



TOOLING AND COMPOSITES RAILWAY

28TH FEBRUARY 2024, ESTEBAN MUÑOZ

STADLER TECHNOLOGY DAY.

BUILDING TRUST



1.- Introduction

2.- Dielectris SikaBiresin RE461/101 (according to EN-45545)

3.- RIM – Reaction injection molding (production method of parts in railway industry)

4.- TOOLING RIM

5.- MODELS & MOLDS

5.1.- Machinable boards

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6.1.- WLU

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6.3.- RTM

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6.5.- Prepregs

7.-Release agents

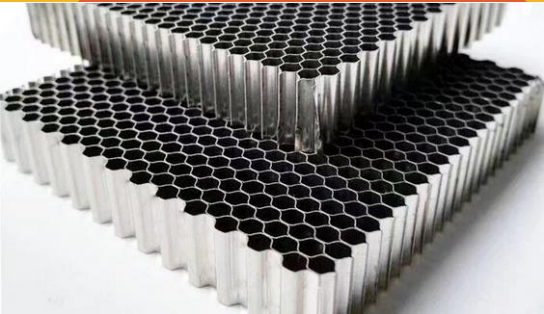
8.- Fabrics

SIKA NEW SOLUTIONS BEYOND THE EXPECTED

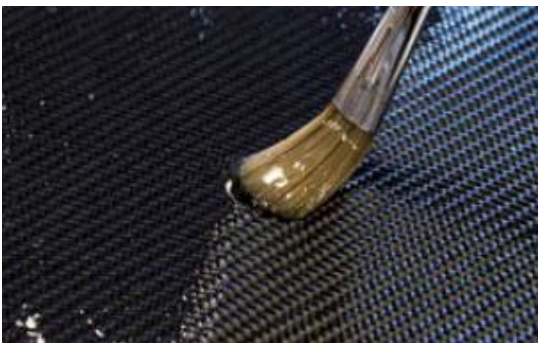


High Performance EP and PUR Systems for
TOOLING AND COMPOSITES

WHAT ARE COMPOSITE MATERIALS



COMPOSITE



Two or more dissimilar materials when which combine become stronger than individual materials

Typically, matrix and reinforced material



MATRIX: Polymers
- Polyester
- Phenolic
- Epoxy

Reinforcement:
- Glass fiber
- Carbon fiber
- Aramide (Kevlar)



EVOLUTION OF COMPOSITES

Ancient times

3400
B.C.

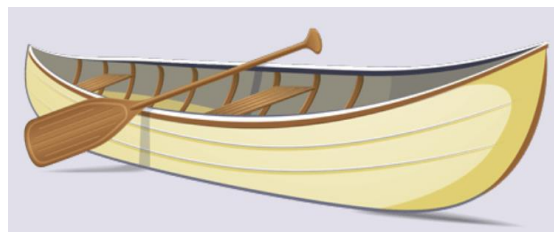


Mesopotamians

“Bricks” were and still are made from mud and straw..

Polymer resins

Late
1800s

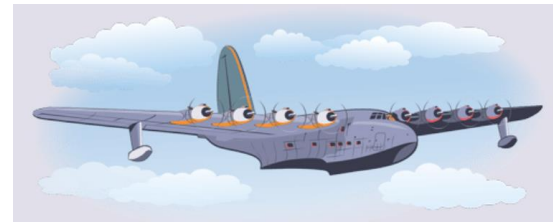


New era for resins

Liquid to solid by crosslinking molecules

Fabrics

World
War II



A Growing Industry

Boats, trucks, sport cars, railway, storage tanks, pipes...

Revolution

Looking
Ahead



New properties

Transport and aerospace markets



COMPOSITES in rail

The use of adhesives / sealants and composite in rail has become a genuine alternative to traditional joining techniques such as riveting, welding and possibilities of design compared to metallic parts.

**Reduction in
vehicle weight**

**Faster
acceleration.
Less energy**

**New design
opportunities**

**Less corrosion
easier repairs**



Most important standards for Sika Advanced Resins

**Tests for
Flammability of
Plastic Materials
for Parts in
Devices and
Appliances**

UL 94-VO
(worldwide)



**Aircraft
applications**

FAR 25.853
(worldwide)



Railway

EN 45545
(EU)



**Flammability test
for motor vehicle
interiors**

MVSS 302
(US)



FLAME RETARDANT DIELECTRIC SYSTEM RE 12461. PRACTICAL PART

DESCRIPTION

Casting resin for mechanical and numerous electrical applications for low and medium voltage when requiring an extinguish characteristic.

PROPERTIES

- Semi Flexible
- Low viscosity
- Several reactivity
- UL 94 V0, UL 746 HAI, HWI
- EN 45545, NF F 16101
- Good thermal conductivity

PHYSICAL PROPERTIES

Composition			POLYOL SikaBiresin® RE 461	ISOCYANATE SikaBiresin® RE 101	MIXED
Mix ratio by weight			100	16	
Mix ratio by volume at 25 °C			100	20	
Aspect			liquid	liquid	Liquid
Colour		SikaBiresin® RE 461-(11)–(16)	White	Dark amber	White
		SikaBiresin® RE 461-(35)	Red		Red
		SikaBiresin® RE 461-(74)	Grey		Grey
		SikaBiresin® RE 461-(94)	Black		Black
Viscosity at 25 °C	(mPa.s)	ISO 2555 : 2018	7.000	20	1.100
Specific gravity at 25 °C	(g/cm ³)	ISO 1675 : 1985	1,57	1,22	-
Specific gravity cured solid		ISO 2781 : 1996	-	-	1,55
Gel time at 25 °C (200 g)	(min)	Gel Timer TECAM	SikaBiresin® RE 461-(11)		10
			SikaBiresin® RE 461-(94)		30
			SikaBiresin® RE 461-(74) (35)		35
			SikaBiresin® RE 461-(16)		50

FLAME RETARDANT DIELECTRIC SYSTEMS

Potting compounds to protect sensitive electronics (sensors, electrical components and transformers)



Resins for capacitors, relays, transformers, sensors, electronic boards, coils, electronic devices and filters. High chemical and mechanical properties. Applications with high temperature requirements, thermal shock resistant and flame-retardant parts.

FIRE AND SMOKE PROPERTIES ACCORDING DIN EN 45545-2

- R22 / HL 1
- R23 / HL 2
- R24 / HL 3

SikaBiresin RE
12531

SikaBiresin RE
12461



RIM – REACTION INJECTION MOLDING

COST EFFECTIVE PRODUCTION METHOD OF PARTS IN RAILWAY INDUSTRY

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RIM – REACTION INJECTION MOLDING

WHAT IS RIM

R

REACTION



I

INJECTION

Chemical reaction solidifies the material

M

MOLDING

Components can be demolded after 15-20 min

2C component liquid PU resin is injected into molds under low pressure

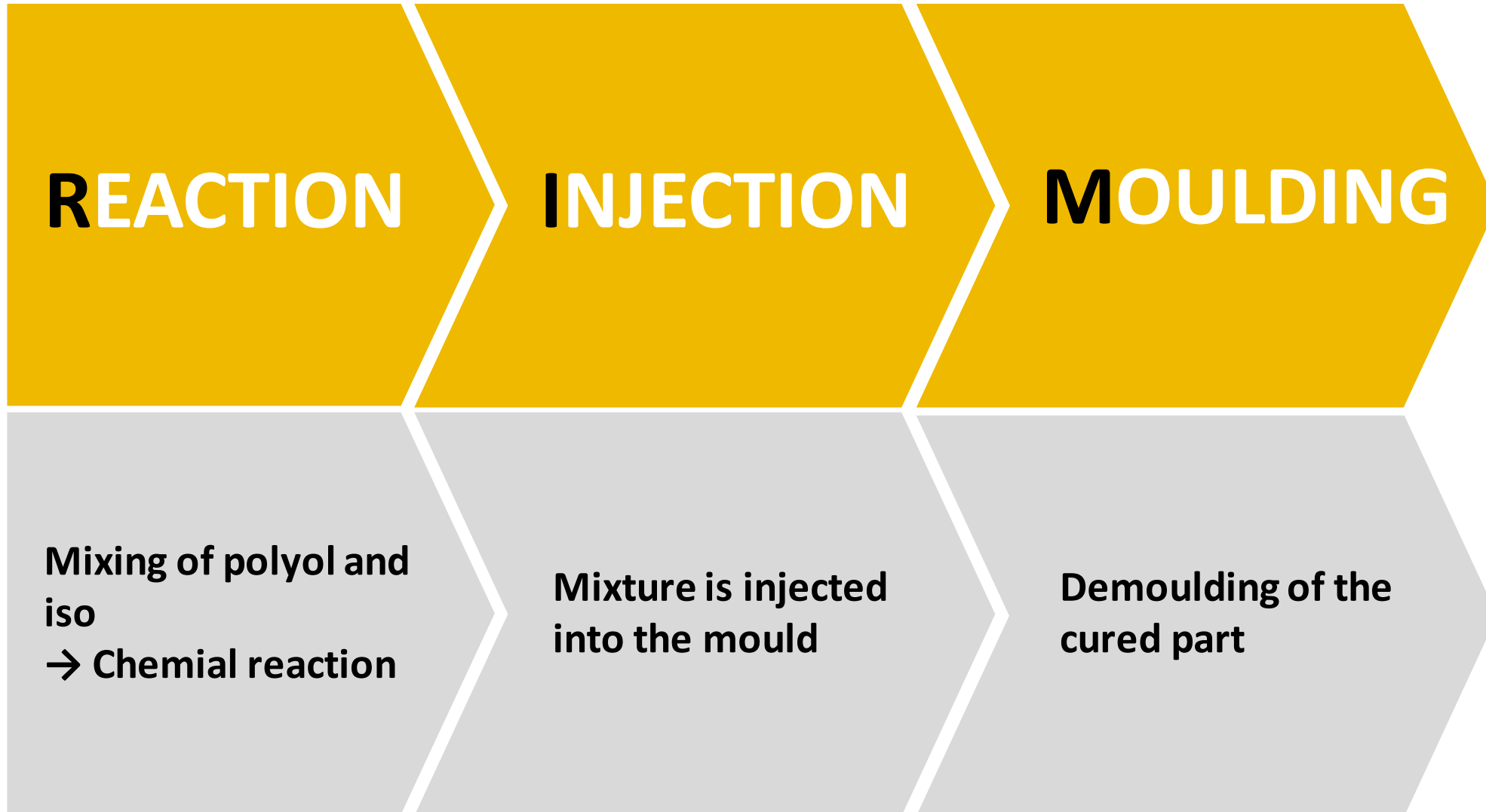


Once cured, the components fit and function like injection molded parts



RIM – REACTION INJECTION MOLDING

RIM PROCESS



RIM – REACTION INJECTION MOLDING

RIM PROCESS

**RIM mould,
made of board
material**



**2C mixing and
metering
machine**



**2C liquid PU
resin**



**Complex parts
with defined
mechanical
properties**



RIM – REACTION INJECTION MOLDING

ADVANTAGES

Prototyping and series production (500-1000 pcs /year)



Small parts (< 100 g)

Standard casting thickness in RIM: 3-5 mm



...up to large parts

Up to 20 kg

RIM – REACTION INJECTION MOLDING

ADVANTAGES

IN GENERAL

- Shorter cycle times
- Fast and economical production method
- Small series can be produced in short time with low costs
- Freedom in design and easy way of modification within the prototyping phase
- Modification of moulds is possible

IN COMPARISON TO HAND LAMINATING PROCESS

- Less manual work
- Reduction of manpower and working time

IN COMPARISON TO INJECTION MOULDING

- Reduction of tooling costs
→ no expensive aluminium tools are necessary due to low pressure
- Lightweight moulds are easier to handle
- PUR resins have better flow behaviour due to their lower viscosity and can achieve greater flow paths at the same wall thickness

RIM – REACTION INJECTION MOLDING

FLAME RETARDANT RAPID PRODUCTION SYSTEMS

Sika Biresin® RG57 FR and RG53 FR

- Simulation of ABS
- Fast curing with good flowability
- Short demolding time
- Manufacturing of stiff + impact resistant flame retardant parts like housings and coverings



Railway headlight housing made out of Sika Biresin® RG57 FR

Sika Biresin® RG53 FR

- ✓ Flexural modulus of 2200 MPa
- ✓ Flame retardant according to **UL 94; V0 at 3mm thickness**
- ✓ Flame retardant according to **Din 75200; ISO 3795**

Sika Biresin® RG57 FR

- ✓ Flexural modulus of 22350 Mpa
- ✓ Flame retardant according to **DIN EN 45545-2; R1/R22/R23**

RIM – REACTION INJECTION MOLDING

FLAME RETARDANT EDGE CASTING SYSTEM

SikaBiresin® KL100 FR

- Direct edge casting of decorative elements and safety edges
- Due to its UV stability and flame retardancy suitable for applications in railway industry
- ✓ Very good UV stability
- ✓ Good flowability and fast curing
- ✓ High chemical and impact resistance which protects against vandalism
- ✓ Colourable with addition of 3.5% colour paste to the polyol
- ✓ Flame retardant according to **DIN EN 45545; R3**



Table edge made out of SikaBiresin® KL100 FR

RIM – SUMMARY



Fast and economical production process

- Production of prototypes and small-medium series production



Low mould investment

- Reduction of tooling costs in comparison to aluminium moulds
- Mould can easily be modified within the prototyping phase



Wide product range

- Same properties like injection moulded parts
- Simulation of thermoplastic materials
- Flame retardant systems



Diverse field of application

- Very small to large parts
- Applications in railway, special vehicles, medical and other devices, sports and leisure, ...

TOOLING in composites production processes



Tooling RIM

- El hecho de que la presión de inyección sea baja permite una variada elección de materiales para la fabricación del molde dependiendo de la cantidad de piezas a reproducir, el tamaño del molde, temperatura de trabajo, precisión de la dimensión, ...

- Silicona
- Mode rígido de PU
- Molde rígido epoxi
- SikaBlock :
 - SikaBlock PROLAB 65
 - SikaBlock M945



Training tooling placas mecanizables



tooling

ri



BMW 3-er Cockpit / Upper Shell

Biresin® RG53

Mould made of
SikaBlock® M945

tooling



Covering for tables

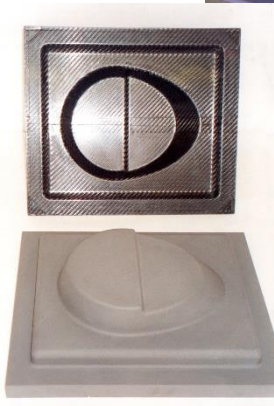
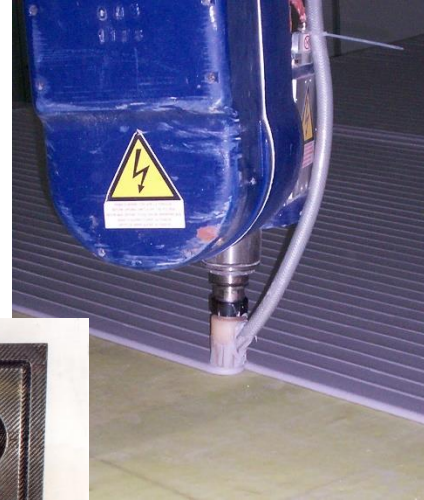
Biresin® RG57FR

- Small series with 100 – 1000 parts per project
- Fulfils DIN EN 45545-2
- HL2 with 3mm thickness
- R22 Interieur / R23 Exterior

Mould made of

SikaBlock® M980

MODEL / MOLDS.- MACHINABLE BOARDS & PASTE MATERIALS



BOARD MATERIALS

OVERVIEW BOARD MATERIALS ▶ Detailed Information see page 6/7					
	Suitable for model making	Suitable for mould making	Density [g/cm ³]	Colour	Characteristics
PUR					
Labelite 8GY SikaBlock® M80	○		0.08	grey yellowish	Low density boards with fine, dense non-powdery surface; easily workable with low dust formation when milled ▶ simple big models/moulds, backup/reinforcements constructions
Labelite 25YW SikaBlock® M330	○		0.25	peach yellow siena	
Labelite 45PK	○	○	0.45	pink	
SikaBlock® M600	○	○	0.60	light brown	Medium density boards with fine, dense surface; good compressive strength and edge stability ▶ models and moulds for lower number of pieces
SikaBlock® M700	○	○	0.70	light brown	
SikaBlock® M1000	○	○	1.0	white	Tooling boards with dense smooth surface, higher compressive strength and edge stability ▶ models and moulds for higher number of pieces
SikaBlock® M945	○	○	1.35	green	
EP					
Lab 975 New	●	●	0.70	light green	Medium density EP-boards with fine, dense surface; high heat distortion temperature and low CTE ▶ models and moulds for Prepreg applications
Lab 973	●	●	0.75	blue	

- highly recommended
- recommended
- conditionally possible

MODEL PASTES

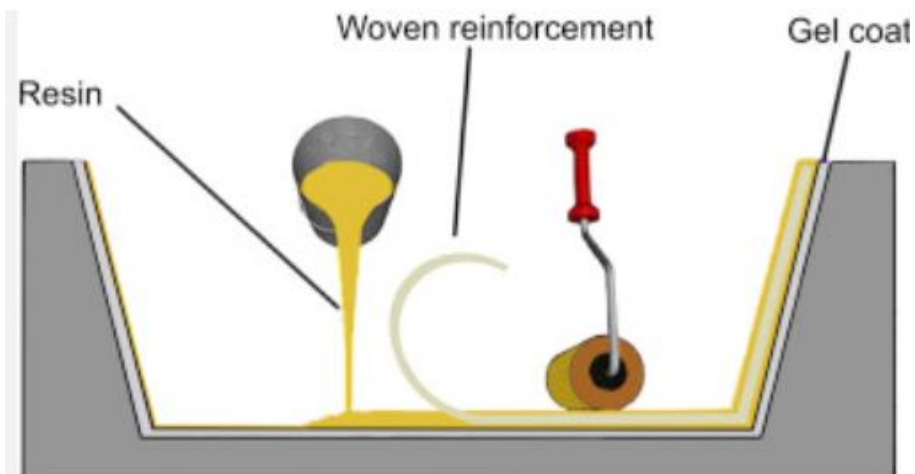
OVERVIEW MODEL PASTES				► Detailed Information see page 6/7
	Suitable for model making	Suitable for mould making	Density [g/cm ³]	Characteristics
PUR				
Biresin® M72	●	○	0.9	Easily workable; fine, dense surface; offers various advantages especially in large scale modeling; low risk of cracks due to high flexibility
EP				
SC 175	●	○	0.63	Very good surface aspect; good behaviour on vertical support up to 30 mm; high thermal resistance
SC 380	●	○	0.82	Very good surface aspect; good behaviour on vertical support up to 30 mm; high thermal resistance and high mechanical properties; for large dimension tools/composite tooling and mocks-up production
SC 390	○	●	1.06	Very good surface aspect; good behaviour on vertical support up to 30 mm; short hardening time even for 2 mm thickness; high using temperature; low CTE: good dimensional stability, especially suitable for prepreg tools

- highly recommended
- recommended
- conditionally possible

COMPOSITE PRODUCTION PROCESSES

Wet Lay UP / Hand Lay Up

Hand lay-up is **the simplest and oldest open molding method for fabricating composites**. At first, dry fibers in the form of woven, knitted, stitched, or bond fabrics are manually placed in the mold, and a brush is used to apply the resin matrix on the reinforcing material.



FLAME RETARDANT SOLUTIONS WITH Tg -130 °C

	A	SikaBiresin® CR132 FR	SikaBiresin® CR134 FR
	B	SikaBiresin® CH132-2	SikaBiresin® CH132-5
Mixing ratio g	A	100	100
	B	20	24
Potlife, RT		60	115
Mixed viscosity [mPas]		1.330	1.000
Tensile E-Modulus [GPa]		3.6	3.05
Tensile strength [MPa]		52	65
Elongation at break [%]		1.6	3.9
Impact resistance [kJ/m²]		15	21
Tg [°C]		132	132

Our most current General Sales Conditions shall apply.
Please consult the Product Data Sheet prior to any use and processing.
Actual Product Data Sheets and information about additional products please find in:
www.sika.com/advanced-resins



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E-Mail tooling@de.sika.com
www.sika.com/advanced-resins

SikaBiresin® CR132 FR + SikaBiresin® CR134 FR

DESCRIPTION

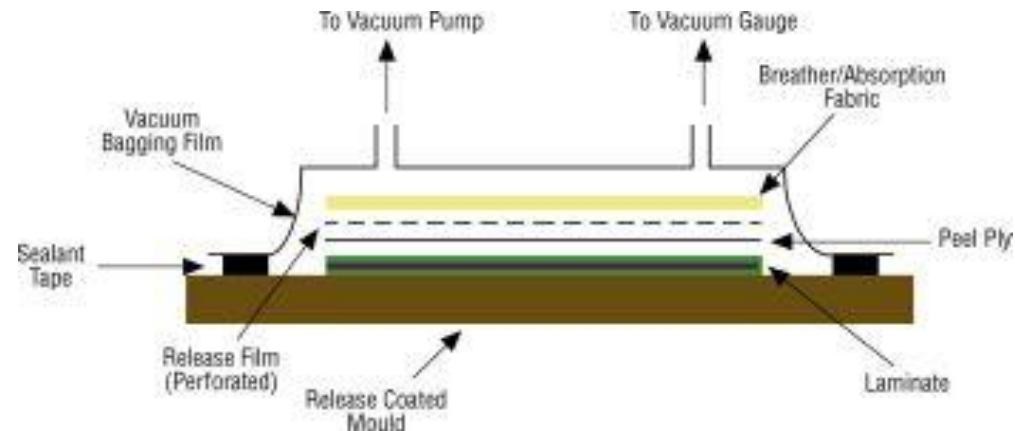
- Flame retardant versions of SikaBiresin® CR132, mainly for hand lay-up processing
- UL94 V-0 Classification

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WET LAY-UP

PRODUCT	VISCOSITIES	POTLIFE	FINAL TG
<u>CR75/CH75-1/CH90-3</u>	1800/35/500	28-82'	75°C
<u>CR82/CH80-1-2-6-10</u>	1800/80-10/800-400	30-330'	80-90°C
<u>CR122 /CH122-1-9</u>	850/15/550	90-150'	103 – 120°C
<u>CR132 /CH132-2-7</u>	1800/10/550	60-210'	135°C
<u>CR172 /CH170-3-6</u>	6000/10/800	110-220'	170-174°C
<u>CR190/CH190-5</u>	4000/200/2000	150'	190°C



SELF EXTINGUISHING LAMINATION

PRODUCT	VISCOSITY	POTLIFE	FINAL TG	Certification	Homologation
<u>EPOLAM 2500/2500</u>	3500 mPa.s	90' (500 g)	100°C	FAR 25.853	ECS 2186.20
<u>EPOLAM 2500/2501</u>	1800 mPa.s	25' (120g)	95°C	ABD0031	IPS 04-27-002-001
<u>BIRESIN CR132FR</u>	2000 mPa.s	60-200' (100g)	132-142°C	UL94 V-0	
<u>BIRESIN CR134FR</u>	1000 mPa.s	60-150' (100g)	125-132°C	UL94 V-0	



INFUSION - COMPONENTS



Principle :

- Dry lay-up of the reinforcement (fabrics, foam) in an airtight mold.
- Sucking of the resin into the reinforcement.

Advantages :

- Less contact of the operators with the resin
- Repeatability, reproducibility
- Optimization of the resin/fiber ratio and of the mechanical properties.

Range :

- SikaBiresin® CR80, **CR83**, CR120...

INFUSION

PRODUCT	VISCOSITIES	POTLIFE	TG FINALE	COMMENTS
<u>CR83/CH83-2-10</u>	510/10/160	60-300'	80-84°C	Very low viscosities . High modulus, impact resistance
<u>CR80/CH80-1-10</u>	900/50-10/400-210	45-330'	85-90°C	For carbon look parts
<u>CR120/CH120-3-6</u>	900/10-35/240	90-180'	114°C	Few competitors
<u>CR131/CH135-4-8</u>	2000/30/160-260	140-260'	126-138°C	Easy degasing 4 hardeners
<u>CR225</u>	1600/100/650	850'	215°C	Among the highest Tg



RTM (RESIN TRANSFER MOULDING)

- **Principle**
 - Injection of a resin into a heated mold containing the dry reinforcement.
- **Applications**
 - High-speed production of technical parts
 - Exemples :
 - Bicycle frames
 - Industrial parts
- **Resin requirements**
 - Adapted reactivity
 - Reduced demolding time
 - Associated to adapted reinforcement



RTM

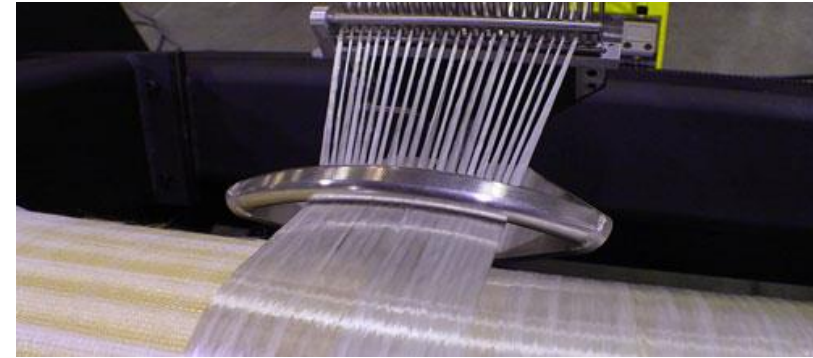
- Range :
 - Epoxy systems
 - **NEW**
 - PU systems
- Features :
 - Low viscosity at injection temperature
 - Controlled reactivity
- **Many other possibilities - adjustments**



PRODUCT	VISCOSITIES	POTLIFE	TG FINALE	COMMENTS
<u>SikaBiresin®CR</u>	1700/15/320	45-140'	120-140°C	Very low viscosity. Flexibility and reactivity
<u>SikaBiresin®CR135/CH135-4</u>	5750/10/940	160'	150°C	RTM class A Finish
<u>SikaBiresin®CR144/CH1xx</u>	13000/XX/2000	12-140'	91-172°C	High TG, very short cycles
<u>SikaBiresin®CR690</u>	240/450/200	25-55'	185°C	Hot Polyuretane system

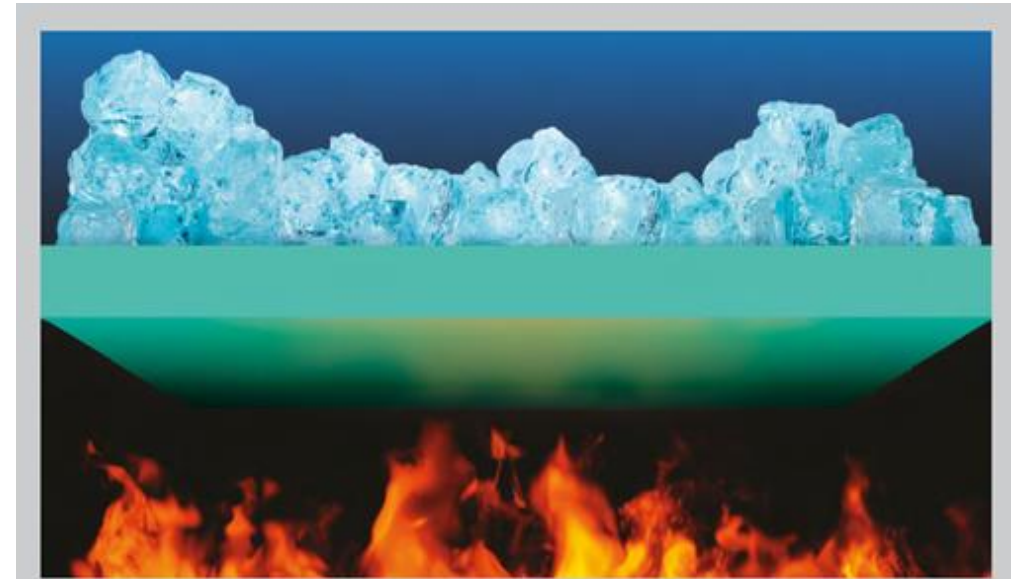
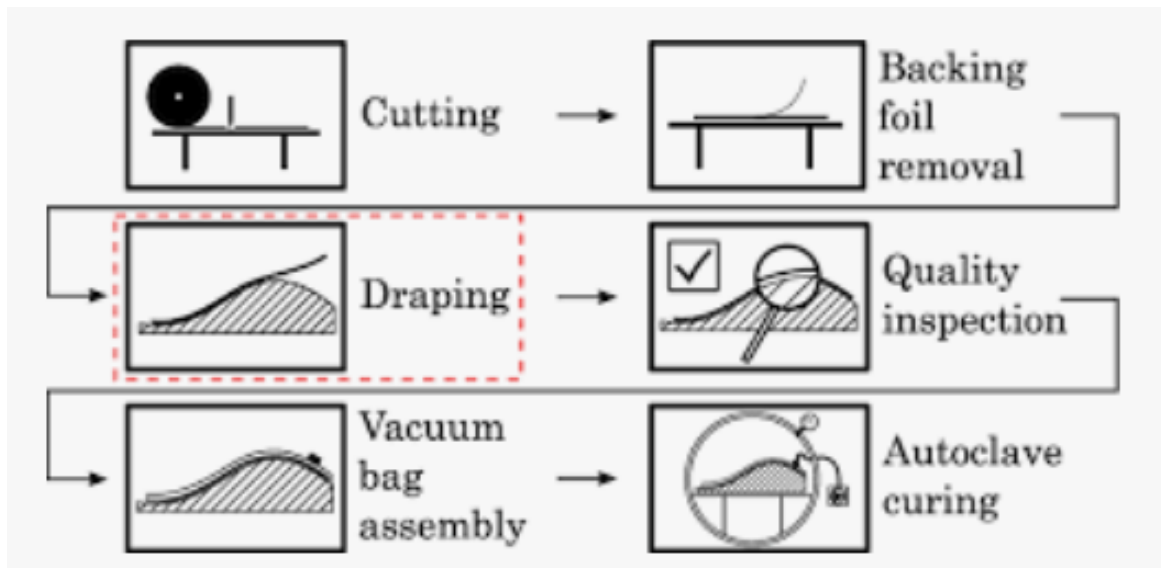
FILAMENT WINDING

- **Principle**
 - Impregnation of fibers laid onto a rotating mandrel.
- **Applications**
 - Gaz tanks (Hydrogen, LNG...)
 - Printing rolls
 - Industrial pipes...
- **Resin requirements**
 - Elongation at break
 - Low sagging during polymerization
- **Chemistries :**
 - Anhydride : long pot-life
 - Amine : good chemical resistance



COMPOSITE PRODUCTION PROCESSES PREPREGS

Prepreg is a **reinforcement (tows, woven, or unidirectional) preimpregnated with a known quantity of partially cured (catalyzed resin) matrix**. Prepregs are used to produce high-performance composite structures (transport, aerospace, ballistics, sports, etc.).



LAB 975 New HEAT RESISTANT EPOXY TOOLING BOARD WITH HIGH DIMENSIONAL STABILITY

LAB 975 New is the first choice for the construction of prepreg tools, master models and vacuum forming moulds for temperatures up to 130 °C.

- Density 0.70 kg/ltr.
- High temperature resistance up to 130 °C
- Very low coefficient of thermal expansion α , 32-42 x 10⁻⁶
- High compressive strength
- Easy workability
- Excellent surface quality

RELEASE AGENTS

Mold Cleaners

Chemlease® mold cleaners are designed to keep molds and tools in peak condition.

Mold Primers

Chemlease® mold primers help improve process efficiency and part quality by enhancing the mold surface.

Mold Sealers

Chemlease® mold sealers are specifically designed to help protect investments in composites molds and tooling from chemical and physical damage that occurs during the molding process.

Release Agents

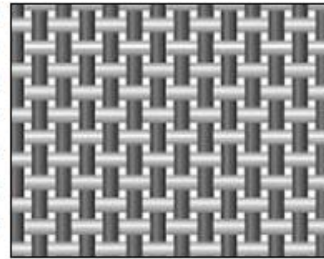
A wide range of Chemlease® release agents / top coat products are available in either water-based or solvent-based formulations, including many semi-permanent options, providing ample opportunity to find the right solution to the toughest composites molding challenges.

FABRICS

- GLASS
- CARBON
- ARAMID

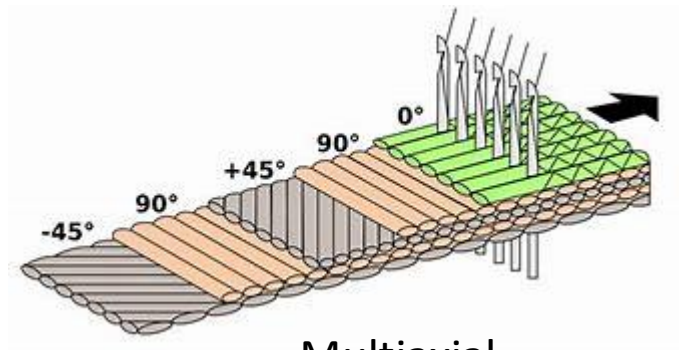
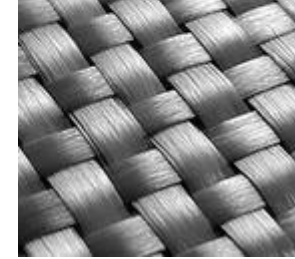
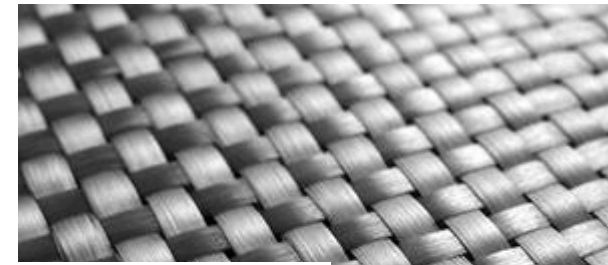
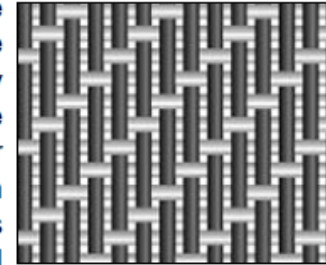
Plain

The plain weave consists of yarns interlaced in an alternating fashion one over and one under every other yarn. The plain weave provides good fabric stability but is generally the least pliable.



Twill Weave

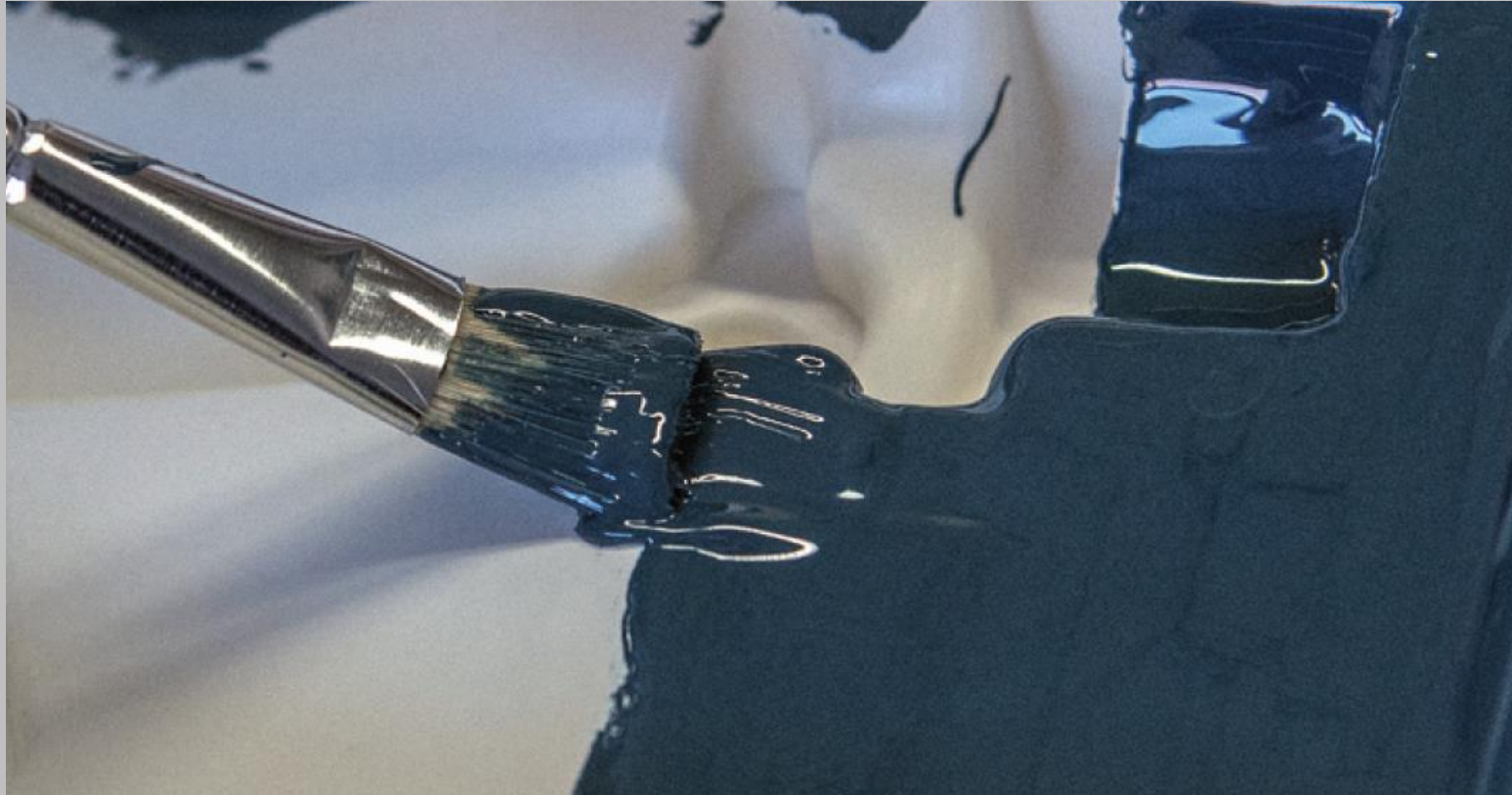
The twill weave is more pliable than the plain weave and has better drapability while maintaining more fabric stability than a four or eight harness satin weave. The weave pattern is characterized by a diagonal rib created by one warp yarn floating over at least two filling yarns.



Multiaxial

Mat





THANK YOU FOR YOUR ATTENTION !

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