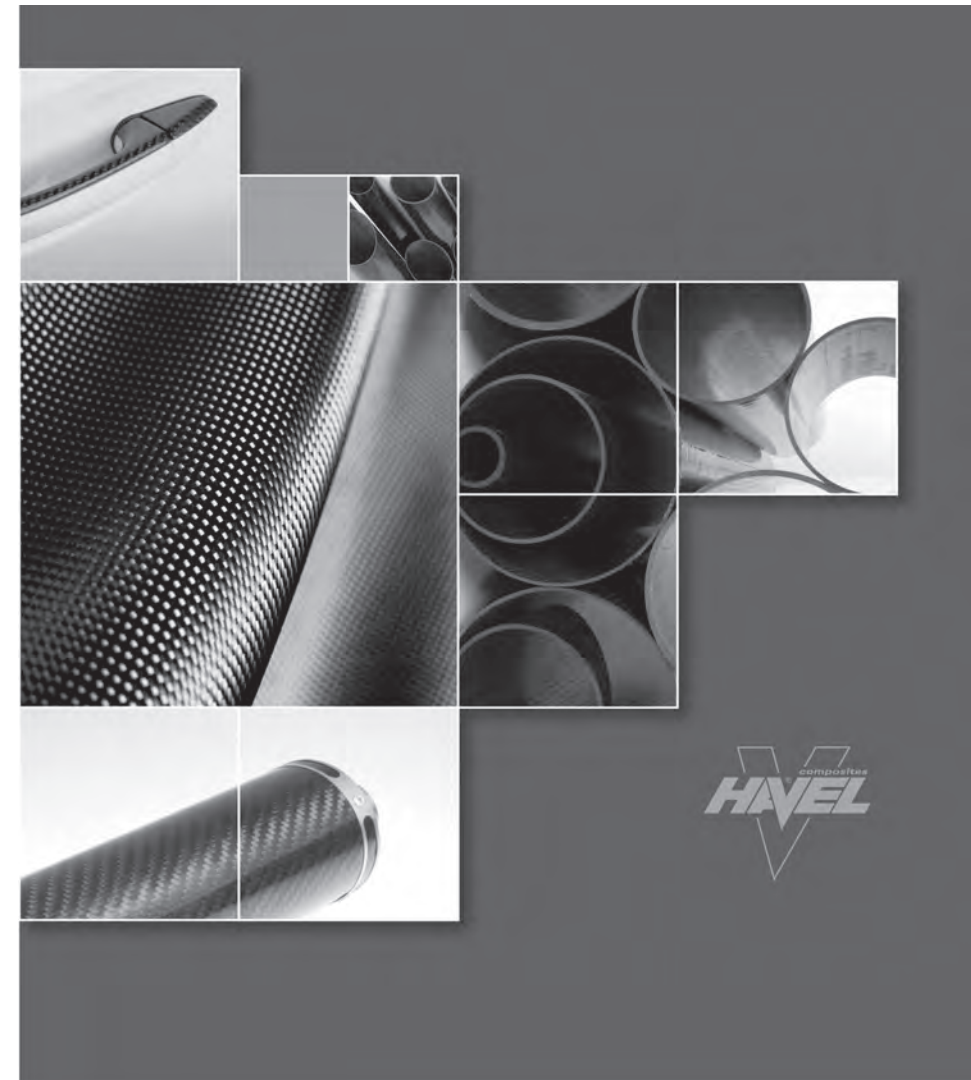
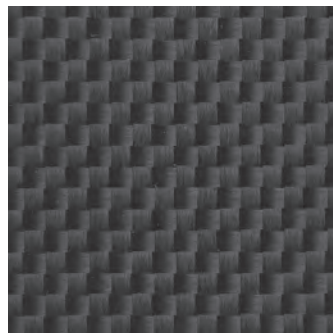
Biaxial carbon reinforcement

Carbon biaxial fabric 100g/m ² , width 1270 mm, 6K, +/- 45°
Carbon biaxial fabric 150g/m ² , width 1270 mm, 12K, +/- 45°
Carbon biaxial fabric 200g/m ² , width 1270 mm, 12K, +/- 45°
Carbon biaxial fabric 300g/m ² , width 1270 mm, 12K, +/- 45°
Carbon biaxial fabric 400g/m ² , width 1270 mm, 12K, +/- 45°
Carbon biaxial fabric 600g/m ² , width 1270 mm, 12K, +/- 45°

Per order we are able to supply also another not here mentioned carbon reinforcement, for instance various types of multiaxial and biaxial carbon reinforcements

Classic wound carbon reinforcements

Standard classic wound carbon fabrics
Carbon fabric 68 g/m ² , plain, 1K
Carbon fabric 80 g/m ² , plain, 1K
Carbon fabric 93 g/m ² , plain, 1K
Carbon fabric 160 g/m ² , plain - twill, 3K
Carbon fabric 200 g/m ² , plain - twill, 3K
Carbon fabric 600 g/m ² , twill, 3K
<i>Available in various widths (100, 120, 135 cm)</i>





ARAMID, HYBRID AND OTHER REINFORCEMENTS

Aramid is organic polymer (aromatic polyamide), aramid fibre is made by spinning from complex solution of chemicals based on 1,4 phenylenetereftalamid. Aramid fibres are first of all twisted into strands. Strands can be woven to very dense fabric of orange-brown colour. Aramid fibre itself is light yellow and it is characterized by high tensile strength and low density, this combination brings their high specific strength.

There are two basic types of aramid fibres: meta-aramid (Nomex) and para-aramid (Kevlar, Twaron).

Aramid fibres feature on negative expansion coefficient, low elongation, high elasticity, they are resistant to abrasion and chemicals. They degrade slowly under UV radiation.

Aramid fabrics are widely used namely for their high impact and tensile strength. They are excellent choice for helicopters blade, rocket engines for solid fuel tanks, pressure vessels for CNG and another parts which are highly loaded and must withstand the vibrations. Also the wings of Airbus A380 are reinforced with aramid fibres, which trade name is Kevlar.

Kevlar are aramid fibres with high tensile strength and low elongation at break. It was introduced into market during seventies by company Du Pont. At present there are typical two types: Kevlar® 29 and more recent Kevlar® 129, which is lighter, more flexible and stronger. Another structural material on the market is Twaron® and Twaron High Tenacity – these are also aramid fibres similar to Kevlar.

Offer of aramid reinforcements:

Standard woven aramid reinforcement	Cross-Out
Aramid fabric 36 g/m ²	plain
Aramid fabric 61 g/m ²	plain
Aramid fabric 110 g/m ²	twill
Aramid fabric 173 g/m ²	plain, twill, satin
<i>Certain fabrics are available in various widths and on other colours (black, black-yellow)</i>	

Hybrid reinforcement

The term “hybrid” represents that these fabrics consist of more than one type of fibres. Creating multilayer composite it is possible – if needed to use various fibre types – to produce the material from fabrics consisting of various suitable fibres. In knitted fabric one type of fibres can be in warp and another type in weft direction, but in more often cases different fibres change in both directions. Common hybrid reinforcements are knitted fabrics or woven ones in 0/90° directions. Hybrid reinforcements can be also in form of stitched fabrics, unidirectional as well as multiaxial.

Aramid/carbon

Highly impact resistant, there is a combination of tensile strength of aramid fibres and tensile/compression strength of carbon fibres. Both fibre types are low density/weight, but their price is pretty high.

Aramid/glass

Relatively low density, high impact resistance. Tensile strength of aramid and good tensile/compression properties of glass fibres, low price.

Carbon/glass

Carbon fibre contributes to high compression strength and modulus and reduces density, while glass cuts down the price.

Offer of most common hybrid woven reinforcements

Aramid-Carbon fabric 71 g/m ² - plain
Aramid-Carbon fabric 165 g/m ² - plain
Aramid-Carbon fabric 245 g/m ² - twill 2/2
Aramid-Carbon fabric 170 g/m ² - plain
<i>Available in various widths (most often type used 100, 120 cm)</i>

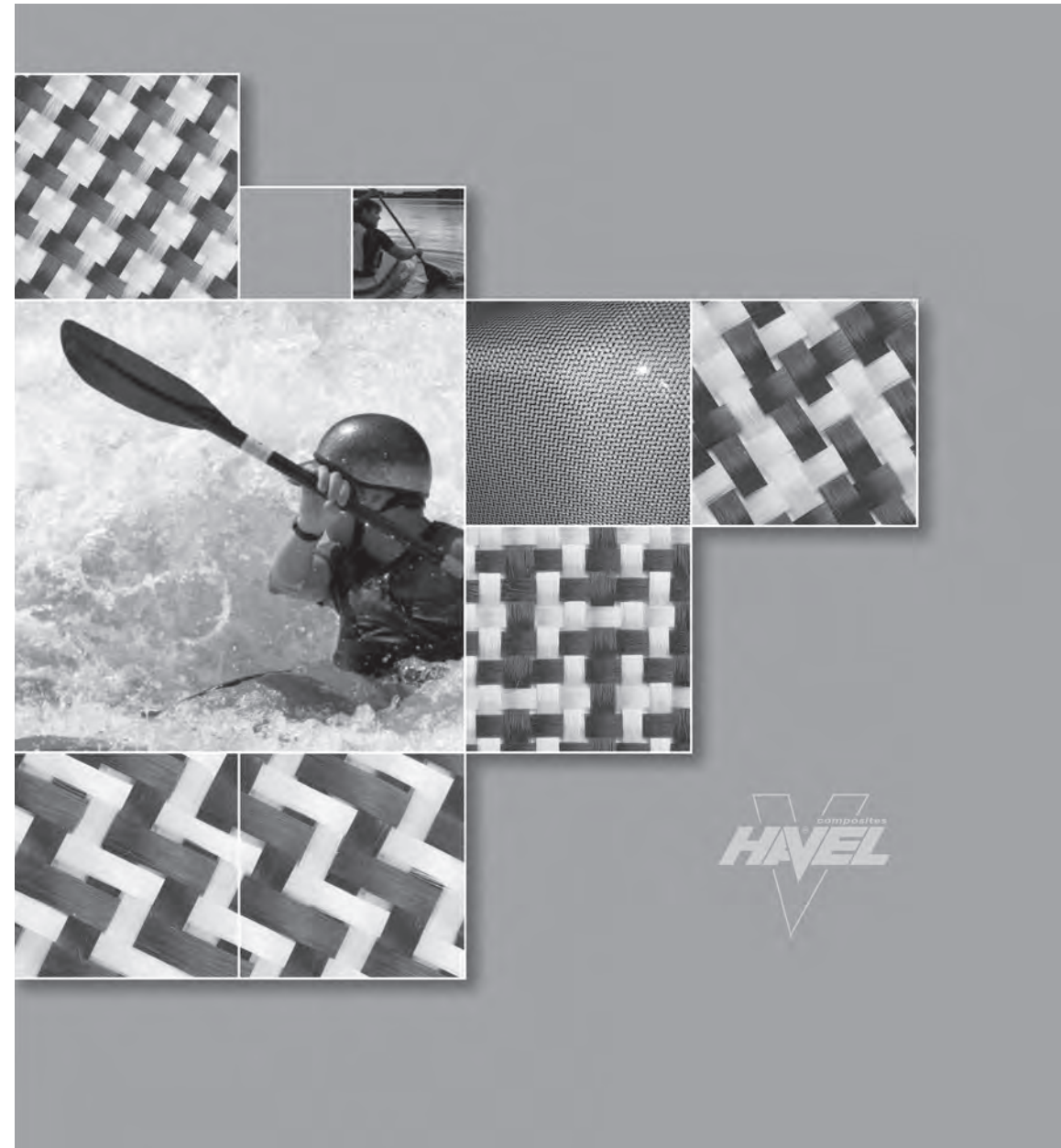
Diolen woven reinforcements

Various square weights, structure types, widths and colours.

Most often type used – Diolen fabric 200 g/m² – twill, black

Basalt woven reinforcements Various square weights, structure types, width and colours.

Most often type used – basalt fabric 200 g/m² – plain



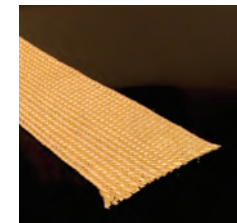


TAPES & BRAIDS



Tapes

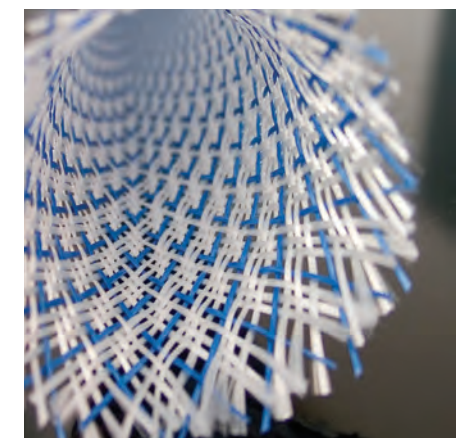
We offer wide range of woven tapes – glass, carbon, aramid, hybrid and Diolen in various style (classically woven, unidirectional) in widths from 10mm up to 200 mm and weights from 100 to 600 g/m².



Braids

We also offer a line of braids – glass, carbon, aramid and hybrid with various structures, weight from 2 to 150 g/running meter with diameters from 5 to 100 mm.

Detailed offer you can find on websites www.havel-composites.com in the section Braids and tapes.





SANDWICH MATERIALS

SANDWICH MATERIALS

Sandwich structure originates by combination of light core material and stiff, very resistant two outer side skins which are glued by resin or adhesive. The load capacity of such a structure is depending mainly on the quality of skin material, resistance of bond between core and skins, on the thickness of sandwich structure and on the stiffness of core material.

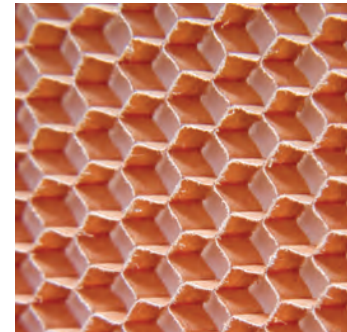
Sandwich structures are used both for reduction of weight and for overall stiffness enhancement of composite part.

As core material are used most frequently:

Honeycomb made of thin aluminium sheets, Nomex – aramid fabric impregnated with epoxy resin, polypropylene, but also from paper impregnated with polyester or phenolic resin.

Rigid foams most often based on polyurethane, PVC, polystyrene or polyetherimid and polymethacrylimid.

Balsa wood very light wood with special structure and orientation of lignin fibres.



We supply a complete range of 3A Composites Core Materials products. This company has production facilities in Sins, Switzerland. 3A Composites Core Materials was founded in 1956. Since its inception, the Swiss factory has been producing AIREX® sandwich materials and balsa wood under the name BALTEK®. AIREX® products are special closed-cell foams for sandwich technology.

BALTEK®

Natural balsa wood, renewable core material



BALTEK® is the only core construction material made from a natural, renewable resource - balsa wood. The balsa tree combines various special properties: fast growth, low to medium density and unique weight-specific mechanical properties.

3A Composites Core Materials owns and manages Plantabál S.A. through its forestry companies, and 3A Composites PNG Ltd. several thousand hectares of FSC®-certified balsa plantations in Ecuador (FSC-C019065) and Papua New Guinea (FSC-C125018).

AIREX® TegraCore™ is a flexible, closed-cell thermoplastic polymer foam that combines excellent retardation properties with low flammability, smoke, toxicity and heat release rate, along with high temperature resistance and excellent lightweight properties. In addition, very low moisture and resin absorption, thermoformability, damage tolerance and chemical resistance are part of the high performance combination.

AIREX® TegraCore™ is an exceptional thermal insulation foam or core material for use in lightweight composite applications that require high fire protection properties for complex shapes in harsh environmental conditions. Thickness 1 to 25 mm.

Application:

- Aircraft and aerospace: Interiors, luggage baskets, side walls, seats
- Shipbuilding: non-flammable interiors, cladding
- Railways: Interiors, partitions, roof panels
- Industrial: High temperature applications X-ray tables

The material meets the requirements of standards:

Aviation: FAR 25.853 / ABD0031 / ABD0031 Railway: CEN TS 45545-2

Processing:

- Contact lamination (manual / spray)
- Injection molding (RTM)
- By gluing
- Use with prepregs
- Vacuum infusion

Type	Thickness in mm	Weight kg/m ³	Size in mm
TegraCore	1-25	53	2500x590

AIREX T90

is a thermoplastic and recyclable structural rigid closed cell PET foam. AIREX® T90 is a core foam material with excellent fire, smoke and toxicity (FST) properties. It is suitable for lamination with all types of resins and processes and is easy to process mechanically and thermoformed. It is also resistant to chemicals and does not absorb water. Curing and post-curing at higher temperatures is trouble-free because it is highly heat resistant.

The material is supplied in several hardnesses with a density of m³:

Application:

- Shipbuilding - hulls, decks, bulkheads, interiors
- Automotive and train industry - roof panels, interiors, floors, doors, partitions, thresholds

Type	Thickness in mm	Weight in kg/m ³	Size in mm
T90.60	3 - 50	65	2440x1220
T90.100	3 - 50	110	2440x1220
T90.150	3 - 50	145	2440x1220
T90.210	3 - 50	210	2440x1220

- Energy - wind turbine blades, gondola, shelters of turbine generator
- Aviation - common parts of light sports aircraft
- Other industries - molds, tanks, pipes, containers ...

Processing:

- Contact lamination (manual / spray)
- Injection molding technology (RTM)
- By gluing
- Can be used with prepregs by vacuum infusion

The material meets the requirements of standards:

Aviation: FAR / CS 25.853 / ABD0031

Railway: EN 45545-2

Construction: EN 13501-1



AIREX C70

Universal structural foam Polyvinyl chloride (PVC) foam with closed pores are one of the most commonly used core materials for the production of sandwich structures. In fact, PVC foams are a hybrid of PVS and polyurethane. PVC foams offer a balanced combination of static and dynamic properties and good resistance to water absorption. They also have a wide operating temperature range from -240 ° C to + 80 ° C, and are resistant to many chemicals. Another advantage is the possibility of using polyester resins, thanks to the good resistance of the material to styrene.

Application:

- Shipbuilding - hulls, decks, bulkheads, interiors
- Automotive industry and railways - roof panels, interiors, floors, doors, partitions, thresholds
- Energy - wind turbine blades, gondola, turbine generator covers
- Aviation - common parts of light sports aircraft
- Other industries - molds, tanks, pipes, containers, covers

Processing:

- contact lamination (manual / spray)
- injection molding technology (RTM)
- by gluing can be used with prepregs
- by vacuum infusion

Type	Thickness in mm	Weight in kg/m ³	Size in mm
C70.55	2 - 50	60	2450x1150
C70.75	2 - 50	80	2180x1020
C70.90	2 - 50	100	2050x950
C70.130	2 - 50	130	1900x850

AIREX® T92

AIREX® T92 is a thermoplastic structural rigid foam. AIREX® T92 is a closed cell foam core material, very suitable for lamination using all types of resins and processes. The result of the AIREX® T92 manufacturing process is a core material with very consistent properties. The shear deformation / damage tolerance is significantly improved and allows use in most sandwich structures. T92 is mechanically very easy to process, can be thermoformed and is highly heat resistant. It is chemically very stable, does not absorb water and shows no expansion. AIREX® T92 is characterized by excellent resin absorption, which can be further reduced in combination with our SealX technology.

Type	Thickness in mm	Weight in kg/m ³	Size in mm
T92.60	5 - 100	65	2440x1220
T92.80	5 - 100	85	2440x1220
T92.100	5 - 100	100	2440x1220
T92.130	5 - 100	135	2440x1220



Rohacell® ONLY PER ORDER

Rohacell® is polymethacrylimid (PMI) rigid foam with closed cells. It has excellent mechanical and thermal properties. In comparison to other foam types this one offers the best ratio weight/mechanical properties and also the highest thermal stability. Rohacell® is used in wide range of applications in various composite industries from transportation to sporting goods and leisure. It is also used in medical engineering, aerospace, communications and building.

This foam is thermoformable to complex 3D shapes. It is compatible with lot of adhesive and resin systems and it is possible to combine it with various thermosetting and thermoplastic prepregs. Structural parts can be produced in autoclave or using various infusion technologies (RTM, DPRTM, VARTM, SCRIMP) and also hand lay-up. Comparative advantage of Rohacell® is that it is possible to cure adhesive resin and skins of sandwich structure in one step. Rohacell® IG (industrial type) is the foam with closed cells based on PMI and it does not contain any chloro-fluorohydrocarbons. Rohacell® IG is also available in required cell sizes (Rohacell® IGF). This type can be processed at 130°C and maximum pressure 0,3 MPa.

- ROHACELL® IG** is the standard grade for industrial applications, RTG tables and sport equipment. Processing up to 130°C.
- ROHACELL® A** for aerospace industry and high performance parts. Processing up to 130°C.
- ROHACELL® HF** high frequency type, particularly suitable for use in antennas, radomes and X-ray imaging tables. Processing up to 130°C.
- ROHACELL® S** self-extinguishing type, for rail, road and marine applications. Processing up to 130°C.
- ROHACELL® P** high density type, for ski, hockey sticks and boats. Processing up to 130°C.
- ROHACELL® WF** for aircraft industry and another advanced structures. Processing up to 180°C.
- ROHACELL® RIST** for resin infusion technologies – RTM, VARTM etc. Processing up to 180°C.
- ROHACELL® RIMA** has extremely fine cells, for resin infusion processes where minimum possible uptake of resin is required. Suitable for aeronautics and space applications, car industry and sporting goods. Processing up to 180°C.
- ROHACELL® EC** electric conductive, used for airwaves absorption and electro conductive applications. Processing up to 180°C.
- ROHACELL® XT** for higher temperatures. Used for structures made of BMI resins, thermostable up to 232°C.

*Airex foams can be thermoformed at relatively low temperatures (close to 100°C), while Rohacell foams need mostly higher temperatures (180-200°C).
Available to order.

Rohacell®

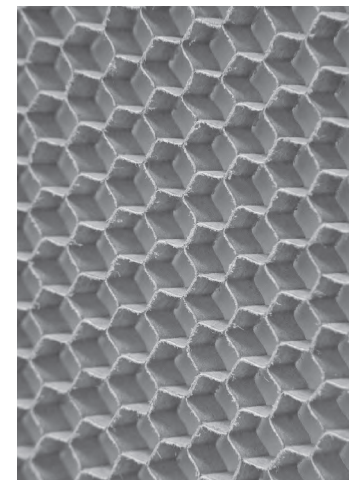
Rohacell IG 31	size 2500x1250	thickness 1-130mm
Rohacell IG 51	size 2500x1250	thickness 1-120mm
Rohacell IG 71	size 2500x1250	thickness 1-110mm
Rohacell IG 110	size 2160x1100	thickness 1-100mm

Honeycombs

NOMEX honeycombs

Aramid honeycombs are made of NOMEX paper. NOMEX is the brand name as well as Kevlar. The production starts by impregnation of NOMEX paper with phenolic resin what creates honeycomb cells with high strength and very good resistance against flame. This material is widely used for aircraft light panels (phenolic resin is also used for skins of the sandwich). Special types where the enhanced flammability is required (train and other transport means interior parts) are modified by filling of cells by phenolic resin to increase adhesive area and the system is effective as insulation in the same time.

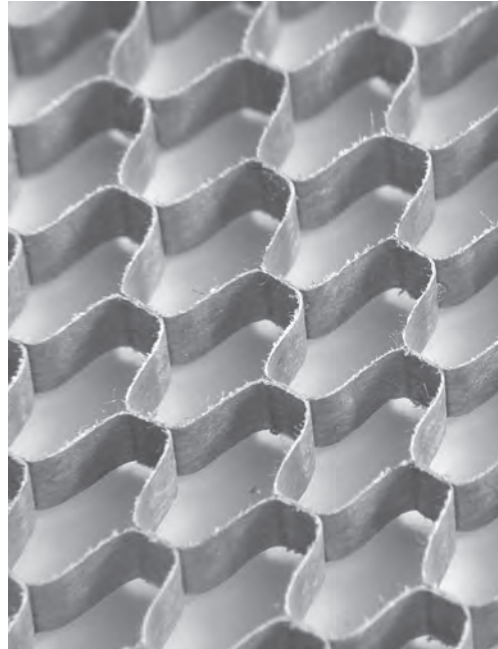
Panels made of aramid honeycombs are the lightest material for beams manufacturing. These panels with glass or carbon fibres skins create most stiff and the lightest cross walls, engine bulkheads and wing ribs.



NOMEX honeycomb are available in 2 basic types:

Oxagonal - OX

Type/thickness	Weight (kg/m ³)
OX – 2/3/4/8 mm	29
OX – 3/4/5/10 mm	48



Hexagonal – HEX

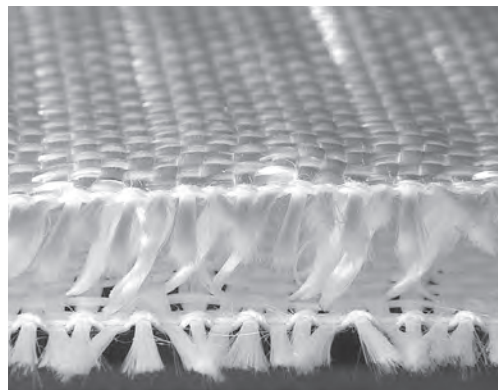
Type/thickness	Weight (kg/m ³)
HEX – 1,5 mm	29
HEX – 3/5/10/12 mm	48
HEX – 2/10 mm	64

Per order we are able to supply various thickness of honeycombs in combination with different weights. Standard sizes are cca 1100 – 1250 x 2400 – 2550 mm.

Per order we are also ready to supply aluminium honeycombs. Please, contact our business department for more information.

Parabeam® - 3D glass reinforcement

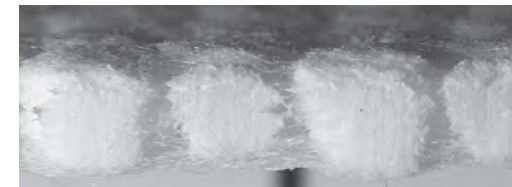
Parabeam® 3D is glass reinforcement, woven 100% of E-glass yarns. It consists of two outer cover layers which are connected through by vertical crossfibres, which are sewn into cover layers (structure reminds of sandwich structure). During impregnation of Parabeam® the reinforcement absorbs the resin and these vertical crossfibres rear up to the given height thanks to the capillary forces. Basic type of Parabeam® reinforcement is Paraglass product and the version Paratank is used for industrial applications, namely for double-wall tanks.



Type	Thickness (mm)	Weigh (g/m ²)	Width (cm)
Parabeam (Paraglas)	3,5	780	127
Parabeam (Paraglas)	8	930	127
Parabeam (Paraglas)	10	1430	127
Parabeam (Paratank)	4,5	850	127
Parabeam (Paratank)	6	900	127

Spheretex SN

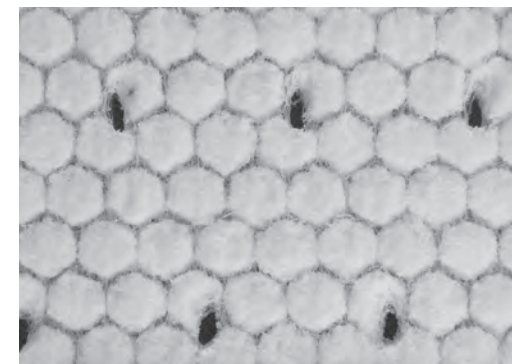
Spheretex SN is very flexible sandwich material which conforms to complex shapes. Processing of Spheretex SN is similar to other materials used in composite industry, like glass mats, woven roving or sewed reinforcements. In many cases polyester or vinylester resins are used.



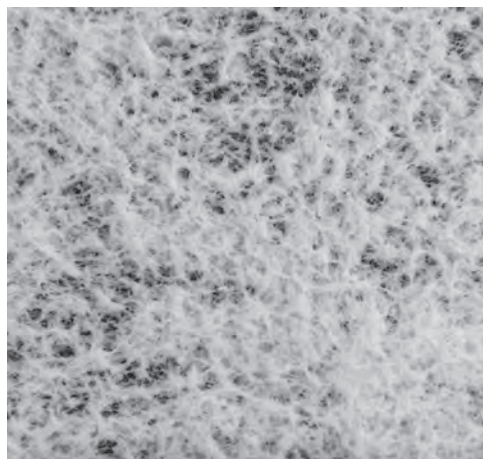
Type/thickness	Weight	Width
Spheretex SSN - 1 mm	115 g/m ²	125 cm
Spheretex SN – 1,5 mm	115 g/m ²	125 cm
Spheretex SN – 2 mm	170 g/m ²	125 cm
Spheretex SN – 3 mm	300 g/m ²	125 cm

Coremat

Coremat is made of non-woven polyester fibres containing plastic microspheres and it is used like thin core material or as print blocker in laminates (avoiding the print through of laminate structure under gelcoat, it is possible to obtain very good quality of surface) manufactured by hand lay-up or spray-up technologies. It is necessary to impregnate Coremat by resin completely to avoid delamination, microspheres save the resin consumption and give enhanced toughness to the structure. The main reasons for Coremat usage is are: saving the weight, resin and reinforcement layers amount, increasing of strength, rapid of laminate build-up and perfect surface.



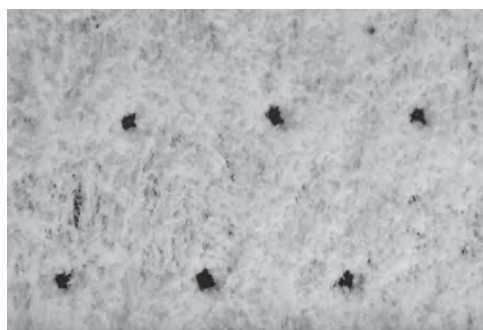
Type	Weight	Width
Coremat XM	2 mm	100 cm
Coremat XM	3 mm	100 cm
Coremat XM	4 mm	100 cm
Coremat Xi	1 mm	100 cm
Coremat Xi	2 mm	127 cm
Coremat Xi	3 mm	127 cm



Havel Core - soft

Havel Core is the sandwich material similar to Coremat XX, but it is more pliable with better drapability.

Havel Core – soft
thickness 2/3/4/5 mm
width 100 cm.



U-PICA MAT

News in our assortment. It is soft sandwich material for resin impregnation. Weight 60 g/m². Suitable and cheaper alternative to Coremat.

U-PICA MAT
thickness 1/2/3 mm
width 100 cm.





FILLERS

Suitable for thickening of all resins and paints. They are used in all cases where it is necessary to avoid sagging. In our offer we have following filler types:

- Aerosil 200** is a hydrophilic fumed silica with a specific surface of 200 m²/g. For better properties we recommend to combine it with milled cotton fibres, microcellulose, microspheres or chopped glass fibres.
- Cabosil M5** is material based on silica, suitable alternative to Aerosil 200.
- Mikrobalons** are hollow glass microspheres are used mainly for thixotropic mixes and to increase compressive strength of composites and castings. There are available 2 grades: Lite (85 g/l) and standard (125 g/l).
- Microcellulose powder** ensure thickening already by adding of low amount. This filler is popular because of low price. Length of fibres: cca 0,2 mm.
- Cotton flakes** are applied by production of light-weight thixotropic adhesives, casting resins for moulds and surfaces of structural moulds using mixture of 50% of chopped glass fibres and 50% of cotton flakes. 200 g = 1 l.
- Milled cotton fibres** thicken already by adding of low amount. Suitable alternative where it is not possible to use microcellulose. Length 0,5 or 0,7 mm.
- Chopped glass fibres** 0,2 mm, 3 mm, 4,5 mm, 6 mm a 12 mm.
- Milled glass fibres** glass powder
- Milled carbon fibres** carbon powder is used mainly for increasing of mechanical properties and also for lead-in of electrostatic charge
- Chopped carbon fibers** very strong filler increasing the stiffness conductivity of the product, can also be used separately in SMC or BMS prepregs.
- Milled aramid fibres** create after mixing with resins very rigid material
- HAVELex 1 (plastic balls)** new special filler which enhance the viscosity similar as Aerosil and similarly like microballons lowered volume weight of resin. This filler is made of special plastic. After mixing with resin it has considerably higher strength and compared to microballons and AEROSIL it is very rigid. This plastic filler is very tenacious, light and ultra volumines. It is sold on kilograms, cca 25 g = 1 l. Filler has white colour.
- Apyral** flammability-reducing filler, ensures self-extinguishing of resins and at the same time does not significantly increase the viscosity of the resin and thus the weight of the products. Adding 10% -20% will significantly increase the self-extinguishing ability.



SILICONES FOR MOULDS



SILICONES FOR MOULDS

Silicone resins are very elastic materials suitable mainly for moulds production. Thanks to their properties it is possible to manufacture small and medium size moulds and parts with high accuracy. Silicones are produced in two basic types: condensation and adduced.

For mould production are more suitable adduced ones because of their better mechanical properties. Silicones are supplies as two component materials. Thanks to rapid curing and negligible shrinkage it is possible to cast mould in one shot.

ZA 13 MOULD WT 45

Quality casting silicone resin, soft and very flexible type. The delivery contains ordered amount in 1:1 ratio, i.e. by ordering 1 kg it will be delivered 0,5 kg of resin and 0,5 kg of catalyst. Working time is 45 min., demoulding time is 4 hours. Viscosity: 4 500 cPs. Product is after curing very elastic with Shore hardness 13. Mixing ratio 1:1 by weight.

ZA 22 MOULD

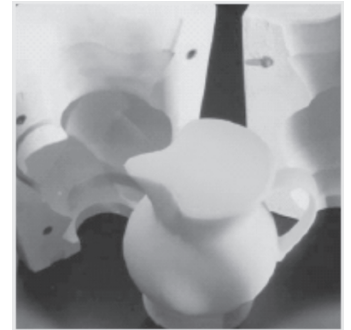
Liquid blue silicone resin including catalyst. Suitable for casting of moulds and parts. Working time 15 min., demoulding time 1 hour. Viscosity: 5 000 cPs. This type is very popular, after curing it reaches Shore 22 hardness.

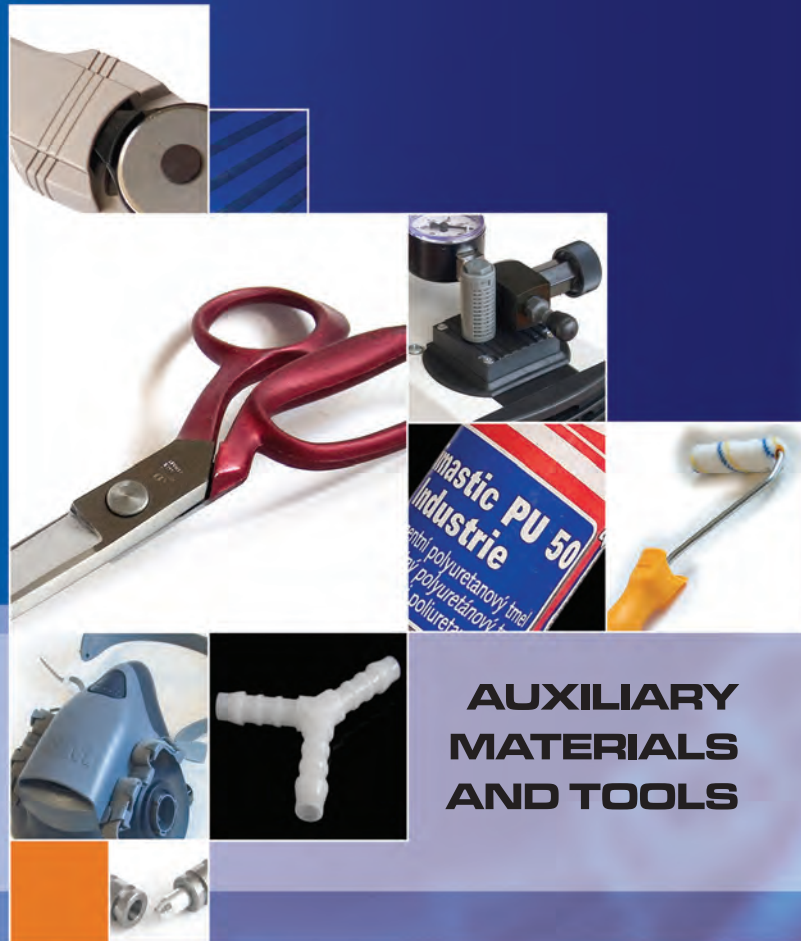
HT 33 TRANSPARENT

Liquid silicone resin for casting moulds and products. It is little bit more rigid type, nevertheless very flexible and tear resistant. Suitable for larger moulds or less shape demanding moulds and castings. Also this type is very favourite, after curing it has Shore 33.

HT 45 TRANSPARENT - Liquid transparent silicone resin suitable for casting molds and products. Workability time 10 min. Unmoulding time 1 hour 20 minutes. Viscosity: 8,000 cPs. This type is very popular and after curing it reaches a Shore A hardness of 45. Mixing ratio 1: 1 (by weight) The catalyst must be ordered separately. A retarder can be used to extend the pot life and a thixotropic agent to thicken. The thixotropic agent helps to form thin coatings, for example for demoulding decorative stucco, sculptures and paperweights, etc.

For ordering please contact our commercial department, tel. no. +420 585 129 022 or info@havel-composites.cz, the goods is also possible to buy through our e-shop on www.havel-composites.com





AUXILIARY MATERIALS AND TOOLS



AUXILIARY MATERIALS AND TOOLS

Putties and adhesives

HAVEL Filler very popular and proven line of polyester two component putties.

HAVEL Filler U general purpose putty suitable for filling of common substrates including cast iron, aluminium and composites. HAVEL Filler U is thick, very good workable putty, easy sanded, without pores.

HAVEL Filler G putty highly loaded with chopped glass fibres. HAVEL Filler G easily replace missing sections of material. It is medium thick, well workable. It can be applied in thick layers creating strong material with glass fibres, can be sanded. Green colour.

HAVEL Filler S putty for filling of medium and small unevenness. It is thick, very good workable, good adhesion to the substrates. Colour light grey.

HAVEL Filler SP fine putty for finishing of small unevenness fillings, groves and voids. Thank to its very fine structure is easy workable, ivory colour.

HAVEL Filler F spray version of putty

HAVEL Filler SFP this filler is recommended in case when extremely good sanding is required. Light orange colour.

For curing of all putties of Havel Filler line it is used red hardener delivered together in ratio 100:2. Working time is 5 min., sandable after 30 min. Various package quantities are available.

Emfimastic PU putty

One component flexible adhesive material for bonding of composite parts and filling of gaps. It bonds flexibly composites, metals, some plastics, wood and lot of other materials. This material is very often used in our workshop, well approved. It is delivered in cartridges 310 ml in white, grey or black colour. There are available two versions: softer (Emfimastic PU 50) or harder, more tenacious (Emfimastic PU 60).

ISPOFLEX 50

is a one-component polyurethane elastomeric sealant, cured by the action of moisture present in the air or in substrates to form a flexible and durable bond with high tack to various materials. FIELDS OF APPLICATION ISPOFLEX 50 can be used for gluing and sealing various materials that could be subjected to vibrations or deformations in construction. Adhesion is excellent on many materials (ceramics, glass, wood, PVC, metals, EPS).



Acralock SA 10-05 / 15

Two-component methacrylate adhesive designed for chemical bonding of most surfaces, forming strong joints and integrated units of steel, aluminum, engineering plastics, modern composites and other materials. Packaging in application cartridge 50 ml, workability 4-6 minutes. excellent adhesion to most surfaces, chemical resistance.

HAVEL Adhesive

Structural adhesive for bonding of composite and wooden parts and rigid foams like Airex. This adhesive has been developed namely for bonding parts which are not fully precise and it is necessary to fill non-accuracy and smaller voids by bonding.

HAVEL Adhesive G 40

Quality adhesive with shorter working time cca 20-40min. Adhesive is thick, light yellow, non-transparent.

Mixing ratio with component B 20 100:13 ±2 (g) – working time 20 – 30 min.

Mixing ratio with component B 30 100:17 ±2 (g) – working time 30 – 40 min.

Curing can be accelerated by tempering at 40 – 60°C.

HAVEL Adhesive G 60

High strength of bonds. For curing use HAVEL Adhesive G 60 component B in ratio 100:47 by weight. Components are to be mixed properly before bonding.

5 minutes epoxy adhesive

Professional resin mainly for bonding composite and other material parts. Very suitable for production operations when rapid bonding or fixing of parts is necessary before lamination. Popular help by more complicated and demanding repair of damaged parts. Adhesive is two-component (A+B).

INFUTAC

Contact adhesive spray for temporary gluing applications is used for temporary gluing. Its use is particularly suitable where it is necessary to attach the material in particular, eg in a vertical position or on another complex and rugged surface. This product is ideal for holding the fabric (or even more layers of fabric) in place, which will then be impregnated with resin. Apply a light coat to one coat and allow to dry for approximately one minute, but at least 10 seconds. When applied to multiple layers, it is usually allowed to dry for a longer time. After use, it is important to clean the spray nozzle to prevent clogging. For extra strong gluing, spray both surfaces, both sides (eg mold and fabric) that you want to glue and let them dry for at least 30 seconds before further processing.



Release agents

Blue WAX - Quality release agent based on wax. Suitable for polyester and epoxy gelcoats and resins. Suited also for multiple use. Package: 400 g. Apply 2-3 layers, let individual layers to get dry 10 – 20 min. followed by polishing. After the last layer polish properly and let it to get dry 1 – 2 hours before utilization.

Release wax TR 104 - quality release agent based on carnauba waxes, suitable also for higher temperatures. Package: 425 g.

Release wax Oskar's M700/C WAX – very high quality and approved release agent based on wax. Package: 425 g.

Formula FIVE - wax separator

Release agent Vantico QZ 5111 / QV 5110

QZ 5111

Liquid release agent based on wax for model manufacturing. Contains solvents. It can be applied by brush or by spray gun 2 – 3 times with intervals 10 – 15 min, allow drying and every layer polish with soft cloth.

QV 5110

Pasty release agent based on wax. For model manufacturing, contains solvents. After it gets dry (cca 30min) polish the mould with a soft cloth.

FREKOTE release agents

Frekote 700-NC

General purpose highly effective release agent suitable in cases of complex mould geometry. Dries quickly at room temperature and creates glossy surface on mouldings. It is applied onto clean mould surface by spray-up, brush or with thread-loose cotton cloth. Apply up to 4 layers, individual ones let get dry 5 – 10 min.

Frekote 700 NC is clear liquid, recommended processing temperature is 15 – 60°C, thermal stability is up to 300°C.

Frekote 770-NC

Higher thermal stability up to 400°C

Frekote B-15

Primer release agent – used for filling of micropores and scratches on mould surface. Using all Frekote products B-15 serves as excellent primer, which increase release effect. It is applied as thin even layer onto clean mould surface by spray-up, brush or with thread-loose cotton cloth. Apply minimum 2 layers, every layer let get dry 30 min. before next one. Final curing lasted 24 hours at room temperature.

PVA separator

The most reliable separator. Many times tried and tested. Suitable for almost all applications. We recommend combining with a separating base wax to multiply the reliability. It is applied with a sponge, brush or gun in the spray version. Available in various color combinations.

Separation base wax - basic wax separator under PVA.



Powdered pigments and colour pastes

These products are available for you to vivify your products by interesting colour in RAL colour list. They are compatible both with polyester and epoxy resins.

► **NEWS** ◀ We offer wide range metallic powdered pigments for gelcoats and also already coloured metallic gelcoats.

For more detailed information please contact our trade department or visit www.havel-composites.com



Expandable vacuum materials

Peeling tissues (peel ply)

Great help not only by vacuum processes. Peeling tissue separates the end product from auxiliary materials (for instance breathing/bleeder cloth) and in the same time it is permeable for the resin. After curing and tear off leaves coherent dull surface without microbubbles. Moreover this surface it is not necessary to sands for next lamination or bonding.

We offer the wide range of peel plies:

Peel ply 83 g/m² – budget priced (with red strip)

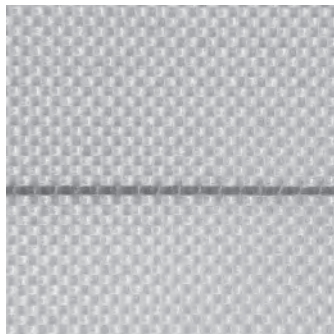
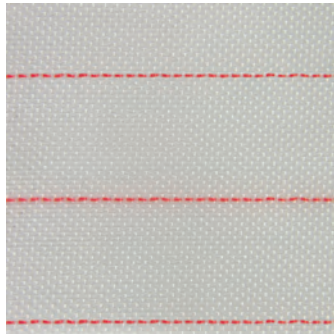
Quality peeling tissue, which contains red guide lines. Made of high strength nylon 66, temperature resistant up to 200°C. Available in widths from 1,5 to 150 cm.

Peel ply Interglas

Quality peeling tissue from prestigious manufacturer of glass fabrics. There are available two types: 64 g/m² or 93 g/m² in various widths from 2 to 160 cm.

Peel ply 50 g/m²

High quality low weight peeling tissue, also available in PLUS version with special surface treatment for easier peel off, what is substantive advantage mainly for complex parts and greater amount of bled resin. Orange colour.



Bleeder mats for vacuum bagging

Material is used by vacuum processes for complete full-area breathing of excess resin

- Medium thick – 150 g/m² – width 152 cm
- Medium Thick – 200 g/m² - width 200 cm

Vacuum foils

Perforated separation foil - for more complex shapes or for smaller and weaker products, we recommend using the separation foil (between the laminate and peel ply). With this foil easier to tear down the auxiliary vacuum equipment and extra help restrict unwanted and premature removal of the product from the mold. They are available in different colors (red, blue, orange). They differ mostly thermal resistance (120 ° C - 140 ° C), thickness and width.

Vacuum foils

Vacuum foil PO180

polyamide vacuum film and multilayer extruded film providing multiple layers of safety. Can be used for vacuum or vacuum infusion technologies with epoxies or polyesters. NON-POROUS. Compatible with all resins. Temperature resistance up to 180 ° C. Also suitable for autoclaving. Width 30/60/80/120 cm. Color: pink.

Vacuum foil PO150

High-performance film designed for the production of hollow composite structures by vacuum. Not recommended for the infusion process. Good temperature resistance. Spontaneous release from polyester, epoxy, PU and phenolic resins. Width 175 cm, Color: transparent.



Perforated separation foil ELA20-125° C P1 / P3

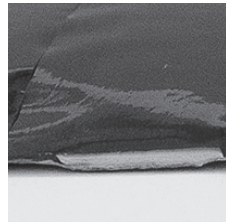
perforated film is used in vacuuming laminate parts. With this technology, often only a tear-off fabric is sufficient, which ensures the penetration of excess air and resin into the extraction mat. The tear-off fabric also provides the subsequent possibility to separate - separate the sucked-in suction mat with the tear-off fabric itself. In more complex shapes or smaller or weaker products, we recommend using this foil in addition between the laminate and the tear-off fabric. With this foil, you can more easily tear off the auxiliary suction material and, in addition, reduce unwanted and premature removal of the product from the mold. Thickness: 0.02 mm. Hole diameter 0.015mm. Width 100 cm, Color: blue.

Compoflex 150

All-in- one: bleeder mat, peel ply and release film. Compoflex is polypropylene breathing mat surface treated that way to serve as three materials, which are commonly used by composite parts production. The material surface is smooth and porous from one side. It performs more rapid absorption into inner soft layer. Basic advantage of Compoflex is easier tear off mainly by complex shapes namely in areas where greater resin excess is concentrated. Compoflex also saves money and production time – one layer instead of three. Thickness: 0,6 mm, Resin absorption: 305 cm³/m², Tensile strength: 120 - 180 N

We are ready to deliver all accessories for vacuum processes, in our assortment you can find also:

- ▶ Vacuum pumps (P1, P2, P3)
- ▶ Vacuum butyl rubber adhesive and sealing materials (strip 10 x 2 mm or plasticine)
- ▶ Sealing strips for vacuum – thickness 2/3 mm – width 4/6/10/12 mm
- ▶ Tubing – vacuum tubes
- ▶ Vacuum couplings (T, I, Y) – various diameters
- ▶ Vacuometers
- ▶ Vacuum valves and nuts (brass x rubber)



Organic solvents

In our range is bargain-package: **acetone – technical grade**
 Sale per litre, amount by request or original package (drums 200 l/175 l)



Protection working aids

In our range you can find:

- ▶ Chemical half masks 3M (sizes S, M, L) including chemical and dust filters.
- ▶ Masks against dust 3M
- ▶ Dust respirators
- ▶ Chemical full-face masks
- ▶ Kit of protection aids for spraying - TOOLS KIT (chemical mask, kit for cleaning of spray guns, paper jacket, protective glasses, dust respirators)
- ▶ Protective overalls
- ▶ Protective gloves (rubber, single-use)



Tools

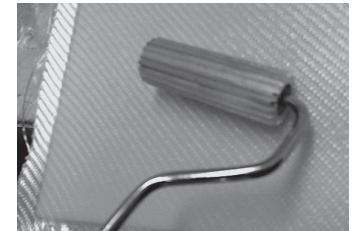
Metallic rollers

They serve for squeezing-out of excess resin and air bubbles.

PADDLE

Metallic roller with axial grooving, perhaps most frequent type. This roller is namely suitable for laminates with thickness 0,5 – 2 mm. It creates the pressure to laminate and push the air bubbles in front of it. Bubbles gathered and the excess resin are cumulated under the roller and in the moment of exceeding of roller grooving they are squeezed-out towards the laminate surface.

PADDLE roller is ideal mainly for uniform distribution of excess resin, for relatively precise definition of impregnated laminate thickness and resin content. Too rapid movement of roller can lead to splattering of resin.



NOBBY

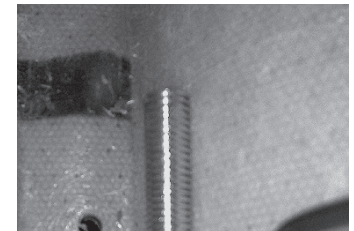
Metallic roller with axial and transverse grooving what creates on the roller surface triangle tips. It was namely developed for effective and quick squeezing-out of big and medium size air bubbles of 2 – 4 mm thick laminates. Using this roller it is not necessary to roll every layer separately. NOBBY roller is able to squeeze-out the bubbles even from several layers at once. Its usage is not right for rolling of the first layer and also for uniform distribution of resin.



FIN

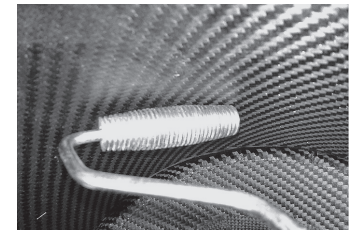
Metallic roller with transverse grooving. It is suitable for squeezing-out of excess resin and air bubbles in the first layer and in cases where the rollers splat exceeding resin.

This roller can be used for thin laminates up to 1 mm. FIN roller is also suitable for the last laminate layer – it creates smooth surface in the laminate backside. It is not suitable for higher laminate thickness as it plunges easily into thick laminate creating rugged surface.



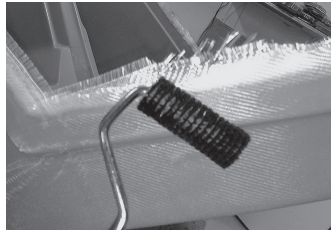
RADIUS

Metallic barrel-shaped roller. It is suitable for concave shapes where other rollers are not able get in. RADIUS rollers are delivered in various lengths, diameters and curvature. If you produce complex shaped parts it is recommendable to have various sizes ready.



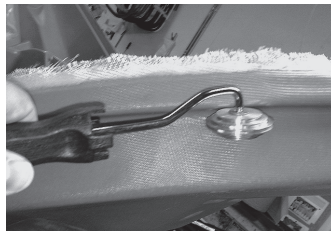
SPIRAL BRISTLE

Flexible roller is made of rigid bristles. It is ideal for squeezing-out of small air bubbles and microbubbles namely in first fabric layers. Spiky bristles pierce fabric mainly in areas where small air bubbles are generated. These include micro-bubbles, which is a huge number of first layer and their presence in the surface of the gelcoat is a nightmare anyone who requires a perfect finish and design. Laminated parts littered with such micro-bubbles in most cases is inapplicable and not just for architectural reasons

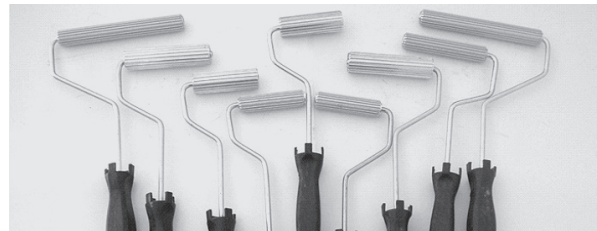


CORNER

CORNER metal roller to push back the edges of the bubbles and excess resin. Diamond-shaped metal cylinder. It is suitable for extrusion of excess resin and air bubbles in the deep edges of shapes and laminated parts. To reduce the number of bubbles is recommended to use for completing a special edge to edge roving.



In our offer you will also find different types of brushes, rollers deposition and their accessories including packaging material. More on www.havel-composites.com



PROFESSIONAL SCISSORS FROM QUALITY STEEL

Metallic scissors 1024

Supplied in size:
10'', 12,75''

Metallic scissors 405

Supplied in sizes:
6''
6'' 1x swan-necked
6'' 2x swan-necked

Metallic scissors 1026

Supplied in size:
8''

Metallic scissors 1249

Supplied in size:
6'' 2x swan-necked

Metallic scissors 1020/HQ

Supplied in sizes:
7'', 8'', 9'', 10'', 11'', 12''

Metallic scissors 1253

Supplied in size:
7'' 2x swan-necked

Metallic scissors 1020/C

Supplied in sizes:
7-14'', 10''12''

Havel Composites offers also other scissors types in various price levels incl. electrical ones. We ensure service, sharpening of scissors and technical advice.

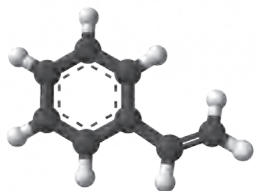
We also offer:

- ▶ Electrical aku scissors EC-CUTTER – suitable for all materials, spare heads and edges are available
- ▶ Cutting wheels OLFA – 28 mm, 45 mm, 60 mm
- ▶ Breaking knives – inclusive spare knife-edges

...and much more on www.havel-composites.com



Basic Chemicals



Technical acetone

effective solvent, dilution of gelcoats - CAS 67-64-1

Styrene

solvent for diluting polyester. of resins and gelcoats - CAS 100-42-5

Benzyl alcohol

solvent for epoxies - CAS 100-51-6

Basic epoxy resin

viscous pure epoxy - CAS 25068-38-65

Isophoronediamine

for the production of hardeners - CAS 2855-13-2



