Ampreg 21

Epoxy Wet Laminating System

- **Low initial mixed viscosity**
- **Good cure progression from ambient only cures**
- **Non Pigmented Resin and Hardeners**
- **Improved Health and Safety**
- **Optimised for Hand Lay-Up**
- **Excellent Fibre Wetting**
- **Germanischer Lloyd approved**

Introduction

Ampreg 21 has been optimised for the manufacture of large composite structures using hand layup, and vacuum bagging techniques.

The relatively low initial mixed viscosity of Ampreg 21 allows easy wetout of heavyweight reinforcements. It has been formulated to give a good Health and Safety product.

Ampreg 21 has been designed to give excellent mechanical and thermal properties from both ambient temperature cures, and moderate temperature postcures (50°C).

This system is available with a range of hardener speeds, from Fast to Extra Slow.

Instructions for Use

Workshop Conditions

Ampreg 21 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 21 should be mixed at the following ratios:

Hardener	Mix ratio (resin:hardener)	
	by weight	by volume
Fast to Extra Slow	100:33	100:38
High Tg	100:29	100:34

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 two components must be mixed thoroughly. If mixing by hand particular attention should be paid to the side and bottom of the mixing vessel. All solvent free epoxy systems have limited pot-life so use from the pot quickly of transfer to a shallow vessel with large surface area to allow the heat of the resin/hardener reaction to dissipate and prolong the working life of the system. Do not mix more than can be used within the working time of the particular resin/hardener system.

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. It is recommended to use a high solids sealer such as Chemlease RPM712N (Europe) or MP117 (USA) to seal new moulds, prior to application of the release agent.

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 laminating the first layers and faster hardeners in the later layers. In this way the whole thickness laid down remains workable for approximately the same time. For further advice, please contact Gurit Technical Support.

Ampreg 21 can be blended with Ampreg Pregel to reduce drainage on vertical surfaces. Please refer to the Ampreg Pregel Technical Datasheet for further information.

Bonding Techniques & Peel Ply

It is recommended to use nylon peel ply for any secondary bonding applications. Peel Ply is typically 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. 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.
Gurit recommends the use of its Stitch Ply A peel ply, or suitable Tygavac 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 Gurit Technical Support.

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 mixed system working time, as applying the vacuum earlier may result in excessive resin flow and resin starved laminates. For advice on effective vacuum bag consolidation, please contact Gurit Technical Support.

Core Materials

Gurit 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 21. For further information on the use of core materials with Ampreg 21, please contact Gurit Technical Support.

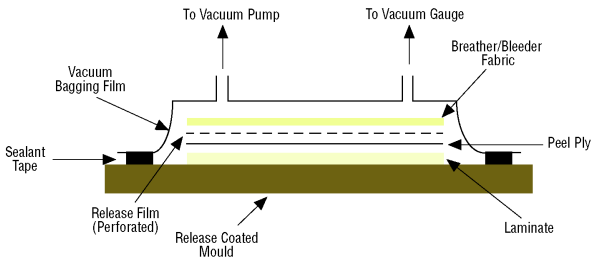

Figure 1

Curing Schedule

Ambient Temperature Cure

The system has been developed to provide good mechanical properties after an ambient only cure. The minimum recommended cure temperature is 18°C. Excellent mechanical/thermal properties can be achieved after a slightly elevated temperature post-cure. An initial cure of at least 48 hours (with slow hardener) or 16 hours (with fast hardener) at 18°C is recommended before demoulding.
When using the Slow, Extra Slow or High Tg Hardeners exclusively, an elevated temperature postcure is strongly recommended.

Elevated Temperature Cure

Post curing the laminate will greatly increase mechanical/thermal properties. The system will achieve similar properties with a cure of 5 hours at 70 - 80°C or 16 hours at 50°C. The latter temperature is easily achievable with low cost heating and insulation techniques.

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.

When postcuring it is recommended to use a ramp rate of 10°C/hour when heating from ambient to the postcure temperature, to ensure that the thermal performance of the laminate stays ahead of the oven temperature. Higher ramp rates may result in the resin softening and distortion of the part.

Properties

Component Properties

	Resin	Hardener				
		Fast	Standard	Slow	Extra Slow	High Tg
Mix Ratio (by weight)	100	33				29
Mix Ratio (by volume)	100	38				34
Viscosity @ 15°C (cP)	4800	1830	164	193	180	110
Viscosity @ 20°C (cP)	2970	1222	121	111	120	80
Viscosity @ 25°C (cP)	1562	762	90	63	60	60
Viscosity @ 30°C (cP)	901	560	66	45	40	40
Viscosity @ 40°C (cP	353	212	36	16	30	-
Shelf Life (months)	24	24	24	24	24	24
Colour (Gardner Index)	2	5	7	8	9	-
Component Dens. (g/cm^3)	1.135	1.018	1.007	0.985	0.974	0.96
Mixed Density (g/cm^3)	-	1.104	1.100	1.09	1.091	1.09
Hazard Definition	Refer to MSDS					

Properties (cont'd)

Working Properties

	Resin/ Fast Hardener			Resin/ Standard Hardener			Resin/ Slow Hardener			Resin/ Extra Slow Hardener*			Resin/ High Tg Hardener
	20°C	25°C	30°C	20°C	25°C	30°C	20°C	25°C	30°C	20°C	25°C	30°C	20°C
Initial Mixed Viscosity (cP)	2004	1194	731	904	537	344	705	481	309	716	432	289	820
Gel Time - 150g Mix in water (hrs:mins)	0:34	0:21	0:13	1:36	0:58	0:35	5:17	3:30	2:19	8:04	5:45	4:06	8:30
Pot Life - 500g Mix in air (hrs:mins)	0:36	0:24	0:12	0:47	0:33	0:19	1:36	1:10	0:44	3:48	2:34	1:19	-
Earliest Time To Apply Vacuum (hrs:mins)	1:46	1:15	0:42	2:38	2:10	1:48	4:28	3:44	2:56	6:44	5:32	4:32	7:10
Latest Time To Apply Vacuum (hrs:mins)	2:32	1:39	1:00	3:29	2:45	2:13	6:15	4:46	3:44	8:34	7:02	5:40	9:10
Earliest Time To Turn Off Vacuum (hrs:mins)	3:12	2:23	1:32	5:04	4:38	3:00	15:00	8:34	5:20	26:29	17:59	11:25	30
Demould Time (hrs:mins)	5:03	2:23	1:32	8:44	4:38	3:00	29:20	15:52	9:16	54:00	35:42	21:47	60:00

* It is recommended to postcure laminates for 16 hours at 50°c, when manufactured using Extra Slow Hardener.

Cured System Properties

	Post Cured (24hour at 21°C + 16hrs at 50°C)				
	Resin / Fast Hardener	Resin / Std Hardener	Resin / Slow Hardener	Resin / Extra Slow Hardener	Resin / High Tg Hardener
Tg DMTA (Peak Tan δ)(°C)	92	81	80	89	-
Tg Ult - DMTA (°C)	92	91	103	108	115
ΔH - DSC (J/g)	6.8	4.7	9.6	15	8
Tg2 - DSC (°C)	78	73	67	70	71
Tg1 - DMA (°C)	76	68	68	77	76
Est. HDT (°C)	77	67	66	74	73
Cured density (g/cc)	1.148	1.150	1.140	1.142	1.14
Linear shrinkage (%)	1.31	1.45	1.31	1.51	1.6
Barcol Hardness	25.7	19.6	20.0	22.2	-
Resin cast tensile strength (MPa	72.7	70.0	69.6	67.4	73
Resin cast tensile modulus (GPa)	3.3	3.0	3.3	3.4	3.2
Resin cast strain to failure (%)	3.7	4.3	3.9	3.0	3.2
Laminate compressive strength (MPa)	659	561	640	499	430
Tensile Strength (MPa)	612	564	633	556	420
Tensile Modulus (GPa)	32	32.2	32.4	32.5	22
Laminate ILSS (MPa)	55	57	50	52	54
ILSS Wet Retention (%)	93.5	82.2	91.5	89.1	-

Health and Safety

The following points must be considered:

1. Skin contact must be avoided by wearing protective gloves. SP-High Modulus 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

Refer to Material Safety Data Sheet

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)

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UK
St Cross Business Park
Newport, Isle of Wight
United Kingdom PO30 5WU

T +44 (0) 1983 828 000
F +44 (0) 1983 828 100
E marine@gurit.com
W www.gurit.com

Australia
Unit 1A / 81 Bassett Street,
Mona Vale, 2103 NSW,
Australia

T +61 (0) 2 9979 7248
F +61 (0) 2 9979 6378
E sales-au@gurit.com
W www.gurit.com

New Zealand
32 Canaveral Drive, Albany,
Private Box 302-191,
North Harbour, 0751
Auckland, New Zealand

T +64 (0) 9 415 6262
F +64 (0) 9 415 7262
W www.gurit.com

Canada
175 rue Péladeau,
Magog, (Québec)
J1X 5G9, Canada

T +1 819 847 2182
F +1 819 847 2572
E info-na@gurit.com
W www.gurit.com