

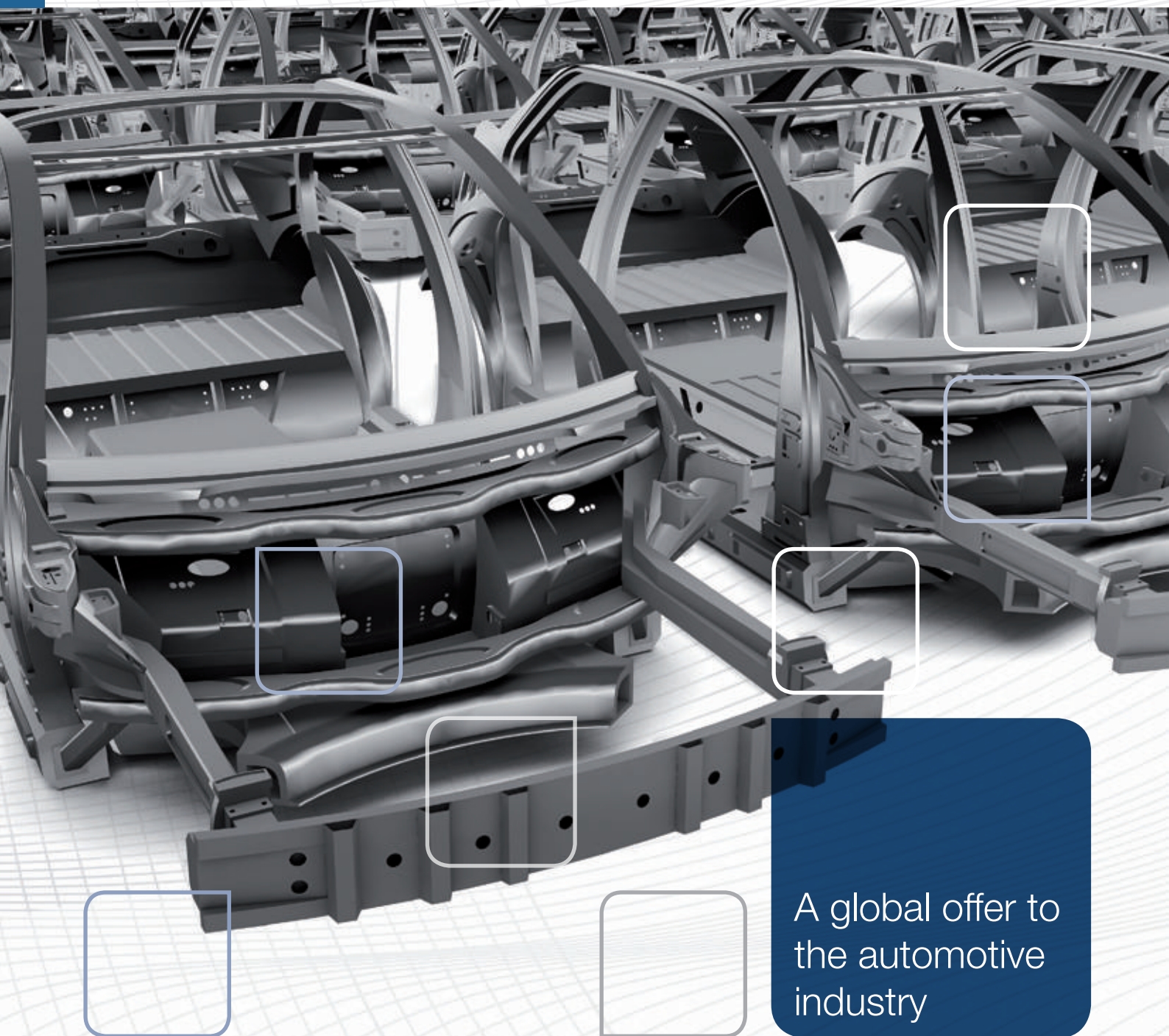
Advanced Materials

HUNTSMAN

Enriching lives through innovation

Araldite®

Composites technology for mass production



A global offer to
the automotive
industry

A new step forward in composites mass production

Huntsman Advanced Materials brings the next step change in composites technology, allowing part production time in just 1 min. With the release of a new global offer for the automotive industry, Huntsman meets demands for faster processing and reduced composite production cycles.

Preforming solution

Araldite® LT 3366 preforming solution

Epoxy binder qualified for mass production of powdered fabrics and preforms ⁽¹⁾

- > High softening point preventing ply-to-ply adhesion during storage and fiber distortion during injection
- > Fast preforming cycle

Softening point	ca. 150 °C
DSC Tg mid-point	75 - 85 °C
Typical preforming cycle	20 ± 10 s at 180 ± 20 °C + cold stamping

(1) Typical preforming conditions: cold pressing after infra-red heating

(2) Data generated with 1-2phr internal release agent

(3) 5°C/min

(4) Torsion mode, 2°C/min

(5) 50K UD, TVI 50%

Building on BMW «i» experience

The new epoxy solutions are built on the first generation Araldite® LY 3585 / Hardener XB 3458 and Araldite® LT 3366, qualified for the first mass produced automotive carbon composites application (BMW «i» program).

Very fast curing solutions designed for highly structural applications

In addition to providing the required process latency, the new solutions exhibit very fast demolding stiffness development, enabling drastic reduction in cure time. Their high elongation at break make them ideal solution for impact resistant composite part production.

Araldite® LY 3031 / Aradur® 3032 ⁽²⁾ For Wet Compression Molding



Tensile modulus ISO 527-2 on neat resin	2 650 - 2 850 MPa
Tensile strength ISO 527-2 on neat resin	70 - 80 MPa
Tensile elongation ISO 527-2 on neat resin	5 - 7 %
DSC Tg midpoint ⁽³⁾ ISO 11357-2 on CFRP	110-120°C
DMA Tg onset ⁽⁴⁾ ISO 6721 on CFRP	95 - 105 °C
ILSS ⁽⁵⁾ ASTM D2344 on CFRP	63 - 67 MPa

Araldite® LY 3585 / Aradur® 3475 ⁽²⁾ For RTM / Wet Compression Molding

Tensile modulus ISO 527-2 on neat resin	2 700 - 2 900 MPa
Tensile strength ISO 527-2 on neat resin	75 - 80 MPa
Tensile elongation ISO 527-2 on neat resin	8 - 10 %
DSC Tg midpoint ⁽³⁾ ISO 11357-2 on CFRP	120-130°C
DMA Tg onset ⁽⁴⁾ ISO 6721 on CFRP	105 - 115 °C
ILSS ⁽⁵⁾ ASTM D2344 on CFRP	56-60 MPa

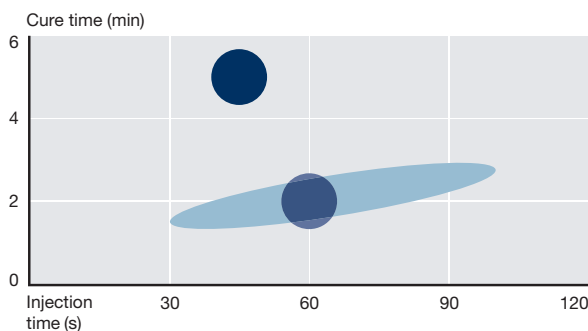
Aradur® 3475 hardener platform

The ideal reactivity for each part

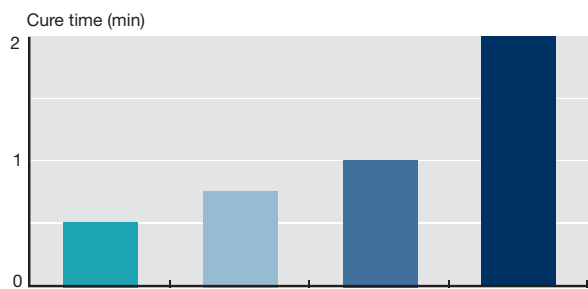
The hardener reactivity can be adjusted to optimize part production time without influencing mechanical performance:

- > HP-RTM: injection time optimization to different part size
- > WCM: very fast cure (no injection latency required)
- > Prototyping: using low temperature molding (standard RTM)

HP-RTM - Cure time versus injection time at 115°C (Reference at 100°C)



Wet compression molding - Cure time at 140°C



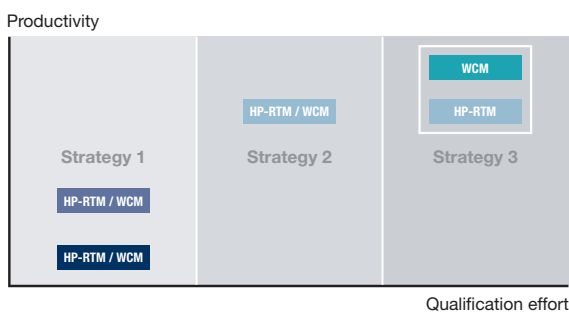
Optimizing productivity and qualification

The ideal strategy for each program

Depending on HP-RTM part size and the number of HP-RTM / WCM parts to produce, different strategies can be followed to optimize productivity and qualification cost:

- > **Strategy 1** One system for all (single product)
- > **Strategy 2** One platform for all (Aradur® 3475 hardener platform)
- > **Strategy 3** Two or more products

Strategies for composites production



Araldite® LY 3031 / Aradur® 3032

For Wet Compression Molding



Araldite® LY 3585 / Aradur® 3475

For RTM / Wet Compression Molding

Araldite® LY 3585 / Aradur® 3475 hardener platform

The ideal reactivity for each part

Reference: Araldite® LY 3585 / XB 3458

First generation fast cure system built for BMW «i»



Insert

Close

Cure

Demold

New Dynamic Fluid Compression Molding (DFCM) process

Autoclave quality in 1minute

Combining a novel process and fast-cure Araldite® epoxy solutions, highly structural parts with outstanding properties can be produced in 1 minute.

This process is simple, fast and cost effective, requiring low pressure (typically 30 bar) and often removing the need for a fiber preform.

Exceptional benefits versus standard wet compression molding: outstanding mechanical performance thanks to fiber volume content up to 65% in a low wastage process, simple processing, even with heavy-tow industrial reinforcements, void-free parts produced consistently straight from the mold.

NEW exclusive DFCM process

- > Fiber volume content up to 65%
- > Void-free parts
- > Faster process vs. RTM
- > Simple processing of heavy-tow industrial fabrics
- > Pressure only 30 bar
- > Fiber wash eliminated
- > Low equipment investment
- > Reduced waste
- > Fiber preform not mandatory
- > Complex parts possible (medium draw or 2.5+D)
- > Consistent part quality



Simple and fast, the DFCM process bypasses the injection step and brings composites production cycle to just 1 minute.

HP-RTM



Low porosity, medium FVC (50%)

Standard WCM



High porosity, high FVC (60%)

New DFCM



Low porosity, high FVC (60%)

Consistent quality straight from the mold

Advanced Composites Process Simulation

The shortest possible manufacturing time

In our Composite's Centre of Excellence in Basel, advanced composites process simulation is used to design a production process tailored to each part.

Precise descriptions of the resin are used to generate material models (Figure 1) which are projected onto the CAD data. This enables prediction of the material behavior during the injection and curing process at each point on the composite part.

Resin cure is essential to overall process performance and cure simulation can substantially reduce part development time. Figure 2 shows a pressure vessel: during processing of thick-walled structures, temperature builds up due to the exothermic reaction. Using cure simulation, exotherm peaks can be predicted, simplifying process engineering and enabling selection of the correct resin system and process parameters.

In liquid composite molding, void free parts are key to maximum part performance. By applying flow simulation we support process engineers to evaluate injection strategies and to find optimum processing parameters to ensure complete filling of the part (Figure 3).

Resin selection, flow pattern, injection concepts and cure schedule: virtual process cycles are carried out to refine process design, ensure optimized mold layout and quickly identify ideal processing parameters.

Cure simulation

Predict	Support
> cure cycle time	> process parameter determination
> exotherm temperature	> resin system selection
> evolution of Tg and conversion	> process safety

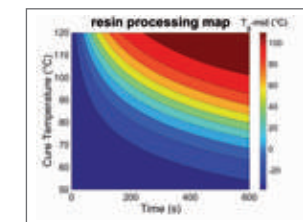


Fig. 1 Material model

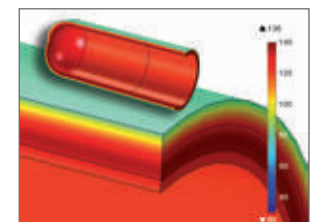


Fig. 2 Exotherm prediction

Flow simulation

Predict	Support
> flow front evolution	> injection strategy
> filling time	> inlet / outlet position
> pressure evolution	> early stage process design
> process induced filling variability (e.g. preferential flow channels, inserts)	

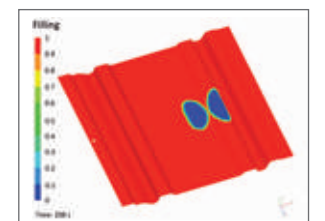
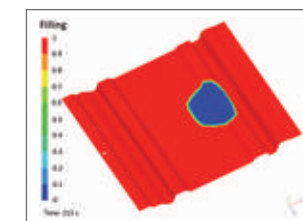


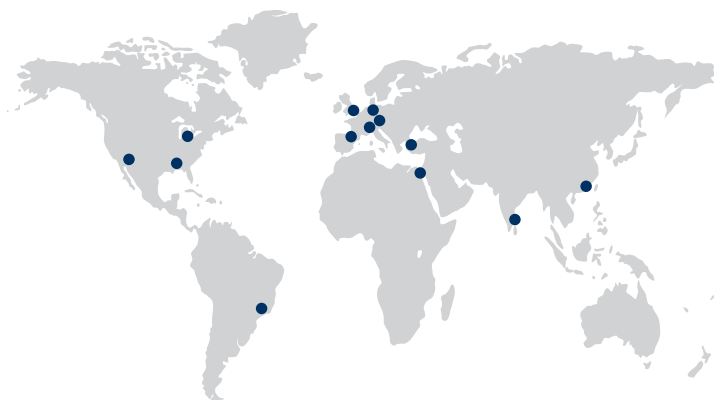
Fig. 3 Effect of process induced variation

Huntsman Advanced Materials

Our Advanced Materials division is a leading global chemical solutions provider with a long heritage of pioneering technologically advanced epoxy, acrylic and polyurethane-based polymer products.

Our capabilities in high-performance adhesives and composites, delivered by more than 1 600 associates, serve over 2 000 global customers with innovative, tailor-made solutions and more than 1 500 products which address global engineering challenges.

Global presence – 13 manufacturing sites



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