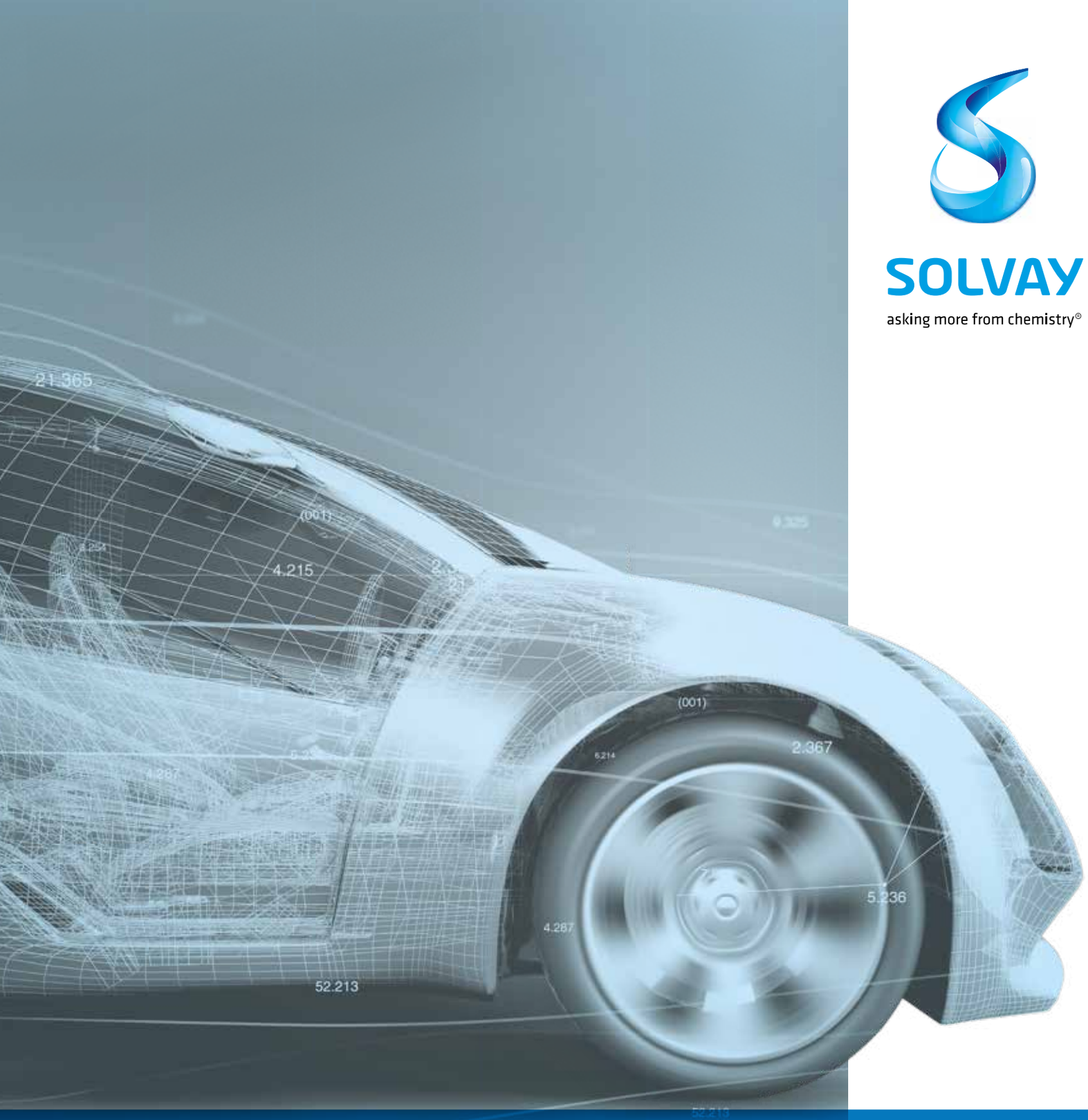


SOLVAY

asking more from chemistry®

Composite Materials for Automotive Applications

COMPOSITE MATERIALS

more performance. Advanced material solutions for the manufacture of lightweight, high performance and complex structures.

A world leader in composite materials for structural applications, Solvay proactively develops innovative and class-leading material systems to meet the needs of the Automotive OEMs and their supply chain, creating solutions for weight and emission reduction, recyclability and pedestrian protection.

Solvay, the partner of choice for the Automotive market

The Automotive industry faces many challenges: improving energy efficiency, reducing vehicle emissions, increasing safety and appeal at reduced program cost. Solvay's composite material scientists, Automotive experts and application engineers work with you to address these tough challenges and to create and refine, industry-leading solutions of the highest standards.

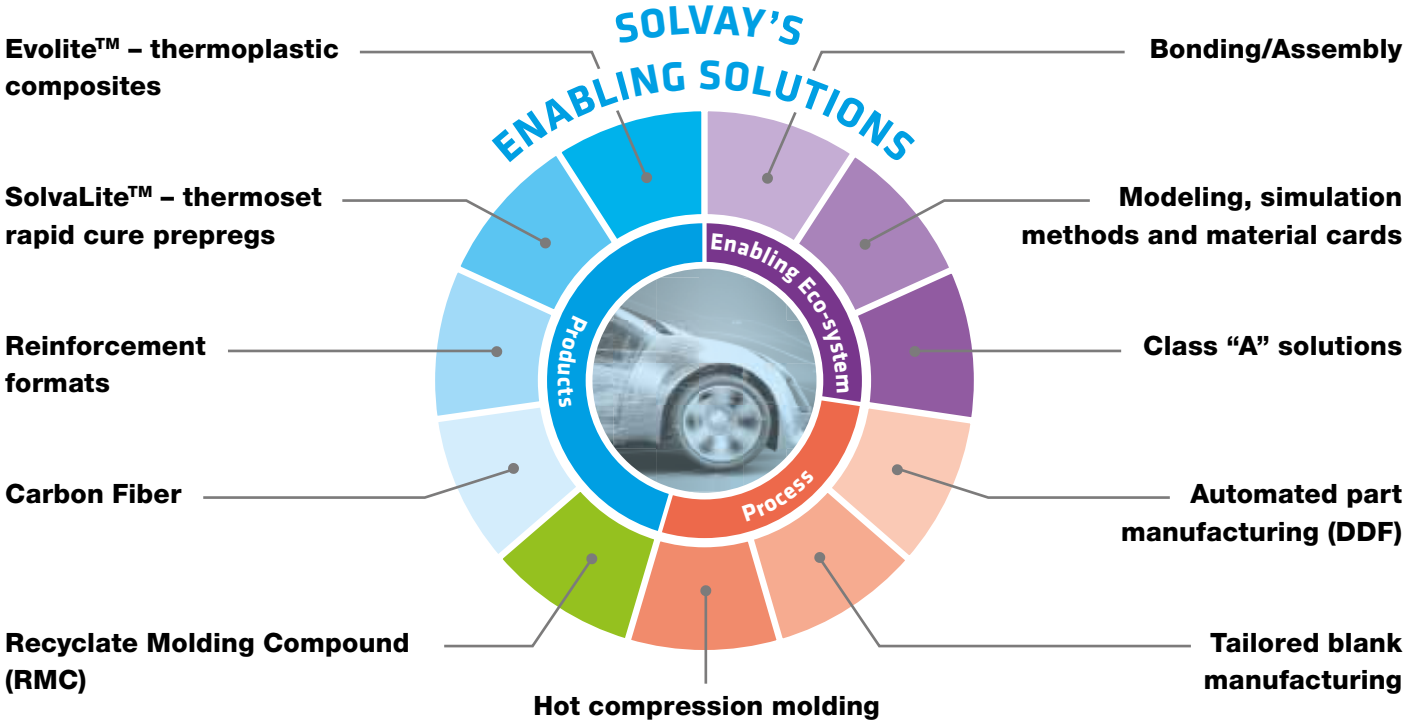
Whether your goal is to reduce the vehicle mass or develop a new design for your vehicles, Solvay works collaboratively to deliver the optimum solution for you:

- Large and robust product portfolio offering lightweight, cost-effective, multi-material technology solutions.
- Compatible surfacing films.
- Industry leading rapid cure resin systems for hot compression molding.
- Materials for structural Body In White structures, body panels and visual components.
- Materials compatible with automation systems and rapid processing.
- Strategic collaborations with OEMs and Tier 1 while being strongly integrated.

SERIAL AUTOMOTIVE

Solvay is leading the adoption of composite materials in serial automotive for structural and bodywork applications, through differentiated material solutions that address Total Cost of Ownership reduction.

We have developed solutions to support the drive for lightweight, cost – effective, multi-materials vehicle solutions to meet the needs of the automotive OEMS for high volume manufacture.



We continue to refine our portfolio of materials and process technologies tailored to automotive applications to enable volume ramp up, robustness and scalability.

Our leading application engineering capabilities combine expertise in materials, technologies and processes to meet our customers' needs.

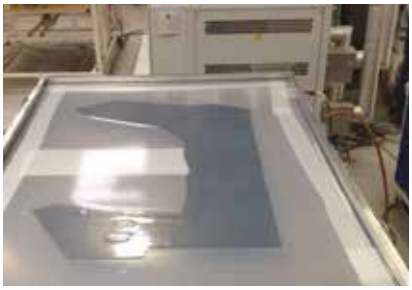
AUTOMATED PART MANUFACTURING

KEY BENEFITS

- Increased throughput
- Enables single minute Takt times
- Suitable for hot compression molding and performing
- Automated ply cutting combined with robotic pick and place builds a tailored flat blank
- No internal or external release agent (ideal for painting or bonding operations)
- No human interaction
- Diaphragm forming of the blank aids fiber draping by maintaining a consistent pressure and tension during 3D forming
- Enables complex 3D geometries to be formed in a single process step, without preforming
- Flexible cell equipment can support multiple components with a tool and program change

MANUFACTURING ROUTE:

COMPOSITE MANUFACTURE → TAILORED BLANK MANUFACTURE → DIAPHRAGM FORMING OF 2D BLANK INTO 3D PART → COMPRESSION MOLDING



Tailored blank sandwiched between two diaphragms

Finished part

TYPICAL APPLICATIONS:
Serial production of automotive structural parts up to 80,000 components per year from a single manufacturing line. Floor pans, sidewall panels, crush cans, body panels.

APPLICABLE RANGE

- SolvaLite™ 23, SolvaLite™ 710-1, SolvaLite™ 712, SolvaLite™ 730 and SolvaLite™ 760 rapid cure materials.
- Double Diaphragm Forming membrane material, combining excellent 3D forming with self releasing properties.
- Dry fabrics for HP-RTM preforms using SolvaLite™ 750.

THERMOSET HOT COMPRESSION MOLDING

KEY BENEFITS

- Single step molding process
- Use of existing automotive pressing supply chain equipment
- Mechanical performance equivalent to autoclave cured components
- Allows rapid processing of composites through short cures
- Reduced tooling investment when compared with sheet metal stamping
- Process can be easily automated

Chevrolet Spark EV battery tray manufactured from SolvaLite™ 23

Complex 3D component manufactured from SolvaLite™ 710-1

A Pillar manufactured from SolvaLite™ 730

Bulkheads manufactured from SolvaLite™ 710-1

BMW M4 GTS hood manufactured from SolvaLite™ 760

B Pillar manufactured from SolvaLite™ 730

TYPICAL APPLICABLE RANGE

Products	Product form	Reinforcement	Tg (DMA Onset) °F (°C)	Application
SolvaLite™ 23	Prepreg	Glass fiber	Low: 170 (77)	Secondary structures
SolvaLite™ 710-1	Prepreg	Carbon or glass fiber	High: 302 (150)	BIW structures/closures
SolvaLite™ 712	Prepreg	Carbon fiber	High: 170	Class A/ BIW structures/closures
SolvaLite™ 730	Prepreg	Carbon or glass fiber	Medium: 266 (130)	BIW structures
SolvaLite™ 760	Filament winding	Carbon fiber	Medium: 257 (125)	BIW closures

TYPICAL APPLICATIONS:

Mass production of primary and secondary automotive structures.

THERMOSET HOT COMPRESSION MOLDING

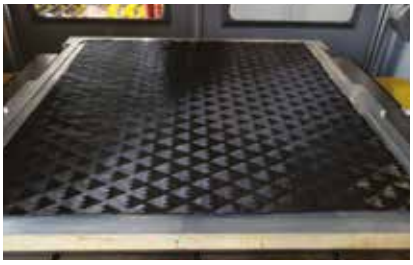
HOT COMPRESSION MOLDING ADDRESSES HIGH LEVEL MANUFACTURING CHALLENGES

Challenges	Solutions
Infrastructure and supply chain	**Materials and processes developed for use with existing equipment and expertise within the automotive supply chain.**
Tooling capex	**Significantly lower tooling investment compared with current metal BIW structures.**
Quality	**Industry leading mechanical performance and quality.** • Induces high hydrostatic pressure ~10-50bar (<6bar autoclave). • Low resin loss (<10%) with V_f (50-60%). • High quality surface finish and low porosity (<1%). • Tg develops ahead of the cure, allowing hot demolding and stable components. **In-situ cure monitoring and rapid data capture for cycle time optimization and quality control.** • Resin ionic viscosity monitoring and cure conversation analysis through the use of Dielectric sensors (DEA). • Optional built-in sensors for accurate surface pressure and temperature monitoring.
Cycle time	**Sub 3 minute cure time.** **Sub 5 minute takt time potential.**
Process repeatability	**Highly automatable and compatible with existing robotic and automation technologies.**
Process complexity	**Single stage manufacturing process compared to metal molding.** **Isothermal tooling requires no thermal cycling.** **Demold hot with industry standard ejection.**

AUTOMATED FILAMENT WOUND TAILORED BLANK MANUFACTURE WITH SOLVALITE™ 760

KEY BENEFITS

- Flat blanks can be pressed to make parts in a similar manner to metal pressing (this enables the use of existing capital equipment)
- Filament winding has been identified as a low cost process for making a flat, multi ply, continuous fiber blank
- Process uses cost-optimized raw materials, carbon fiber and resin. Consumables used in prepreg manufacture (poly, paper, etc.) are reduced
- One process for impregnating and building up multi ply blank
- Mechanical properties comparable to prepreg
- High drapability
- Automatable
- Unique visual appearance



Tailored blank before compression molding

Stamping of the blank in a two-sided metal mold using a hydraulic press

TYPICAL APPLICATIONS:
Serial production of automotive parts similar to sheet metal forming.

AUTOMATED FILAMENT WOUND TAILORED BLANK MANUFACTURE WITH SOLVALITE™ 760

CASE STUDY 1: CAR DOOR

Door inner frame after pressing

Trimmed door inner component

MUTE car

CASE STUDY 2: CAR HOOD

Car hood after pressing

Trimmed inner hood component

BMW M4 GTS car

HIGH PRESSURE RESIN TRANSFER MOLDING (HP-RTM) WITH SOLVALITE™ 750

KEY BENEFITS

- Total cycle time of sub 5 minutes
- 2 minute cure capability at 130°C
- 140°C Tg allows for hot-demolding
- Highly tough resin offering benefits such as durability and impact resistance
- Reduced void content when compared to traditional RTM
- Low initial viscosity allows for full wet-out prior to resin cure
- Excellent structural performance
- Fully automatable process (from preforms through to post-mold processing)
- Internal release agent compatible

Press in Application Center

HP-RTM equipment in Application Center

Car floor manufactured from SolvaLite™ 750

TYPICAL APPLICATIONS:

High rate manufacture of body structure components such as floor pans, sidewall panels, crush cans, bulkheads.

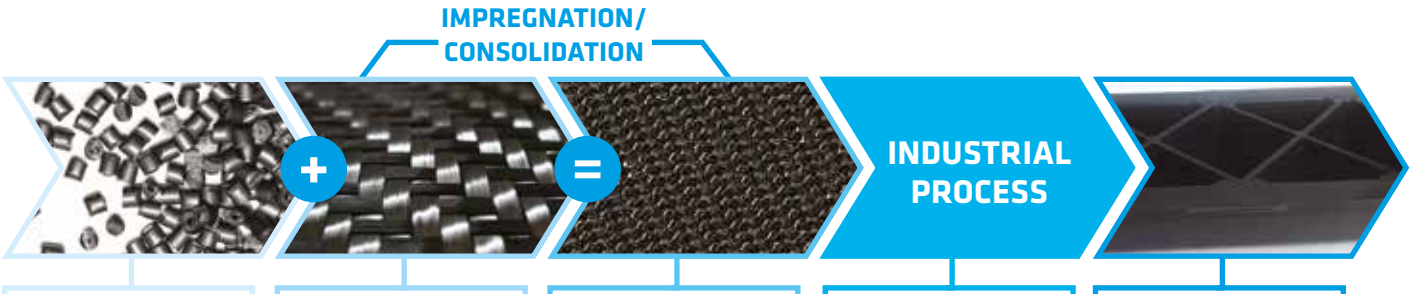
EVOLITE™ – THERMOPLASTIC COMPOSITES

THE FUTURE IS LIGHTWEIGHT

Evolite™ is Solvay's high-end patented thermoplastic product range for composite applications.

Evolite™ is designed for use in ultra-lightweight composite materials and offers outstanding mechanical properties.

Evolite™ thermoplastic composites are available as unidirectional tapes as well as woven and cross-ply laminates on glass, carbon or any other continuous fiber.



EVOLITE™ RESIN

- PA66
- PPS
- PPA

REINFORCEMENT

- Glass
- Carbon

SEMI-FINISHED PRODUCT

- Uni-directional tape
- Woven or cross-ply laminate

INDUSTRIAL PROCESS

- Stamping
- Thermoforming
- Overmolding
- Tape placement
- Tape winding

FINISHED PRODUCT

- Seats
- Beams and pillars
- Chassis components
- Transmission parts
- Floor and roof structures
- Doors

Evolite™ Features

- Overmolding; function integration
- Outstanding crash capabilities
- Reformable and recyclable
- Infinite shelf life
- NVH performance

HIGH PERFORMANCE LOW VOLUME AUTOMOTIVE

SOLVAY IS THE LEADING SUPPLIER OF MATERIALS FOR HIGH-PERFORMANCE AUTOMOTIVE APPLICATIONS:

- Lightweight and high-performance material solutions
- Surfacing films and fast cure resin systems for press, traditional vacuum bag and autoclave processing
- Focused on developing automation-ready materials and processes
- Materials for primary and secondary structures, high temperature and impact applications, body panels and visual components
- Strategic collaborations with Tier 1 & OEMs

STRUCTURAL MATERIALS

- Thermoset composites - epoxy, phenolic, BMI, cyanate ester matrices
- A range of reinforcements and product formats - uni-directional, non-crimp fabrics, woven fabrics and DForm cross plied and tailored blanks
- Complete material characterization capability, (mechanical testing, CAI FMBAI, TMA, Rheology, DSC, C-Scan, image analysis...)
- In-house prototype and application engineering capability through our dedicated application center, composites design engineering, laminating analysis and process development
- Experienced project engineers
- Accredited quality assurance

Composite Materials Product Selector Guide

	Structure					Trim			
Products	Primary	Secondary	High Temp	Impact	Body Panels	Exterior	Interior	**Processing**	**Tg (DMA Onset) °F (°C)**
CYCOM® 2020	●	●			●			Press/Autoclave	356 (180)
MTM® 49-3	●	●						Press/Vacuum/Autoclave	374 (190)
MTM® 58B and FRB	●	●			●			Press/Autoclave	284 (140)
CYCOM® 997	●	●	●					Press/Autoclave	428 (220)
MTM® 28		●		●				Press/Autoclave	212 (100)
MTM® 228		●		●				Press/Autoclave	248 (120)
MTM® 57		●				●	●	Press/Autoclave	230 (110)
LTM® 26 LTM® 26EL						●	●	Press/Autoclave	464 (240)
BPS 240 format 1					●			Press/Vacuum/Autoclave	325 (163)
VTF® 266 (surface film)					●			Vacuum/Autoclave	311 (155)

HIGH PERFORMANCE LOW VOLUME AUTOMOTIVE

PROCESS MATERIALS

- Comprehensive range of composites processing materials optimized for the high-performance Automotive market
- Tailor-made kitted solutions which offer time and cost savings through excellent process repeatability and reduced wastage
- Single-use tailored vacuum bags through to reusable vacuum systems, including standard and heated bag solutions, enabling us to provide innovative curing technology to support autoclave and oven vacuum bag prepreg molding, thus offering reduced costs by lowering cycle times and energy consumption

Process Materials Product Selector Guide

Prepreg product °F (°C)	Bagging film	Release film	Sealant tape	Peel ply	Breather	Flash tape
250 (120) Epoxy OOA and in-autoclave	HS8171 VF450V	A5000 A6200	UCS180	A100 B100	AB100 AB10	FT1
350 (180) Epoxy OOA and in-autoclave	HS8171 VF800G SV3000	A5000 A6200	SM5142	A100 B100	AB100 AB10	FT1

COMPOSITE TOOLING

- Tooling prepregs - Epoxy and BMI. Solvay's prepregs offer outstanding surface finish and longevity for the manufacture of complex mold tools
- Our design service can support tool design optimization to ensure a fit-for-purpose solution
- Soft tooling technology including reusable vacuum bags, integral heater blankets, intensifiers and caul sheets

For all the details on our tooling offer, refer to the Tooling brochure or visit www.solvay.com

Composite Tooling Product Selector Guide

	Product Form	Out Life (days)	Service Temp. °F (°C)	Cure Flexibility/Recommended Cure °F (°C)	Cure Method
DForm® Fabric	Epoxy Prepreg	3	356 (180)	8 hours at 140°F (60°C). Post-cure 15 minutes at 392°F (200°C) plus 8 hours at 374°F (190°C)	Autoclave
LTM® 12	Epoxy Prepreg	3	356 (180)	70 hours at 86°F (30°C) or 5 hours at 158°F (70°C). Post-cure 15 minutes at 392°F (200°C) plus 8 hours at 374°F (190°C)	Autoclave
1-5-1 systems*	Epoxy Prepreg	2	356 (180)	8 hours at 140°F (60°C)	Autoclave
Duratool® 450	BMI Prepreg	45	374 (190)	6 hours at 350°F (177°C). Post-cure 6 hours at 440°F (226°C)	Autoclave

* Faster lay-up

SOLVAY APPLICATION CENTER

Our Application Center in Heanor, UK was set up to develop new composite products and technologies to meet the affordability and high-rate needs of the serial automotive industry.

Currently, the team is concentrating on increased automation for the manufacture and conversion of 2D flat blanks into complex 3D geometries, liquid molding, as well as improving material utilization and reducing or reusing scrap materials.

Please contact us to find out more about the center and to understand how our highly skilled engineers can support your project.

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