



Crystic Crestomer® Structural Adhesives

Range and Application Guide



Introduction

Crystic Crestomer® structural adhesives are used in a wide range of demanding applications in a variety of markets. The key features and benefits for customers are:

- **Improved structural performance.**
- **Productivity gains through significantly reduced construction times.**
- **Low VOC emissions.**
- **Considerable weight savings.**

Stronger Lighter Quicker Tougher

A Record of Achievement

The Crystic Crestomer pedigree was established over 25 years ago. The first commercial application for Crystic Crestomer adhesive was in the manufacture of minehunters. The unique properties of Crystic Crestomer ensured peel and crack resistance was significantly improved. Crystic Crestomer is the only successful material specifically designed to meet this demanding application.



Challenging Mindsets

Crystic Crestomer's outstanding performance record and unique properties have fundamentally challenged conventional thinking among moulders, who have been sceptical of the performance possibilities with adhesives. Freed from the constraints of traditional fabricating techniques, FRP moulders are now capitalising on the design flexibility and time and cost savings that structural adhesives can offer. Crystic Crestomer is now used in a wide range of demanding applications across the marine, transport, building and construction sectors of the FRP industry.

Princess Yachts International (front cover and above left) and the Vosper Thornycroft built minesweeper (above) all use Crystic Crestomer products for demanding structural bonding applications.

Chemistry and Bonding

The combination of strength, resilience and flexibility is due to the novel structure of urethane acrylate resins. The urethane component is fully reacted into the molecular backbone, thus contributing adhesive properties without the hazard associated with free di-isocyanates. The acrylate saturation and the styrene monomer impart thermoset characteristics. The backbone of Crystic Crestomers impart toughness strength and flexibility. The resulting balance of properties makes the Crystic Crestomer range ideal as a structural adhesive with the following features.

- **Excellent adhesion to substrates, fibres, core materials and cured laminates.**
- **Toughness, resilience and flexibility.**
- **Superior fatigue resistance compared to a typical flexible polyester.**
- **Cured with cobalt and amine accelerators and conventional peroxide catalysts.**
- **Low exotherm and high strength even in thick sections.**

The curing characteristics of Crystic Crestomer adhesives have been designed to be as similar as possible to the curing characteristics of unsaturated polyester resins. Currently cobalt/MEKP and amine/BPO curing systems are available to initiate the cross-linking reaction between styrene monomer and the unsaturated urethane-acrylate polymer chain at room temperature.

The effectiveness of the adhesive bond depends upon the:

- **Surface conditions and the surface energy of the substrates being joined.**
- **Ability of the adhesive to thoroughly wet the substrate surfaces at a micro, or even, a molecular level.**
- **Ability of the adhesive to cure with minimal shrinkage, hence, reducing the level of induced stresses in the bond-line during the curing process.**
- **Ability of the adhesive to chemically bond to the substrates.**

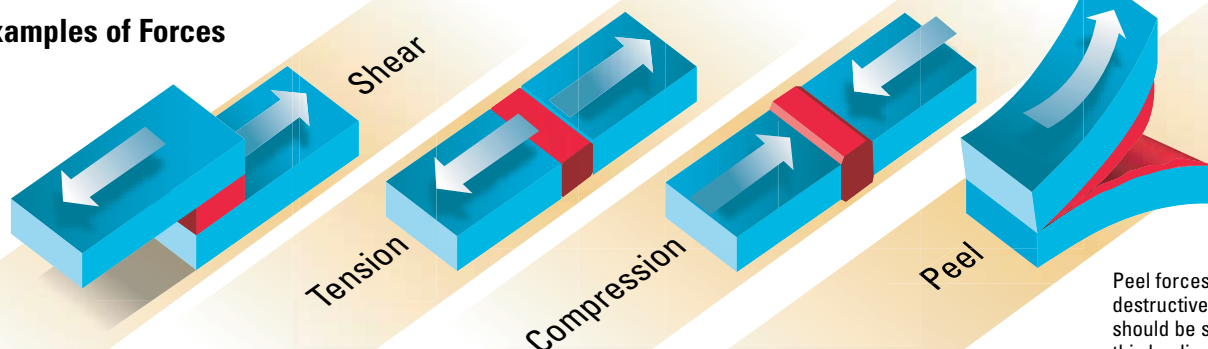
Crystic Crestomer adhesives have been designed with the above factors in mind and utilise both polyurethane and acrylic technologies, which form the basis of two families of adhesives in their own right. The benefits of these adhesives are combined in Crystic Crestomers.

Crystic Crestomer adhesives readily wet substrate surfaces and because they contain low cross-link density, induced bond-line stresses are minimised. The cross linking is such that optimum mechanical performance is achieved within the adhesive itself, so reducing the possibilities of cohesive failure within the Crystic Crestomer adhesive.

Bonds and Bond Strength

Bonded joints can be subjected to a variety of forces (see below). It is, therefore, essential to take into account the design requirements of bonded joints with respect to these forces. A bonded joint should be designed to meet the most severe loading case with an adequate factor of safety. The resistance of the joint and the adhesive to peeling forces generally limits composite bonded joints. In terms of the joints and adhesives resistance to loads, peel forces are the most destructive, followed by shear loads and tensile loads. Bonded joints are generally very resilient to compression loading conditions. Hence, joint design is as much a contributor to successful bonded joint performance as the properties of the adhesive itself.

Examples of Forces



Peel forces are very destructive and joint design should be such as to minimise this loading condition.

Product Range Overview

Crystic Crestomer Product	Description	Approvals	Appearance	*Gel Time (mins)	Tensile Strength (MPa)	Tensile Modulus (MPa)	Elongation at Break (%)	Performance Characteristics
1152PA	High Performance Structural Adhesive	Lloyds Acceptance DNV RINA	Mauve Gel	*50	26	1400	100	Structural adhesive for demanding applications
1153PA	High Performance Structural Adhesive With Long Open Time	Lloyds Acceptance	Mauve Gel	*90	26	1400	100	Long gel time structural adhesive for demanding applications on large components
1186PA	Multi Purpose Structural Adhesive	Lloyds Acceptance	Grey Paste	*50	14	800	6	High strength gap filling adhesive
1196PA	Structural Core Bonding Adhesive	Lloyds Acceptance DNV RINA	Pink Paste	*50	20	1300	4	Low density adhesive specifically developed for demanding core bonding applications
1151A	Advantage Adhesive for Bulk Application. Amine Accelerated	Lloyds Acceptance RINA	Green / Yellow Gel	**25	22	500	>100	Structural adhesive for demanding applications
Advantage 30	High Performance Structural Adhesive Pre-Packed in Cartridges	Lloyds Acceptance DNV RINA	White Paste	30	15	340	>85	High performance structural adhesive for convenience and flexibility

*2% Butanox® M-50 at 25°C **2% Perkadox® BT-50 at 25°C

Packaging and Equipment

The Crystic Crestomer range is available in kegs (pails) with some products also supplied in drums. Crestomer Advantage 30 is packed in 380ml cartridges. Manual and pneumatic guns plus static mixers are also on the product range.



Bond Strengths with Different Substrates

Crystic Crestomer can be used to bond many substrates. The following tables give typical examples of bond failure rates and types of failure observed when bonding various substrates with different products from the Crystic Crestomer range.

All figures shown are for lap shear strengths (MPa)

Crystic Crestomer 1152PA	Results achievable with Crystic Crestomer Advantage and Crystic Crestomer 1153PA are similar to those shown right			
	FRP	Marine Ply	Aluminium	Stainless Steel
FRP	10	-	-	-
Marine Ply	-	5	-	-
Aluminium	-	-	15	-
Stainless Steel	-	-	-	12

Crystic Crestomer 1186PA	Results achievable with Crystic Crestomer Advantage and Crystic Crestomer 1153PA are similar to those shown right			
	FRP	Marine Ply	Aluminium	Stainless Steel
FRP	10	-	-	-
Marine Ply	-	5	-	-
Aluminium	-	-	10	-
Stainless Steel	-	-	-	8

Crystic Crestomer 1196PA	Results achievable with Crystic Crestomer Advantage and Crystic Crestomer 1153PA are similar to those shown right	
	Balsa	PVC Foam (80kg/m3)
FRP	10	6

Substrate Failure
 Cohesive Failure

Fillet joints constructed using Crystic Crestomer 1152PA are stronger and aesthetically superior to FRP laminated joints as well as being quicker to manufacture and giving far lower styrene emission.

There are three different ways in which a joint can fail.

Substrate failure

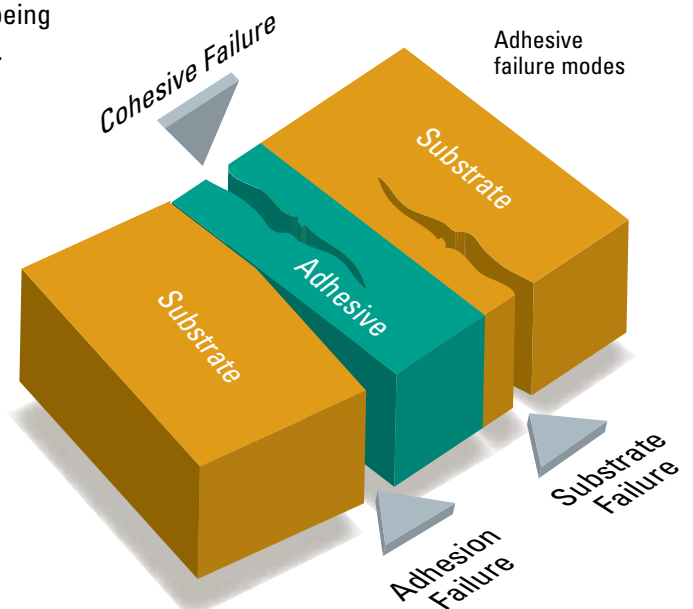
indicates that the adhesive is stronger than the materials being bonded together.

Cohesive failure

is a failure of the bulk adhesive itself and is characterised by a film of adhesive being left on both sides of the failed bond.

Adhesive failure

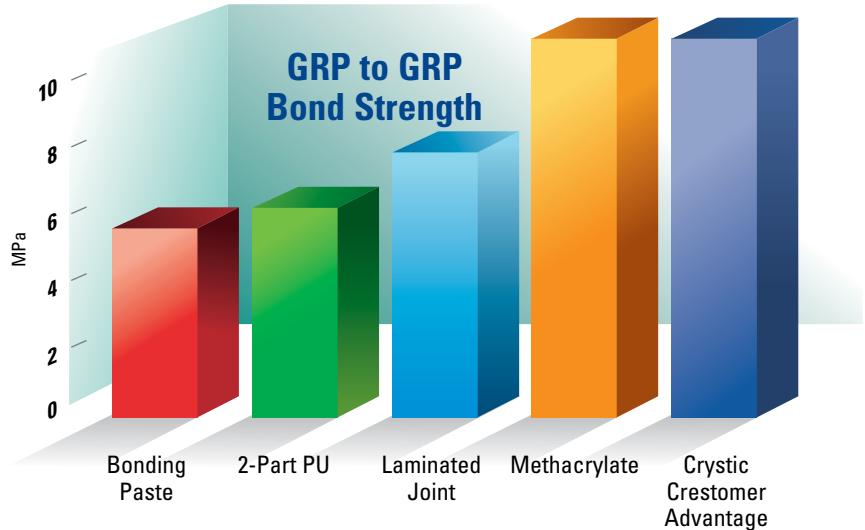
occurs in the bond line between the adhesive and substrate and is characterised by the film of adhesive being left on one side of the failed joint.



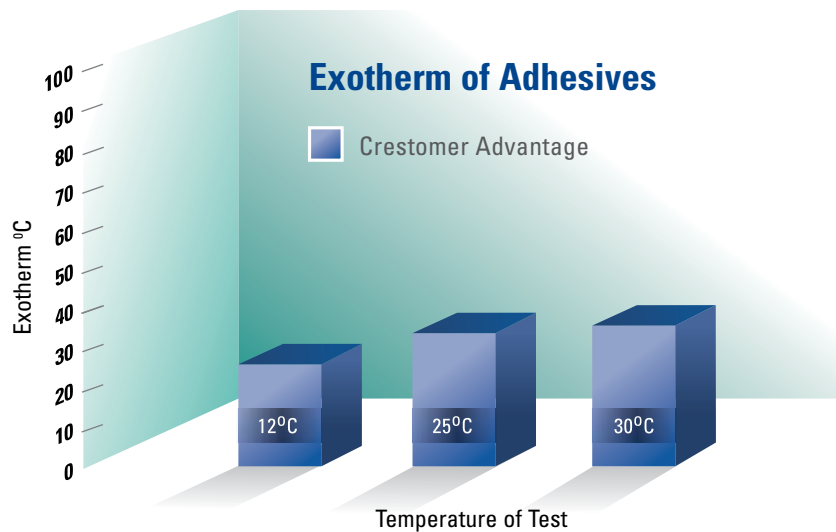
Comparisons with Competitive Materials

Crystic Crestomer adhesives are one of a wide variety of materials that can be used to bond substrates. Compared to other adhesives, Crystic Crestomers offer the following benefits:

- **Monomer type identical to polyester resins.**
- **Cured with conventional peroxides.**
- **Low exotherm during cure.**
- **Available in a range of gel and curing times.**
- **Ease of application.**
- **Cost effective.**



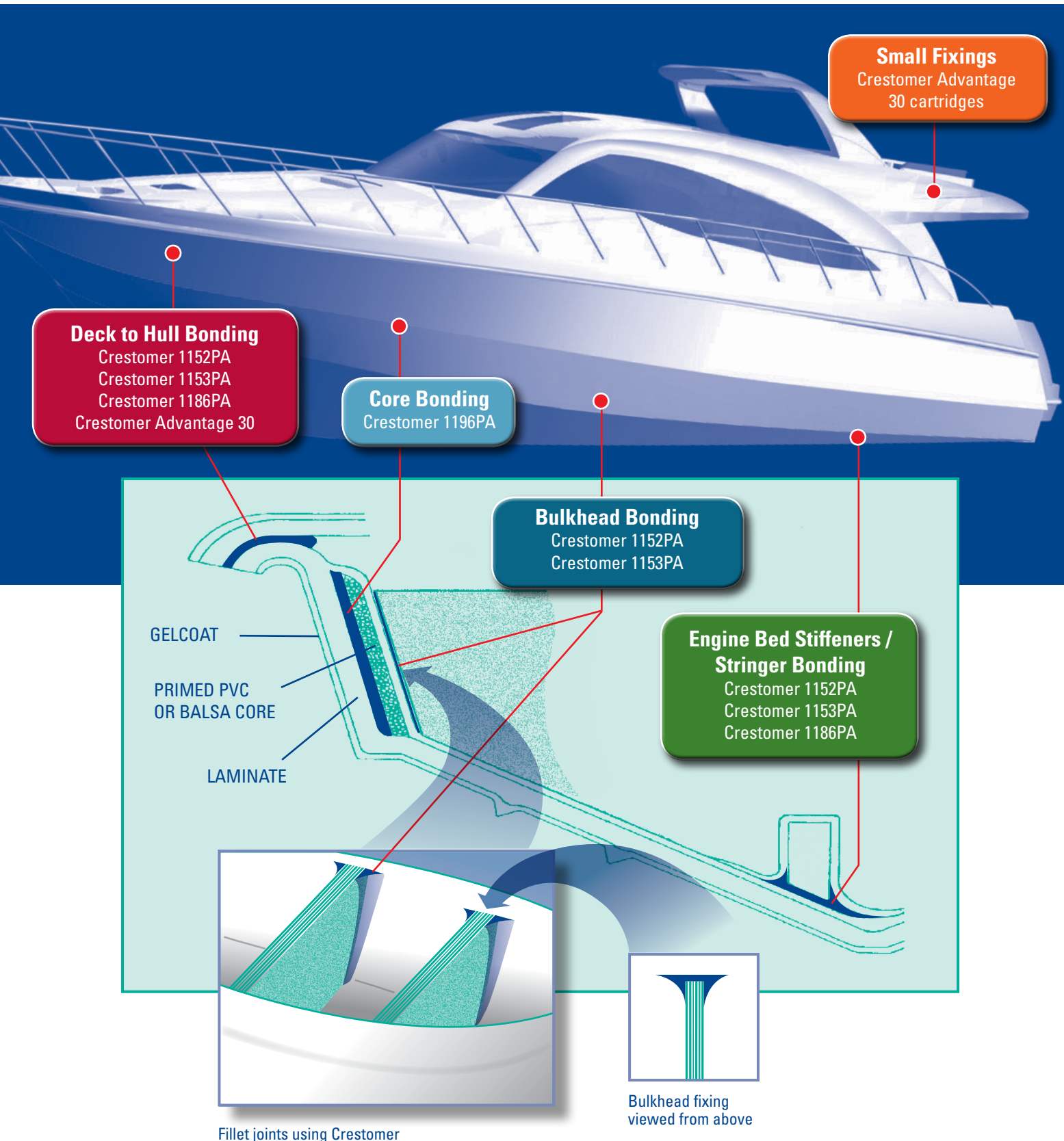
High exotherm in an adhesive can cause the substrate to distort and give poor aesthetic characteristics to the parts being bonded. The chemistry of Crystic Crestomer adhesives ensures that high exotherm temperatures, a characteristic of some other adhesives do not occur. The graph shows the exotherm temperatures of Crystic Crestomer adhesives over a range of test temperatures.



Crystic Crestomers in Action

Marine

Crystic Crestomer products have been successfully used by leading European boatbuilders to improve the performance of their products, to make productivity improvements through time savings in construction and to provide considerable weight savings. The following diagram shows areas where Crystic Crestomer structural adhesives can be used in FRP boatbuilding.



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