



Crestapol[®]

Intelligent Resin Technology

Product Properties and Information Guide



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ABOUT SCOTT BADER

Scott Bader was established in 1921 and today we are an independent, multinational chemical company with over 650 employees worldwide. We are a common trusteeship company, which means Scott Bader is owned by all employees, and can operate with great agility and innovation for the customers and industries we serve.

Today Scott Bader is a US \$287 million global chemical company, with manufacturing facilities in Europe, The Middle East, India, South Africa, Saudi Arabia, Canada and South America.

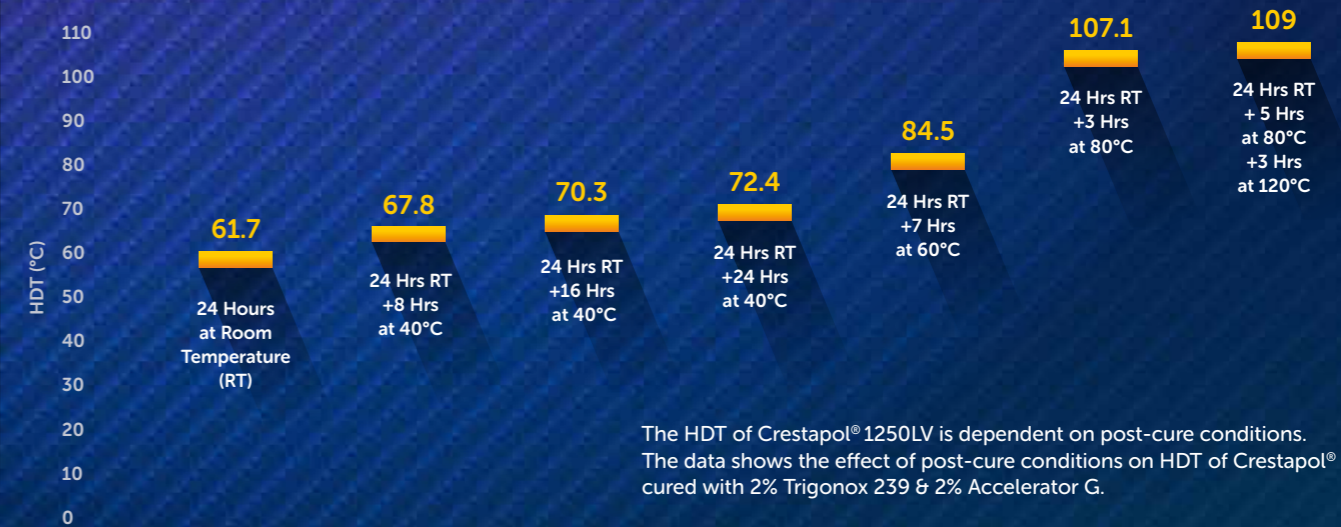
Crestapol[®] 1250LV

Crestapol[®] 1250LV is a low viscosity urethane acrylate type resin which is suitable for infusion, Resin Transfer Moulding (RTM) and similar processes at room temperature, and can be infused at vacuum levels down to -1.0 Bar.

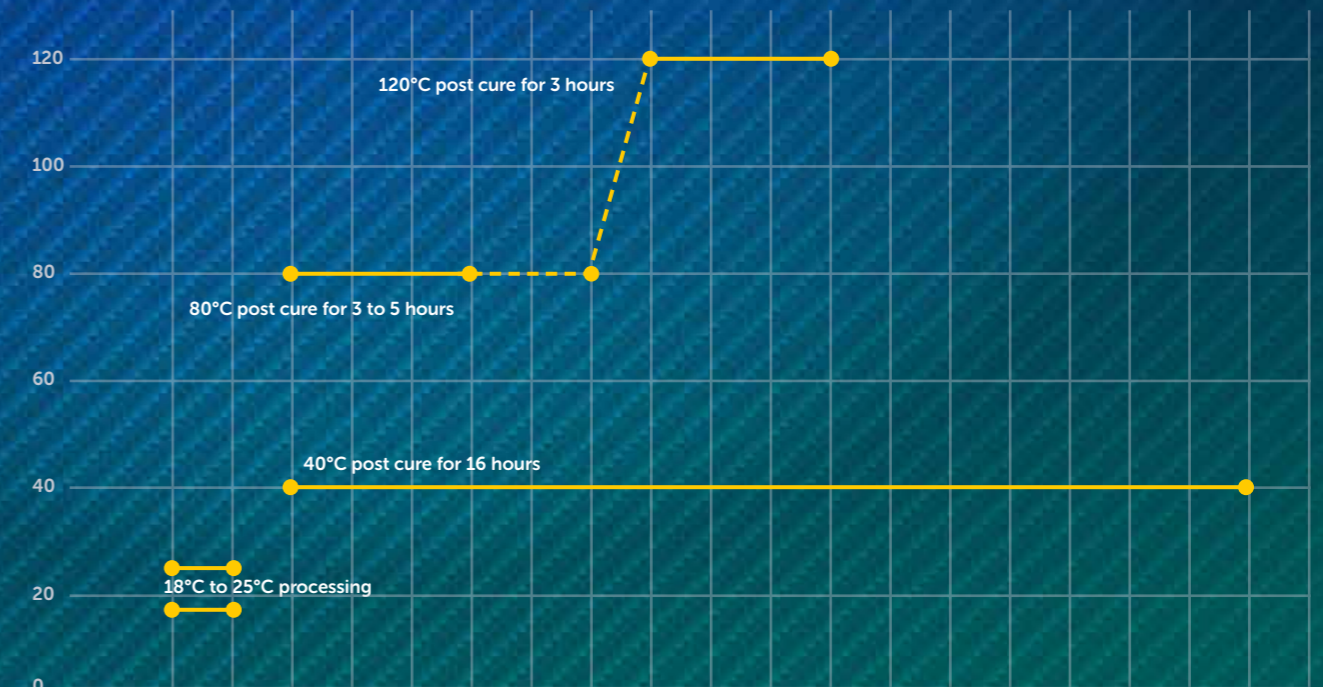
KEY FEATURES OF CRESTAPOL[®] 1250LV

- › Excellent mechanical performance and durability using only moderate temperature post-curing cycles
- › High temperature performance - T_g 130°C / HDT 109°C
- › Compatible with carbon fibre reinforcement materials and general purpose sizing agents
- › Ability to vary cycle time eliminates the need to stock different resin grades

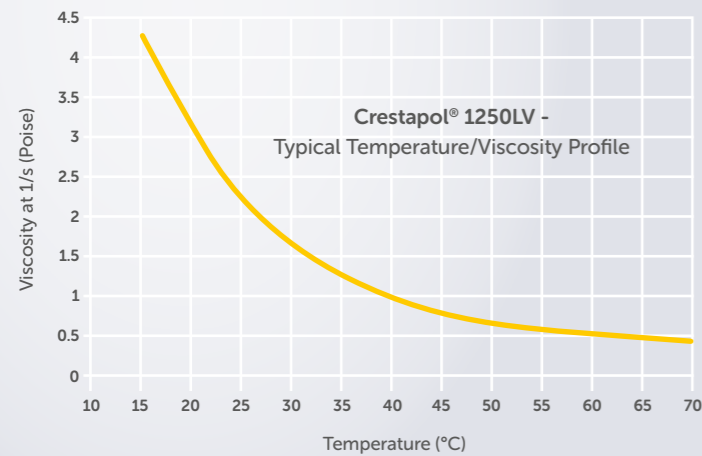
HDT - EFFECT OF POST-CURE ON HDT FOR CRESTAPOL[®] 1250LV



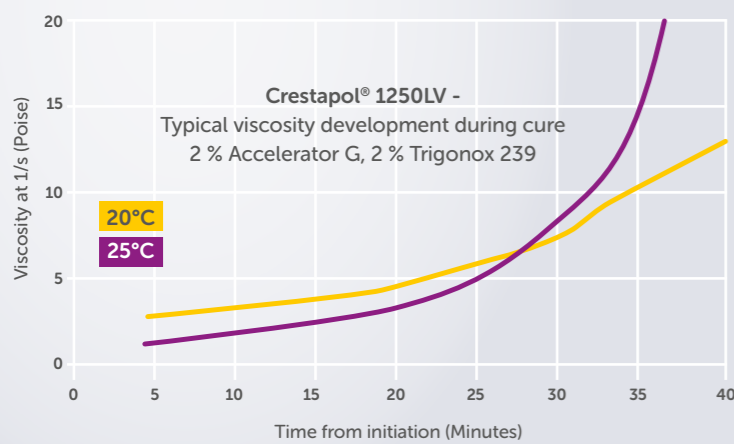
TYPICAL POST-CURE CYCLES FOR CRESTAPOL[®] 1250LV



EFFECT OF TEMPERATURE ON VISCOSITY



POST INITIATED VISCOSITY BEHAVIOUR



CUSTOMER EXPERIENCES

Spanish composite part manufacturer, Karbonius, renowned for innovative Carbon/Aramid, moulding, processing and design of high quality composite parts, manufactures Suzuki S1600 Rally Championship Car using Crestapol® 1250LV resin.

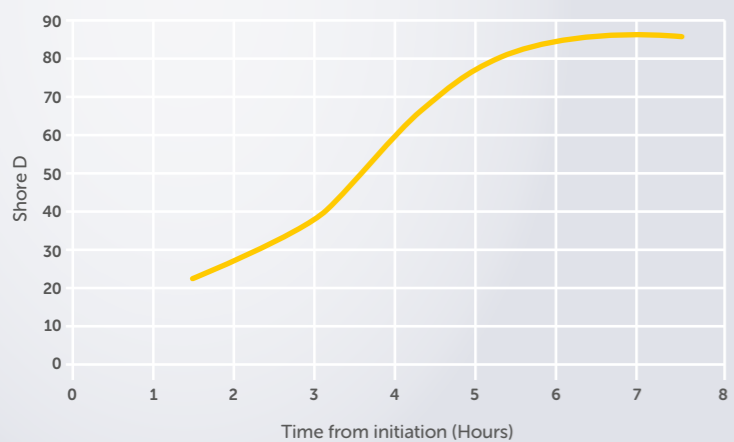
"It is a fabulous resin, saving us 40% (8kg) in weight on the bumpers alone. The parts have lasted 7 races so far, with epoxy resins lasting only 1 race."

The resin is easy to infuse, cures quickly and its properties are unbeatable. This is without a doubt the best resin I have used."



TYPICAL ROOM TEMPERATURE THIN SECTION CURE DEVELOPMENT

(VACUUM INFUSED 600T PLAIN WOVEN GLASS FABRIC)



Crestapol® 1250LV -
Typical Shore-D hardness development 2% Accelerator G, 2% Trigonox 239.
Room temperature vacuum infusion processing.
2 ply 600T woven glass fabric laminate.

MIX RATIOS AND PROCESSING

- ▶ The recommended cure system for Crestapol® 1250LV is Trigonox 239 with Accelerator G
- ▶ Post-cures of either 40°C for 16 hours, 80°C for 3 hours, or 80°C for 5 hours + 120°C for 3 hours are recommended to achieve maximum properties

Typical Liquid Resin Properties of Crestapol® 1250LV

Density (25°C)	1.041 g/cm ³
Viscosity (ICI cone & plate, 25°C)	2.2 poise
Gel time (100g, 25°C)	35 minutes

Typical Cast Properties of Crestapol® 1250LV

24 Hrs RT, 3 Hrs 80°C post-cure
For HDT and Tg, 24 Hrs RT, 5 Hrs 80°C & 3 Hrs 120°C post-cure

Barcol Hardness	38
Heat Deflection Temperature (HDT)	109°C
Glass Transition Temperature (Tg) (DSC)	130°C
Ultimate Tensile Strength	67 MPa
Elongation at Break	2.4%
Tensile Modulus	3.5 GPa
Poisson's ratio	0.34

Typical Cure Speed: Crestapol® 1250LV

Gel time at 20°C (100g)	56 minutes
Gel time at 25°C (100g)	37 minutes

MECHANICAL PERFORMANCE

The table opposite presents a selection of typical mechanical test data obtained using Crestapol® 1250LV and carbon fibre reinforcement fabrics utilising general purpose sized carbon fibres.

Mechanical Properties of Vacuum Infused Carbon Fibre Laminates with Crestapol® 1250LV‡

Test method	23°C Ambient	Post-conditioned strength retention K
ILSS Strength 0/90° Bi-axial Specimen UD Specimen	34 MPa 61 MPa	81% 93%
Flexural Strength* 0/90° Bi-axial Specimen	1032 MPa	82%
0° Compression Strength# UD Specimen	655 MPa	83%

Physical Properties

Water uptake after 28 days immersion at 40°C

0/90° Bi-axial Specimen	0.15% wt.
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Time required for 1mm laminate to reach Shore-D hardness of 80

BS EN ISO 14130

* BS EN ISO 14125

BS EN ISO 14126

‡ Room temperature process & 24 Hours room temperature + 3 Hours 80°C post cure

K Strength retention of carbon fibre laminates after 28 days exposure to 4 cycles of + 50 °C salt spray, - 20 °C freeze and + 60 °C dry conditions is typically 80 to 90%

Please contact Scott Bader Technical Service for further information.

Crestapol® Resin Systems for Rapid Cure, Closed Mould Applications

Crestapol® 1210

CRESTAPOL® 1210 is a tough, low viscosity resin which gives a rapid cure and can be filled as required.

Crestapol® 1218

CRESTAPOL® 1218 is a tough, low viscosity resin which gives a rapid cure and also comes pre-filled with 50 pph filler and pre-aminated. There is also an option to have this resin pigmented white or grey.

KEY FEATURES

- › **High reactivity**
Offering the potential for rapid demould times. Elevated temperature moulding will further enhance the cure time
- › **Mechanical performance**
The inherent "toughness" of the cured resin matrices results in laminates exhibiting excellent mechanical performance despite the presence of high levels of filler
- › **Pigmentable**
Fully compatible with polyester pigment pastes
- › **Gelcoats and adhesives**
Fully compatible with Crystic® Gelcoats and Crystic Crestomer® and Crestabond® adhesives

THE FOLLOWING TABLE GIVES TYPICAL PROPERTIES OF CRESTAPOL® 1210 AND 1218 WHEN TESTED IN ACCORDANCE WITH BS2782.

LIQUID PROPERTIES			
Property	Unit of Measurement	Crestapol® 1210	Crestapol® 1218
Appearance		Clear yellowish brown	Clear yellowish brown
Viscosity @ 25°C 4500 sec - 1	Poise	1.75	0.7
Density @ 25°C	gcm ⁻³	1.10	1.07
Volatile Content	%	36	49
Stability in the dark @ 20°C	Months	>6	>6
Gel time Crestapol® 1210*	Minutes	8.5	-
Gel time Crestapol® 1218**	Minutes	-	12

* @ 20°C 2% Accelerator G, 2% Accelerator D, 1.5% Trigonox 44B

** @ 20°C 1% Accelerator G, 1% Trigonox 44B

Accelerator G is a 1.0% solution of cobalt in styrene

Accelerator D is a 10% solution of DMA in styrene

Mechanical Properties Crestapol® 1210 1218

Property	Unit of Measurement	Resin (without postcure)
Barcol Hardness	-	44
Deflection Temperature under load (1.80MPa)	°C	93
Tensile strength	MPa	79
Tensile modulus	GPa	3.5
Elongation at break	%	3.3

MOULDING GUIDELINES

The gel time and cure speed of Crestapols® can be varied by altering the levels of accelerators and peroxides used. For Crestapol® 1210 standard RTM peroxides such as Trigonox 44B or Trigonox 524 (for elevated temperature) can be used. For longer gel times, commercially available inhibitors can be used. If required, internal release agents can be used. Please contact Scott Bader Technical Support for recommendations.

MOULD CONSTRUCTION

All types of commercial moulds can be used, including polyester, epoxy, metal and nickel shell options.

MOULD TEMPERATURE

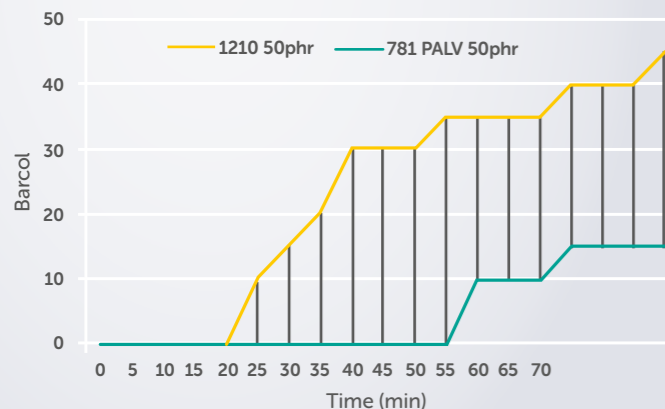
For highest levels of productivity, heated moulds should be used, however products can also be used in ambient temperature GRP moulds.

RELEASE AGENT

Use a high slip semi-permanent release agent on the non gelcoated surfaces of moulds reinforcement type: Glass, Kevlar and Carbon reinforcement can be used with Crestapol® resins. Any commercial glass suitable for use with polyester resins can be used.

For RTM and RTM light Crestapol® 1210 can be processed using a conventional RTM injection machine. Vacuum Infusion can be used to process both Crestapol® 1210 and 1218.

BARCOL DEVELOPMENT OF CP1210 vs TYPICAL POLYESTER RTM RESIN WITH MATCHED GEL TIME (10min)



MOULDING

The correct preparation is essential in order to obtain the full benefits from the use of Crestapol® resins.

RESIN TEMPERATURE

Ensure that the resin is at 18°C or above prior to moulding. If using elevated mould temperatures the resin can be warmed prior to injection to avoid thermal quench.

CUSTOMER EXPERIENCES

Crestapol® Acrylic RTM Resin Application "Custom Grade" Crestapol® RTM Acrylic Resin

The full RTM closed moulding process and tooling used by SSC is well-suited for high volume production of 100 to 10,000 units per annum.

By combining its unique Thrubeam® technology with a 'custom grade' Crestapol® resin specially developed for SSC by Scott Bader, SSC is able to produce GRP composite covers which are more than 20% lighter than other composite covers currently available, based on independent test data.

This has been achieved due to the high mechanical properties of the Crestapol® resin, along with more precision and control through using an RTM injection process. In other words, a thinner, so overall much lighter, Crestapol® glass fibre laminate is needed to encapsulate the Thrubeam® stiffener beams used in all SSC covers, with no loss of performance in use.

"After extensive new product development trials and testing different UPR and epoxy resin systems, we were very pleased that Scott Bader was able to develop a special grade of its Crestapol® high performance acrylic resin for SSC that met all our needs. The custom Crestapol® grade we now use firstly provides a level of physical properties to match our Thrubeam® technology and meet BS EN124 test standards. Secondly, the resin's rheology and very fast cure rate at moderately elevated temperatures enables us to manufacture our composite covers consistently, and with a high level of confidence that parts will meet our quality standards."

Andrew Burton, General Manager of SSC



Crestapol® Resin Systems for FST Applications

Crestapol® 1212

CRESTAPOL® 1212 is a very low viscosity, methacrylate-based thermosetting resin, developed for use in pultrusion and closed mould applications in conjunction with high levels (up to 170 - 200phr) of alumina trihydrate (ATH) fire retardant filler to produce profiles and laminates with excellent low smoke, low toxicity fire performance.

Crestapol® 1213A

CRESTAPOL® 1213A is a methacrylate-based thermosetting resin which is amine pre-accelerated and highly filled with 170 phr alumina trihydrate (ATH) fire retardant filler to achieve excellent low smoke and low toxicity fire performance. This resin is specially developed for both hand lamination and closed mould applications.

Crestapol® 1214

CRESTAPOL® 1214 is a very low viscosity, modified urethane acrylate thermosetting resin, developed for use in pultrusion modified urethane which gives a high quality surface finish and very low shrink. Crestapol® 1214 has undergone repeated flexural, torsion, flammability and electrical testing to a variety of British Standards (BS) and National Coal Board (NCB) approvals, and European and BS fire standards.

CRESTAPOL® 1212 KEY FEATURES

- High reactivity**
Offering the potential for high line speeds compared to other typical thermosetting resins. Offering the potential for rapid demould times. Elevated temperature moulding will further enhance the cure time
- Mechanical performance**
The inherent "toughness" of the cured resin matrix results in profiles exhibiting excellent mechanical performance despite the presence of high levels of filler
- Pigmentable**
Crestapol® 1212 is pigmentable and fully compatible with polyester pigment pastes

CRESTAPOL® 1212 FRACTURE TOUGHNESS



LIQUID PROPERTIES		
Property	Unit of Measurement	Crestapol® 1212
Appearance	-	Clear yellowish brown
Viscosity @ 25°C 4500 sec ⁻¹	Poise	0.7
Density @ 25°C	gcm ⁻³	1.07
Volatile Content	%	49
Stability in the dark @ 20°C	Months	9

** @ 20°C 4% Accelerator D, 2% Perkadox CH50X

Accelerator G is a 1.0% solution of cobalt as compound in styrene

Accelerator D is a 10.0% solution of dimethyl aniline in styrene

FIRE PERFORMANCE IN CLOSED MOULD

Fire performance of Crestapol® 1212 profiles is achieved by addition of aluminium trihydrate (ATH). Due to the inherent low viscosity of Crestapol® 1212 up to 170 phr of ATH can be incorporated to achieve a range of stringent fire, smoke and toxic fume standards. For example, 170phr ATH can achieve M1, F0 to the French Epiradiateur standards.

Fire performance will also be dependent on glass content and profile thickness. Please contact Scott Bader Technical Services Dept for advice on ATH loadings for specific applications.

Fire requirement	Minimum ATH loading	Results
French NFP 92-501	170	M1
French NFP 16-101	170	F0
UNE 23721 : 1990 / UNE 23727 : 1990	170	M1
DIN 5510	100	S4/SR2/ST2
ASTM 162	100	Is = 10 (limit <35) Meets Federal Railroad Admin requirements for surface flammability
ASTM 662	100	Ds (max) = 119 Dm (1.5) = 1 Dm (4) = 4
ASTM E84	165	smoke index 110, flame index 15
ISO 5658	170	HL2
ISO 5659-2	170	HL2
ISO 5660-1&2	170	HL2

FIRE PERFORMANCE IN PULTRUSION

Crestapol's fire performance is achieved by the addition of aluminium trihydrate (ATH). Due to the inherent low viscosity of Crestapol® Resins up to 200 phr of ATH can be incorporated to achieve a range of stringent fire, smoke & toxic fume standards. For example, 170phr ATH can achieve M1, F0 to the French Epiradeatuer standards.

Fire performance will also be dependent on glass content and profile thickness. Please contact Scott Bader Technical Services Dept for advice on ATH loadings for specific applications.

PULTRUSION GUIDELINES

TYPICAL FORMULATION

Crestapol® 1212 and 1214	100 pbw
ATH*	100 - 200 pbw
BYK W996 #	3 - 6 pbw
Trigonox C ‡	1 pbw
Perkadox 16 ‡	0.5 pbw
(dispersed in mma or styrene solvent)	1.0 pbw
Internal release agent added @ 1 pbw on total resin + filler †	1 - 3 pbw
Pigment (if required)	2 - 5 pbw
Die temperature:	140°
(First section unheated to prevent gellation at die entrance)	
Start up	approx 0.2 metre/minute

It is recommended starting up with dry rovings in the die, then gradually increasing the wet-out of the rovings thus allowing simultaneous build-up of cured resin in the area of the pullers, thus ensuring grip is always adequate. (It is essential to ensure that there is never a situation of fully cured profile in the die and dry rovings in the gripper).

* A suitable grade of ATH used for pultrusion, or equivalent product with a median particle size of 2 microns.

Registered trademark of BYK-Chemie GmgH

‡ Perkadox and Trigonox are trademarks of Akzo Nobel Chemicals

† INT-PUL 341 is produced by Axel Plastic Research Laboratories, Inc.



CUSTOMER EXPERIENCES

BBVA headquarters saves energy using Crestapol® 1212 and Crystic® Fireguard 75PA (IMS)

Innova Composite is a leading Spanish composite parts manufacturer with a long established track record in supplying custom designed composite parts for construction infrastructure projects, as well as to other sectors including naval, aviation, automotive, rail and wind energy.

To meet the required UNE-EN 13501-1 fire standard for the building, the composite panels were vacuum infused using Scott Bader's matched fire retardant laminate system, comprising of Crestapol® 1212 high performance urethane acrylate resin with intumescent in-mould spray Crystic® FIREGUARD 75PA (IMS) EXCEL fire protection gelcoat.

"We had excellent technical support from Scott Bader in both materials selection of the intumescent FR gelcoat with Crestapol® 1212 resin and with help to optimise our infusion process at the high ATH filler level to achieve the EN 13501-1 FR specification to the requested B-s2 d0 level at a competitive part price."

Mr. Carles Gil, Technical Director for Innova Composite



INNOVA
COMPOSITE

Crestapol® Application Stories

CUSTOMER EXPERIENCES

Motorcycle Components Manufactured By ArianeTech Ingeniería, S.L.
Using Crestapol® 1250LV, Crystic® LS 97PA and Crestabond® M1-20

ArianeTech was first established in 2004 and today it is a leading engineering services company within the automotive, motorcycle and rail industries, specialising in the design and prototyping of motorcycles and scooters for a variety of high profile customers including Yamaha, Derbi and Rieju.

More recently ArianeTech produced the bikes for the Spanish Championship (Moto 3 and Moto 2).

The motorbike parts were manufactured by Karbonius using Crestapol® 1250LV high performance acrylic resin. The plugs and tools were manufactured by Skillful, LDA using a Rapid Tooling System and Scott Bader's Crystic® Gelcoat LS 97PA and Crestabond® M1-20.

"We appreciate the quality of laminates made by infusion with Crestapol® 1250LV, especially when it comes to the favourable mechanical properties. After several falls during the race tests, the parts made out of Crestapol® 1250LV did not break. Previously equivalent parts were made by hand from glass/polyester which meant that they were heavier and as a result broke easily during the same race tests."

In addition to the exceptional strength and durability of Crestapol® 1250LV, we also like the transparency of the parts which are made with the clear Crystic® Gelcoat LS 97PA, not to mention the easy to use Crestabond® M1-20."

Juanma Navarro (General Manager)



CUSTOMER EXPERIENCES

Pajares tunnel project manufactured using Crestapol® 1212

For over 15 years, TECNIPUL has specialised in the making of GRP (Glass Reinforced Plastic) profiles, specifically using the pultrusion manufacturing process. TECNIPUL has maintained a steady growth over the years and today, TECNIPUL has 15 production lines dedicated to producing pultruded profiles, totalling a combined surface area of 5,000m².

The Pajares corrugated tunnel plates (810cm wide) are made using pultrusion, with Crestapol® 1212 and 170pph ATH.

Crestapol® 1212 was selected because it achieves Bs2d0 (standard EN 13501), but also due to its inherent low water uptake. Crestapol® 1212's low water uptake is essential for this particular project, as TECNIPUL had previously experienced significant water permeation with their tunnels. Using Crestapol® 1212 has enabled the effective recovery of the water which previously leaked into the tunnels.

"Ever since we started working on the TECNIPUL project, we have worked very closely with Scott Bader. We have developed a fantastic partnership with Scott Bader for many years now and we are always confident that Scott Bader can provide us with the required technical support, expertise, advice and of course products which offer the necessary mechanical and FST properties. Overall, we consider Scott Bader to be an excellent partner for high tech composites projects."

Mr. Lluís Muxí, General Manager, TECNIPUL

BENEFITS/ ADVANTAGES

- › Represents the highest grade of fire resistant systems for the construction industry
- › Meets the highest fire standards globally, achieving M1/ F0, HL2, S4/ SR2/ ST2
- › Low water uptake due to the urethane acrylate technology
- › Easy to use in the pultrusion process as a highly filled resin
- › Extremely low viscosity



CUSTOMER EXPERIENCES

Carbon fibre parts for ambulances manufactured by FAIBER using Crystic Crestapol® 1250LV



FAIBER originally began operations in 1981 in Kinnahult, manufacturing items ranging from motorcycle fairings and bodies, to buggy cars. This soon developed into subcontract production for Swedish industrial companies and in the late 1980s, Faiber had its own production plant built in Skene.

Today, the premises have been extended and adapted to FAIBER'S needs, enabling the manufacturing of a large number of different components, from car fenders, boat hulls and advanced enclosures for prototypes, through to slides and ambulance body parts.

FAIBER only uses closed methods and RTM Light/ Vacuum Infusion for production due to high environmental values. Crestapol® 1250LV was chosen as an alternative to epoxy resin for the manufacture of their carbon fibre ambulance structures. This Scott Bader urethane acrylate resin technology is processed via an RTM/ infusion process and allows FAIBER to shorten cycle times and avoid elevated temperature post cure in the production of their high performance carbon composite products.

In addition to these benefits, the compatibility between Crestapol® 1250LV and polyester based systems opens up a range of high performance Iso-NPG gelcoats which were previously off limit to FAIBER.

"Scott Bader has been a supplier to us for more than 20 years and we have always found them to offer high quality products and a high quality service. Finding the new Crestapol® 1250LV product has enabled us to replace the epoxy we have been using in some of our products, which in turn has reduced the process time significantly. Scott Bader with its unique structure with commonwealth ownership, excellent products and its focus on innovation, gives us full long-term confidence where both the product and supplier relationship is concerned."

Susanne Svedberg, General Manager



CUSTOMER EXPERIENCES

Products Manufactured By Dongguan Country Business Plastic Hardware Company Crestapol® 1212

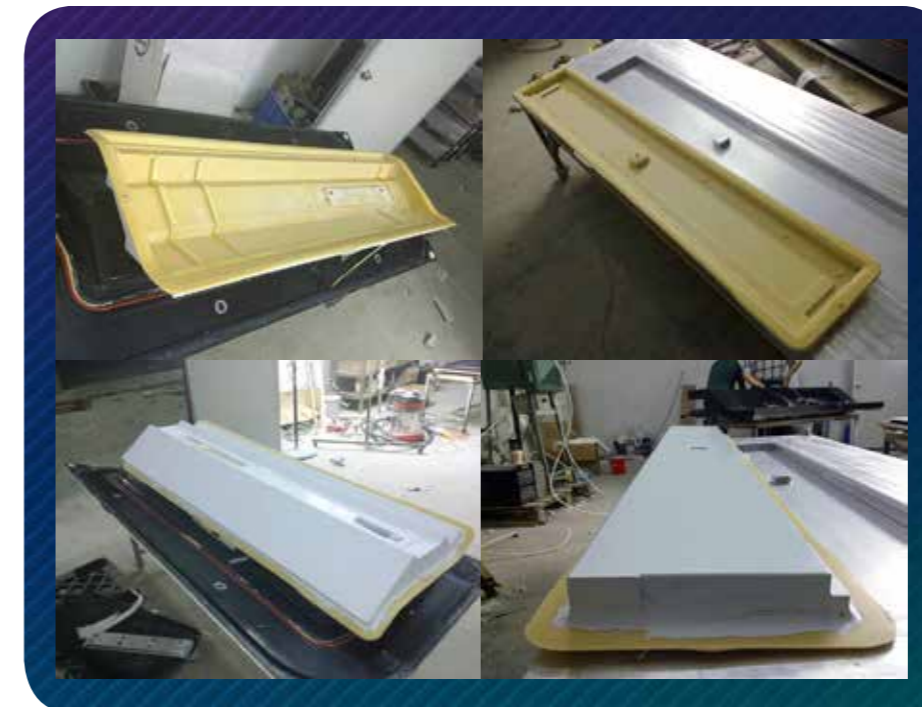
Dongguan Country Business Plastic Hardware Company (Country Business Limited) was founded in 2001 and today specialises in providing professional services from rapid prototyping and product development, to manufacturing.

With its 15,000 square meter factory located in China, Country Business is able to meet the needs of its customers from around the world, in a variety of industries including automotive and railway.

Application: Carrier cover board for CAF Europe train
FR Standard: French NFP 92-501 M1 F2
ATH Loading: 170 Parts ON904
Producing Process: Vacuum Assistant LRTM

"One of the reasons we chose to use Crestapol® 1212 is because it can be used for closed mould with gelcoats to achieve EN 45545 HL2, whereas other company resin systems are only suitable for HLU. Our workers are also happy to work with Crestapol® 1212 filled by 170 phr ATH, as it is possible to achieve FST, which removes the need to use phenolic in the plant. We also chose to work with Scott Bader and Crestapol® 1212 because the FRP parts made by 1212 can be easily repaired, compared to phenolic which makes it impossible to repair parts with!"

Mr.Lai, Owner of Country Business



DONGGUAN COUNTRY BUSINESS
PLASTIC HARDWARE COMPANY

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