



Ampreg 22

Epoxy Laminating System

- **Optimised for open-mould laminating of large structures**
- **Improved health and safety**
- **Germanischer Lloyd approved**

Introduction

Ampreg 22 is an established and widely used laminating system. It is intended for both wet lay-up and vacuum bagging processes and uses the most up-to-date epoxy chemistry available. Its long working time, low exotherm and low viscosity make it ideal for the manufacture of large, high performance composite structures.

The Ampreg 22 system consists of a resin and a choice of five hardeners to provide a complete range of working properties. With its 14 hour hardener Ampreg 22 can provide laminate working times of over 14 hours at 20°C whilst having low exothermic reactions even when used in thick sections. The Fast hardener has such rapid through-cure at 25-30°C that it can be used to produce small mouldings that are demouldable in just a few hours.

The low initial viscosity allows laminates to be produced by contact pressure, vacuum or pressure bag techniques, filament winding, or vacuum assisted resin injection. Thorough wetting of reinforcement fibres is ensured by the low viscosity and excellent air release properties of the resin / hardener mixture. This, in particular, assists with the impregnation of aramid and carbon fibres.

Ampreg 22 resin is coloured bright yellow, with the hardeners having a range of different colours. This makes component identification easier and facilitates thorough mixing of resin and hardener. For example, the Extra Slow Hardener is coloured blue leading to a clearly identifiable green colour when thoroughly mixed with the resin.

Ampreg 22 resin has one of the lowest diluent contents of any epoxy resin system available today. Together with the use of some unique chemistry in the hardeners, the overall system shows marked improvements in handling safety over other products. The system is formulated without DDM, which is particularly important for those using the product in open-mould, hand lay-up situations, where skin contact and exposure to vapours can be difficult to avoid completely.

Instructions for Use

Workshop Conditions

Ampreg 22 is optimised for use between 18 - 25°C. At lower temperatures the product thickens and may become unworkable. At higher temperatures working times will be significantly reduced. Maximum relative humidity for use is 70%.

Mixing and Handling

Ampreg 22 resin is combined with either Ampreg 22 Fast, Standard, Slow, Extra-Slow or 14 Hour hardener in the following ratio:

Ampreg 22 resin : Ampreg 22 hardener
100 : 28 (by weight) All hardeners
100 : 32 (by volume) Fast
100 : 33 (by volume) Standard or Slow
100 : 34 (by volume) Extra Slow or 14 Hour
100 : 29 (by volume) High Tg

It is important that the resin and hardener components are measured out accurately. Measurement by weight and electronic scales are recommended for this purpose. The resin / hardener mixture should be well mixed, paying particular attention to the sides and bottom of the mixing vessel. The mixture should then be transferred to a shallow tray in order to reduce the exothermic heat build up, which would reduce pot life and working time. Accurate measurement of the components and thorough mixing are essential. Deviating from the prescribed mix ratio will not accelerate or inhibit the cure and can seriously degrade the properties of the system.

Ampreg 22 resin and hardeners are pigmented as a visual aid for the user - see component properties table. The colours are primarily a quick and easy guide to help distinguish the resin and different hardener speeds in the workshop. In addition, when mixing the chosen hardener with the resin, its colour blends with the yellow colour of the resin to help indicate that the two components have been mixed.

Ampreg 22 resin and hardeners will lose their colour tint strength with time. This is a natural function of the pigments used and does not affect the product performance. In the case of Ampreg 22 Slow Hardener and Ampreg 22 Resin, the pigment can settle to the bottom of the container with time - if this should happen they may be returned to their original uniform colour by stirring before use.

Mould Release

From smooth metal or grp moulds tests have shown that suitable release can be obtained by use of 5-6 waxings of a carnauba based wax e.g. Polywax. Use PVA for less well prepared or complex surfaces. Whichever mould release is proposed it is recommended that a test laminate is laid up in the mould to be used, with the mould release proposed, in order to ensure an adequate and effective part release. Semi permanent agents such as Frecote or Chemlease are also suitable.

Application

The mixed system is usually applied by foam roller from a roller tray (which also serves to increase exothermic heat release, as described above). High and accurate fibre volume fractions can be obtained by applying known weight of mixed resin / hardener to each fabric / fibre layer. As a general rule of thumb, resin weight per square metre must be no more than, and preferably less than, the area weight of the fabric being wet out. If the laminate is particularly thick, it is recommended that slower hardeners are used for the first layers put down and faster hardeners in the later layers. In this way the whole thickness laid down remains workable for approximately the same time.

Pregel

Ampreg Pregel is a thixotropic resin which, when used with the appropriate hardener, can be added to, or used in place of, Ampreg 22 resin/hardener mixes. Mix Ampreg Pregel resin with any of the Ampreg 22 Hardeners at the ratio indicated in the Ampreg Pregel datasheet. Mixed Ampreg Pregel / Ampreg 22 Hardener can be added to an Ampreg 22 resin/hardener mix to make it more thixotropic. A separate data sheet is available describing this product's use in more detail.

- As a resin modifier to reduce drainage in laminates.
- As an adhesive mix for bonding core materials to Ampreg 22 laminate skins.
- For the secondary bonding of pre-formed Ampreg 22 laminate components.

Bonding Techniques & Peel Ply

Where it is necessary for a bonding operation to be carried out following the cure of the Ampreg 22 laminate, a suitable Peel Ply can be applied to the surface to be bonded during the lay-up process. After curing and just prior to bonding, the Peel Ply is stripped off leaving a clean, dust and grease free surface, with an already 'textured' surface which makes the 'keying' process less time consuming.

Peel Ply is used on laminate surfaces which need to be left to cure or partially cure before further laminating or bonding operations. The peel ply serves two functions - preventing the surface from becoming contaminated and / or damaged, and providing a 'textured' surface that can reduce the level of preparation required for the secondary laminating or bonding operations.

SP-High Modulus recommends the use of its Stitch Ply A peel ply, or suitable alternative product. Any proposed peel ply should be tested prior to use to ensure that it not only releases adequately from the laminated surface but also does not leave any residues behind which may impair adhesion. If in doubt please contact Technical Services.

Vacuum Bag Techniques

Consolidation of the laminate can be obtained either by hand using paddle rollers or by vacuum or pressure bags. A typical vacuum bag arrangement is shown in figure 1. It is important when using high vacuums and using the slower hardeners that vacuum is not applied until at least 50% into the laminate working time, as excessive flow and resin starved laminates may result (see working properties). Heating can be economically and effectively achieved with either space heaters under an insulation tent or heated blankets with insulation over. If vacuum is applied earlier only 30-50% vacuum should be used. Details of the various types of system are available from Technical Services.

Ampreg 22 resin with either Slow or Extra Slow hardener is best suited. Do not expose wet laminates to excessive vacuum pressures - keep below 0.8 bar (80% vacuum). Gurit supplies a range of Tygavac vacuum bag materials and ancillaries. For details of effective vacuum bag consolidation, please contact Technical Services.

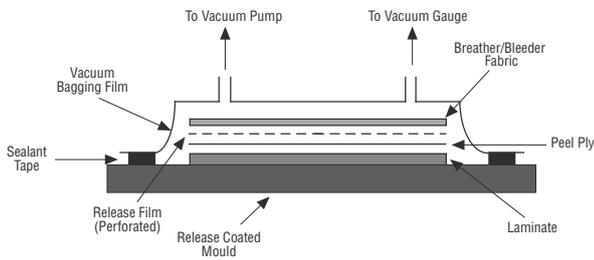


Figure 1

Core Materials

SP-High Modulus supplies **Corecell™** SAN closed cell foam for sandwich laminate construction. Other core materials such as PVC foam, Nomex honeycomb and end grain balsa, are also suitable for use with Ampreg 22 system. For further information on the use of core materials with Ampreg 22 system, please contact Technical Services.

Curing Schedule

Ambient Temperature Cure

The system has been developed to return good mechanical properties after cure at ambient temperatures, the minimum recommended temperature being 18°C, and excellent properties after a slightly elevated temperature post-cure. An initial cure of at least 48 hours (with slow and extra slow hardener) or 16 hours (with fast or standard hardener) at 18°C is recommended before demoulding. Laminates moulded with Fast, Standard or Slow hardener and subjected to an ambient temperature cure should be allowed 14 days before the system can be considered to be adequately cured (see working properties). Such mouldings should be kept in a warm dry environment during this period. When using the Slow, Extra Slow and High Tg Hardeners exclusively, an elevated temperature cure is strongly recommended. Ideally the postcure should be undertaken prior to demoulding.

When using the 14 Hour hardener the laminates must be cured at a temperature of at least 55°C.

Elevated Temperature Cure

Post curing the laminate will greatly increase mechanical properties. The system will achieve similar properties with a cure of 5 hours at 70-80°C or 16 hours at 50°C (with the exception of the 14 hour hardener which needs a minimum of 16 hours @ 55°C postcure). The latter temperature is easily achievable with low cost heating and insulation techniques. The tables in the datasheet show that these cure cycles improve the properties considerably.

The post cure need not be carried out immediately after laminating. It is possible to assemble several composite components and post-cure the entire assembly together. It is recommended, however, that elevated temperature curing should be completed before any further painting / finishing operations. Furthermore, care should be taken to adequately support the laminate if it is to be post cured after demoulding, and the laminate must be allowed to cool before the support is removed.

Properties

Component Properties								
	Resin		Hardener					
			Fast	Std.	Slow	Extra Slow	14 Hour	High Tg
Mix Ratio (by weight)	100		28	28	28	28	28	28
Mix Ratio (by volume)	100		32	33	33	34	34	29
Viscosity @ 15°C (cP)	9270		420	67	43	34	48	110
Viscosity @ 20°C (cP)	3915		270	40	36	22	36	80
Viscosity @ 25°C (cP)	2396		164	24	28	14	30	60
Viscosity @ 30°C (cP)	1312		105	15	21	9	21	40
Shelf Life (months)	24		24	24	24	24	24	24
Colour	yellow		(6)*	red	green	blue	blue	*6
Mixed Colour	-		yellow	pink	green	green	green	yellow
Component Dens. (g/cm ³)	1.147		0.958	0.950	0.947	0.940	0.944	0.96
Mixed Density (g/cm ³)	-		1.108	1.101	1.099	1.097	1.094	1.10
Hazard Definition	Please refer to MSDS information.							

*Hardener is not pigmented - Gardener colour stated.

Working Properties																						
	Resin/ Fast Hardener				Resin/ Standard Hardener				Resin/ Slow Hardener				Resin/ Extra Slow Hardener				Resin/ 14 Hour Hardener				Resin/ High Tg Hardener	
	15°C	20°C	25°C	30°C	15°C	20°C	25°C	30°C	15°C	20°C	25°C	30°C	15°C	20°C	25°C	30°C	15°C	20°C	25°C	30°C	20°C	
Initial Mixed Viscosity (cP)	4132	1995	1265	881	2848	1529	805	431	1610	950	579	361	1402	722	461	294	1288	855	577	378	1110	
†Gel Time - 150g Mix in water (hrs:mins)	0:31	0:26	0:22	0:18	2:18	1:31	1:00	0:40	9:10	5:44	3:35	2:12	14:00	9:10	7:00	4:50	15:00	11:40	09:30	07:30	5:40	
†Pot Life - 500g Mix in air (hrs:mins)	-	0:25	-	0:15	-	0:26	-	0:20	-	2:12	-	1:10	-	5:35	-	2:00	-	14:30	-	5:40	2:20	
†Earliest Time To Apply Vacuum (hrs:mins)	1:30	1:10	1:00	0:50	2:00	1:50	1:30	1:20	5:30	4:40	4:00	3:20	8:40	7:00	5:50	4:45	14:10	12:10	10:30	8:20	4:40	
†Latest Time To Apply Vacuum (hrs:mins)	3:10	2:15	1:40	1:10	3:20	2:45	2:20	2:00	7:45	6:40	5:30	4:20	11:30	9:10	7:20	5:50	19:35	16:00	12:40	10:40	6:40	
†Earliest Time To Turn Off Vacuum (hrs:mins)	5:00	3:30	2:30	1:40	5:00	4:00	3:15	2:40	18:30	15:30	12:30	9:30	48:00	30:00	18:00	11:20	*	*	*	*	15:30	
†Demould Time (hrs:mins)	6:00	4:00	3:00	2:00	8:20	5:20	4:00	3:00	36:00	30:00	25:00	19:00	100:00	62:00	37:00	22:00	*	*	*	*	30:00	

NOTES: *Ampreg 22 with 14 Hour hardener will ideally be post cured before de-moulding. Earliest time to turn off vacuum and demould time are totally dependent on the intended post cure schedule. Please refer to Technical Services for further information on this point.

For an explanation of test methods used see 'Formulated Products Technical Characteristics'. Please refer to the "Intro to Form Prds".pdf, which can be found in the Formulated product section on the website. www.gurit.com

All figures quoted are indicative of the properties of the product concerned. Some batch to batch variation may occur.

†All times are measured from when resin and hardener are first mixed together

Properties (cont'd)

Cured System Properties										
	Room Temperature Cure (28 days @ 21°C)				Post Cured (24 hours @ 21°C +16 hours @ 50°C)					
	Fast	Std.	Slow	Extra Slow*	Fast	Std.	Slow	Extra Slow	14 Hour**	High Tg
Tg DMTA (Peak Tan δ)(°C)	71.5	70.9	71.1	60.8	91.6	78.8	83.6	82.2	70.8	-
Tg Ult - DMTA (°C)	102.7	106.4	108.7	110.3	102.7	106.4	108.7	110.3	94.9	115
∅H - DSC (J/g)	50	44	65	59	13	0	15	27	0	0
Tg1 - DMTA (°C)	61.5	58.3	63.2	50.4	79.7	73.6	73.6	72.7	60.7	77
Est. HDT (°C)	57	56	56	46	77	64	69	67	56	73
Moisture Absorption (%)	2.31	2.25	1.41	1.46	1.92	-	0.62	1.22	-	1.1
Cured Density (g/cm³)	1.16	1.13	1.14	1.14	1.16	1.14	1.14	1.14	1.14	1.14
Linear Shrinkage (%)	1.7	1.4	1.6	1.7	1.7	1.5	1.5	1.6	1.6	1.2
Barcol Hardness	21	22	18	27	25	23	18	20	21	20
Cast Tensile Strength (MPa)	70.3	50.7	54.6	- *	87.8	72.2	75.0	73.3	64.71	74
Cast Tensile Mod. (GPa)	3.78	3.65	3.89	- *	3.64	3.74	3.51	3.36	3.29	3.4
Cast Strain to Failure (%)	3.0	2.3	3.4	- *	4.50	4.04	4.00	4.50	4.87	4.5
Lam. Comp. Strength (MPa)	503	410	429	515	437	462	441	516	443	430
Laminate T.V.M. Strain (%)	2.2	-	2.0	1.9	2.15	-	2.00	2.50	1.98	-
Laminate ILSS (MPa)	52	52	50	45	48.0	53.3	54.0	46.0	47.15	57
ILSS Wet Retention (%)	79	81	90	92	87	84	82	98	87	-

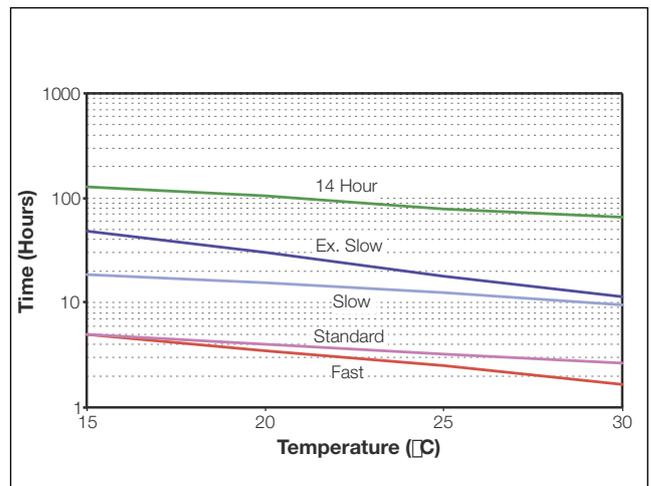
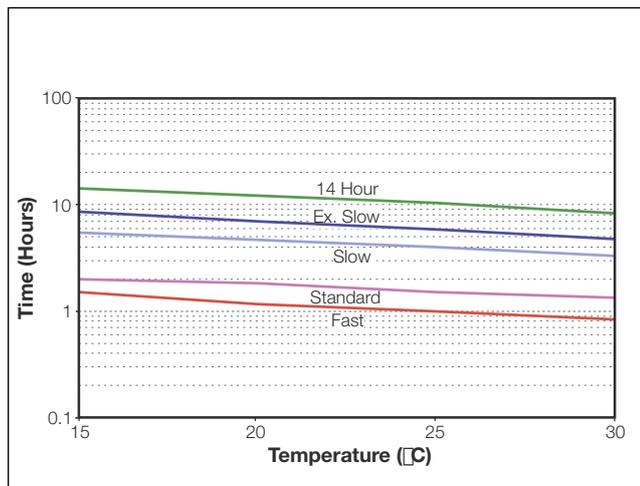
*Ambient temperature cure alone is not recommended with this hardener.

** Data generated from 16 hours @ 55°C postcure.

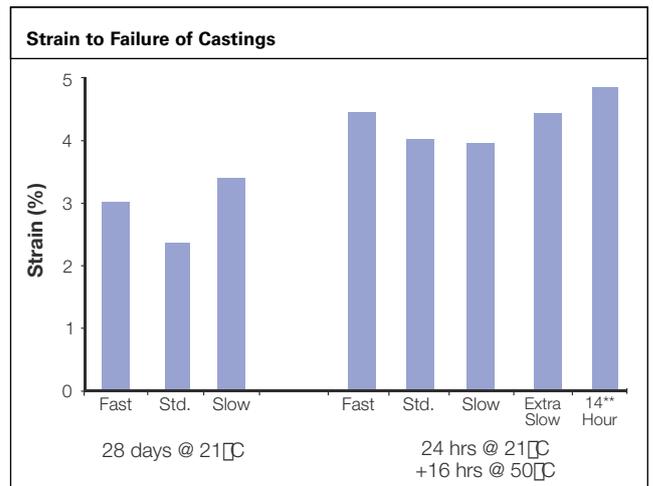
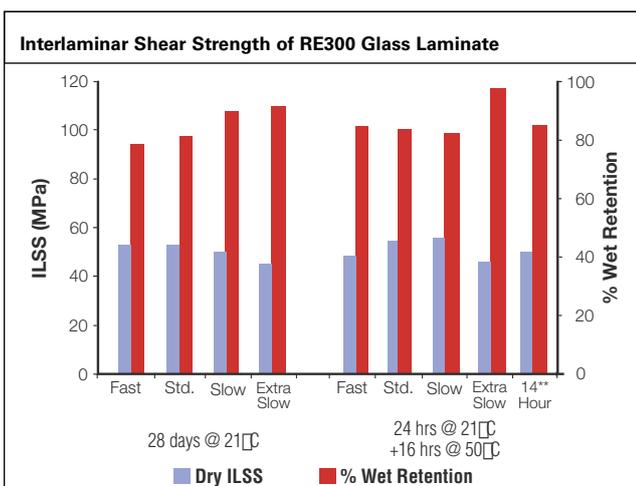
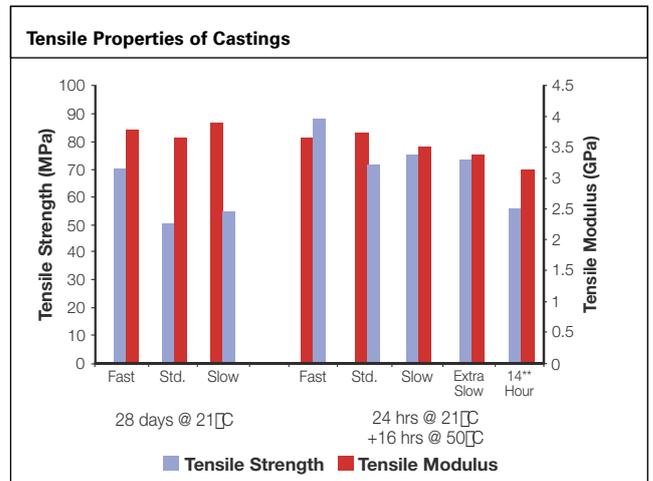
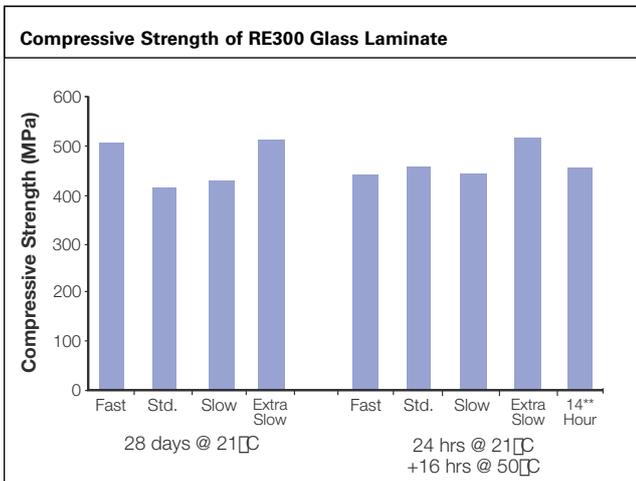
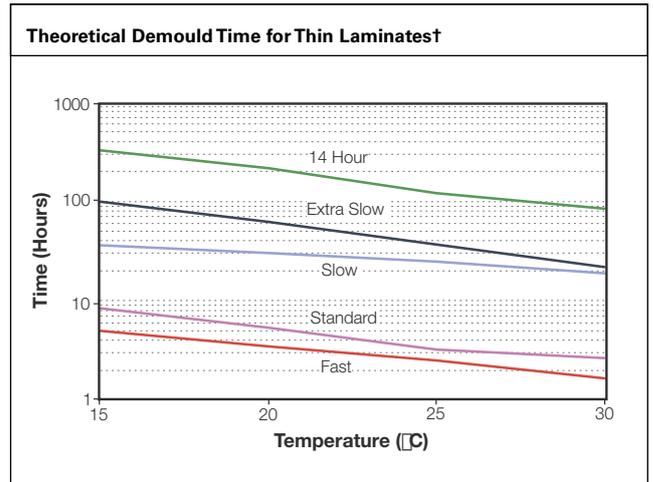
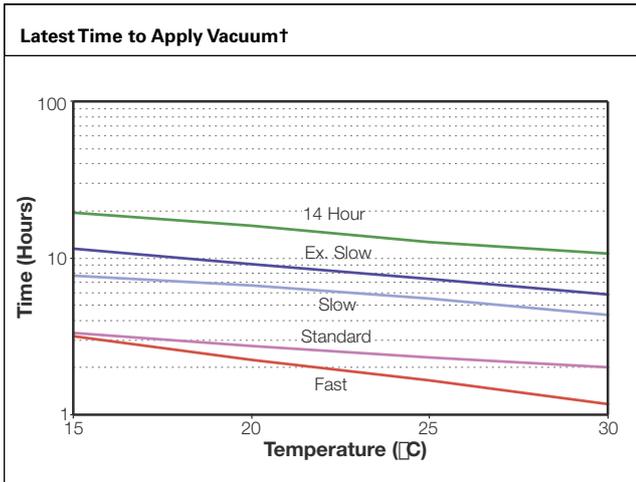
Notes: For an explanation of test methods used see 'Formulated Products Technical Characteristics'. Please refer to the "Intro to Form Prods".pdf, which can be found in the Formulated product section on the website. www.gurit.com

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Properties (cont'd)



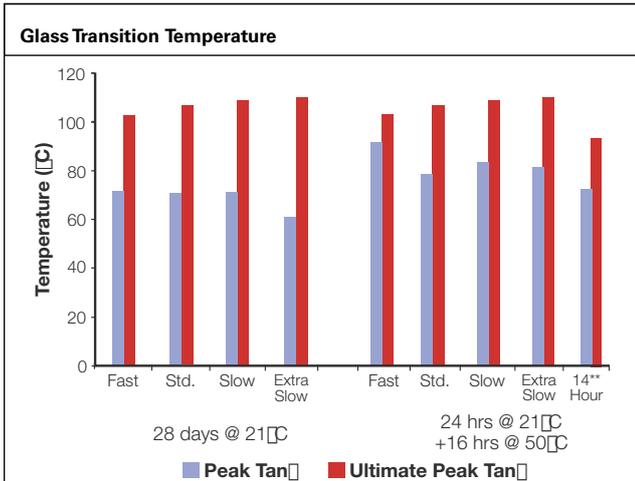
**Data generated from 16 hours @ 55°C Postcure

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**Data generated from 16 hours @ 55°C Postcure

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Health and Safety

The following points must be considered:

1. Skin contact must be avoided by wearing protective gloves. Gurit recommends the use of disposable nitrile gloves for most applications. The use of barrier creams is not recommended, but to preserve skin condition a moisturising cream should be used after washing.
2. Overalls or other protective clothing should be worn when mixing, laminating or sanding. Contaminated work clothes should be thoroughly cleaned before re-use.
3. Eye protection should be worn if there is a risk of resin, hardener, solvent or dust entering the eyes. If this occurs flush the eye with water for 15 minutes, holding the eyelid open, and seek medical attention.
4. Ensure adequate ventilation in work areas. Respiratory protection should be worn if there is insufficient ventilation. Solvent vapours should not be inhaled as they can cause dizziness, headaches, loss of consciousness and can have long term health effects.
5. If the skin becomes contaminated, then the area must be immediately cleansed. The use of resin-removing cleansers is recommended. To finish, wash with soap and warm water. The use of solvents on the skin to remove resins etc must be avoided.

Washing should be part of routine practice:

- before eating or drinking
- before smoking
- before using the lavatory
- after finishing work

6. The inhalation of sanding dust should be avoided and if it settles on the skin then it should be washed off. After more extensive sanding operations a shower/bath and hair wash is advised.

SP-High Modulus produces a separate full Material Safety Data Sheet for all hazardous products. Please ensure that you have the correct MSDS to hand for the materials you are using before commencing work. A more detailed guide for the safe use of SP resin systems is also available from SP-High Modulus, and can be found at www.gurit.com

Applicable Risk & Safety Phrases

Resin

R 36/38, 43, 51/53
S 23, 24, 26, 28, 37/39, 57

Fast Hardener

R 20/21/22, 34, 43, 68, 52/53
S 9, 20, 26, 36/37/39, 45, 61

Standard Hardener

R 21/22, 34, 43, 51/53, 62, 63 68
S 20, 23, 26, 36/37/39, 45, 57

Slow Hardener

R 21/22, 34, 43, 68, 52/53
S 20, 23, 26, 36/37/39, 45, 61

Extra Slow Hardener

R 21/22, 34, 43, 52/53
S 20, 23, 26, 36/37/39, 45, 61

14 Hour Hardener

R 34, 43
S 20, 23, 26, 36/37/39, 45, 60



Transport & Storage

The resin and hardeners should be kept in securely closed containers during transport and storage. Any accidental spillage should be soaked up with sand, sawdust, cotton waste or any other absorbent material. The area should then be washed clean (see appropriate Safety Data Sheet).

Adequate long term storage conditions will result in a shelf life of two years for both the resin and hardeners. Storage should be in a warm dry place out of direct sunlight and protected from frost. The storage temperature should be kept constant between 10°C and 25°C, cyclic fluctuations in temperature can cause crystallization. Containers should be firmly closed. Hardeners, in particular, will suffer serious degradation if left exposed to air.

For more information on crystallization please refer to the Laminating section on the Gurit website. (www.gurit.com/marine)

Notice

SP-High Modulus is the marine business of Gurit (the company). All advice, instruction or recommendation is given in good faith but the Company only warrants that advice in writing is given with reasonable skill and care. No further duty or responsibility is accepted by the Company. All advice is given subject to the terms and conditions of sale (the Conditions) which are available on request from the Company or may be viewed at the Company's Website: www.gurit.com/termsandconditions_en.html.

The Company strongly recommends that Customers make test panels and conduct appropriate testing of any goods or materials supplied by the Company to ensure that they are suitable for the Customer's planned application. Such testing should include testing under conditions as close as possible to those to which the final component may be subjected. The Company specifically excludes any warranty of fitness for purpose of the goods other than as set out in writing by the Company. The Company reserves the right to change specifications and prices without notice and Customers should satisfy themselves that information relied on by the Customer is that which is currently published by the Company on its website. Any queries may be addressed to the Technical Services Department.

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