



Automotive Serial Production With ADVALITE™ Vinyl Hybrid Resins

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REICHHOLD

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- Summary

Reichhold is . . .

- One of the world's largest suppliers of unsaturated polyester resins for composites
- A market leader in resins for coatings and graphic arts
- Truly global, sourcing from 19 manufacturing sites in 12 countries (17 operated by Reichhold) and supported by 5 technology centers
- Serving more than 2000 customers in over 85 countries through a world-wide network of production facilities
- Headquartered in Durham, North Carolina, United States
- 1,300 + employees worldwide



World Headquarters and Technology Center in Durham, North Carolina, United States



Reichhold's team at Tianjin, China

Serial Automotive Requirements

- Automotive Market Needs:
 - Fast cure: 2 minutes
 - E-Coat capable HDT: > 160 C
 - Carbon fibre compatible: ILSS > 50 MPa
 - Automation capable
 - Room temperature storage (prepreg)
- **ADVALITE™** meets the market needs.

Requirement	ADVALITE™	Epoxy
Fast Cure	2 minutes	Challenge
HDT	> 160 C	> 160 C
EHS profile	Very good (*)	Depending the system
Storage Temp/Time	Ambient / “1 Year”	Refrigeration/ Limited

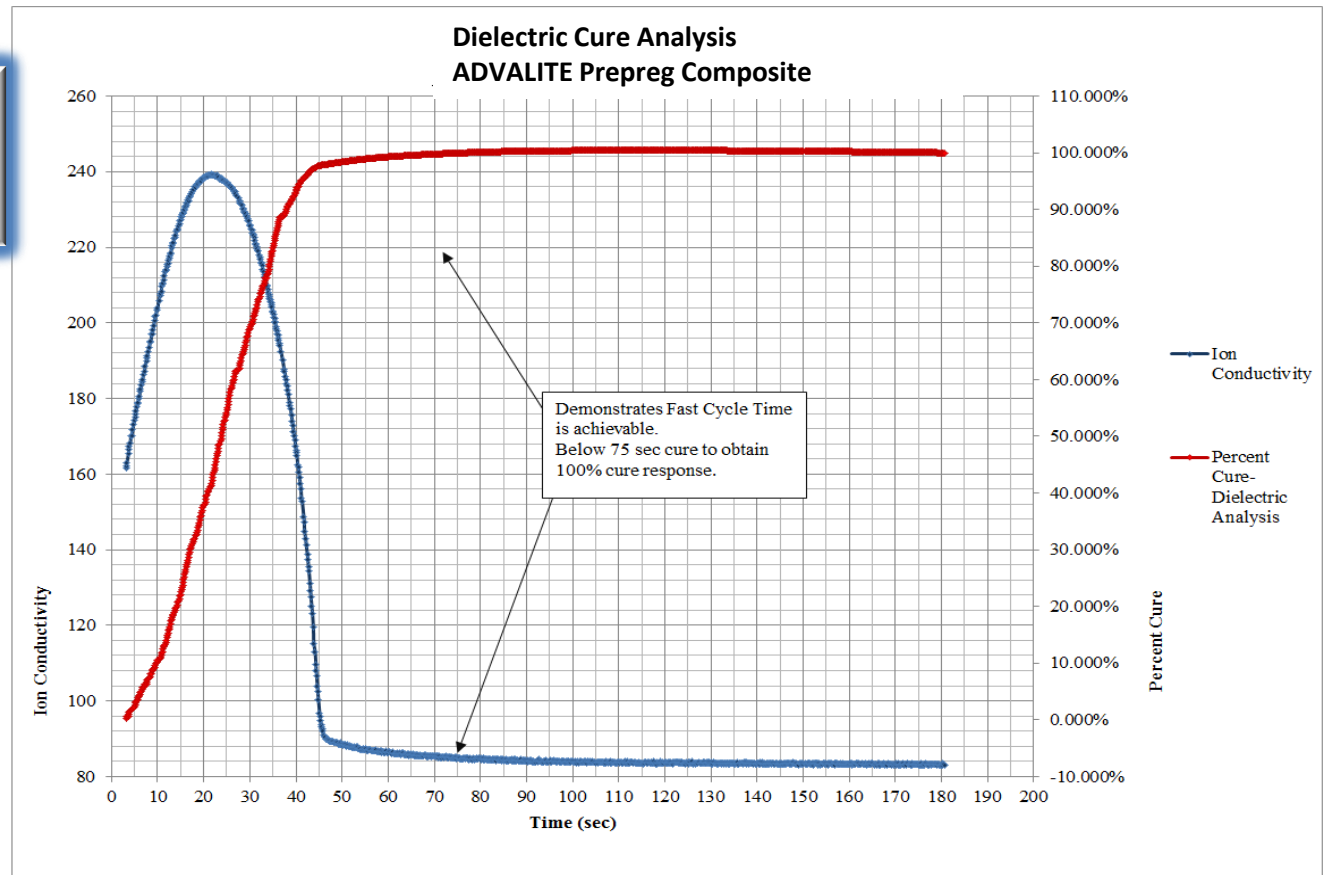
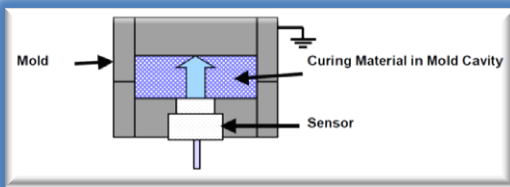
*) Some liquid and hotmelt grades are Non Hazardous “label free”, note organic peroxide initiator (approx. 1-2 %)

ADVALITE™ Vinyl Hybrid Technology

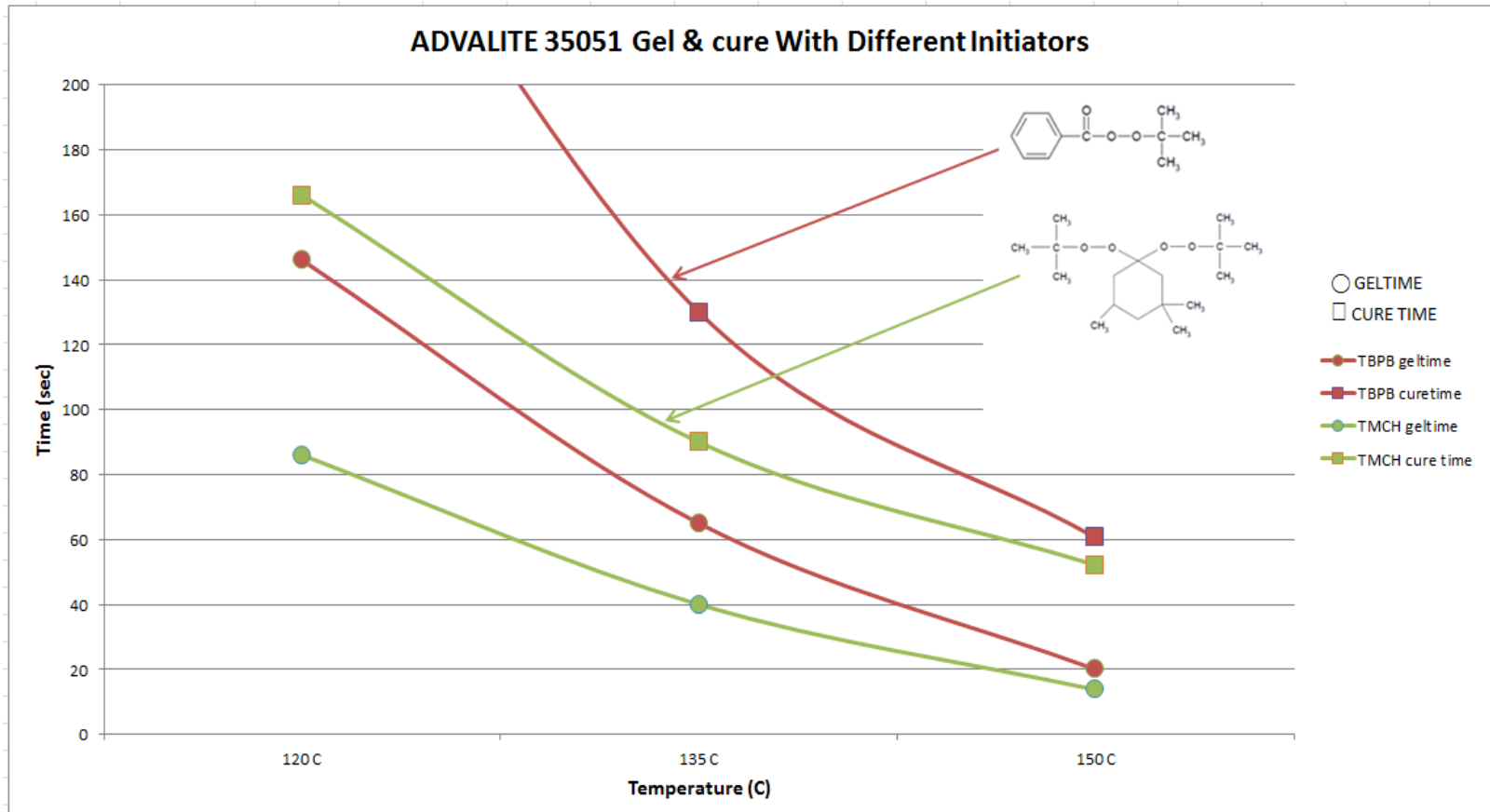
- Advanced material market
- Radical cure
 - Like traditional unsaturated polyesters and vinylesters (SMC)
 - Organic peroxide (**heat** or RT), radiation (UV, EB, etc)
- Styrene free
 - Ultra low VOC / no emission
 - No off-gassing (head space analysis)
- Unique combination of snap cure / reactive diluent free thermoset resin systems
 - Cost effective
 - Structural material
 - Improved dry/ wet Tg
 - Improved TACT times
- Very versatile technology platform

ADVALITE™ Properties, Cure Speed

ADVALITE™ radical cure speed outperforms epoxy cure reactions



ADVALITE™ Technology, Cure Capabilities



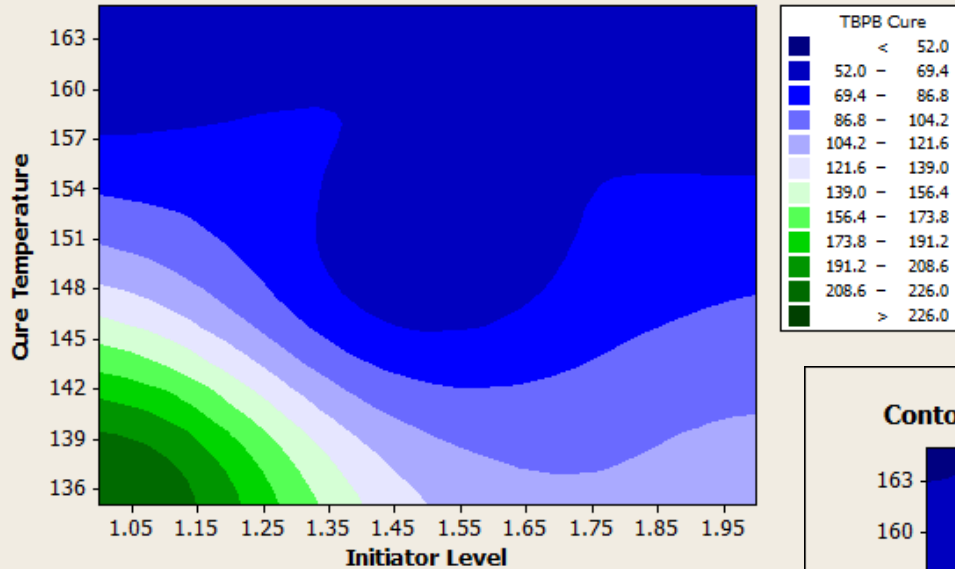
Robust stoichiometry, free radical cure is less sensitive to the mixing ratio

ADVALITE™ Technology, Cure Capabilities

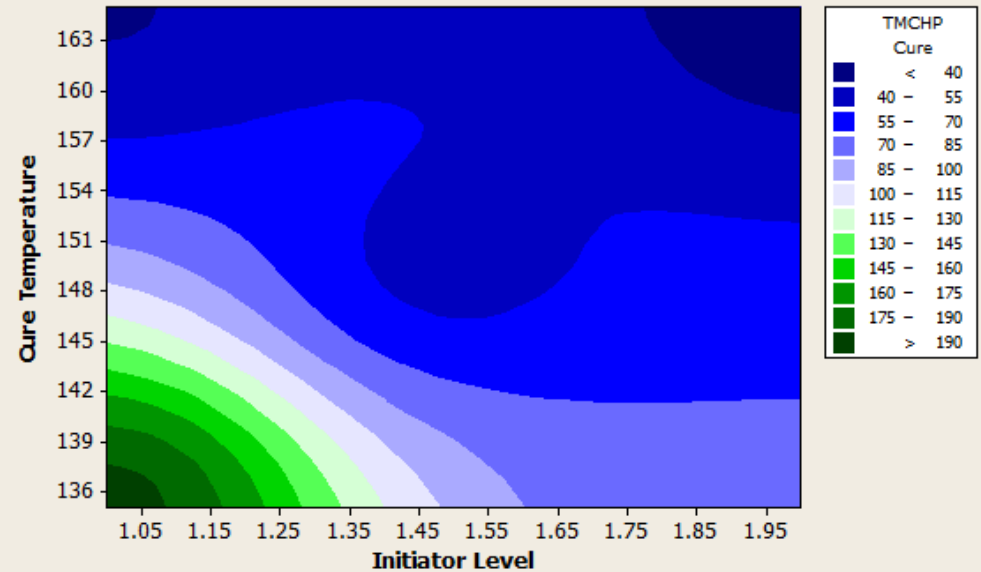
ADVALITE™ Resin Systems
Meet Cure Requirements for
Automotive High Production
Volume

ADVALITE™ 35051-00
Dielectric Cure Analysis

Contour Plot of TBPB Cure vs Cure Temperature, Initiator Level



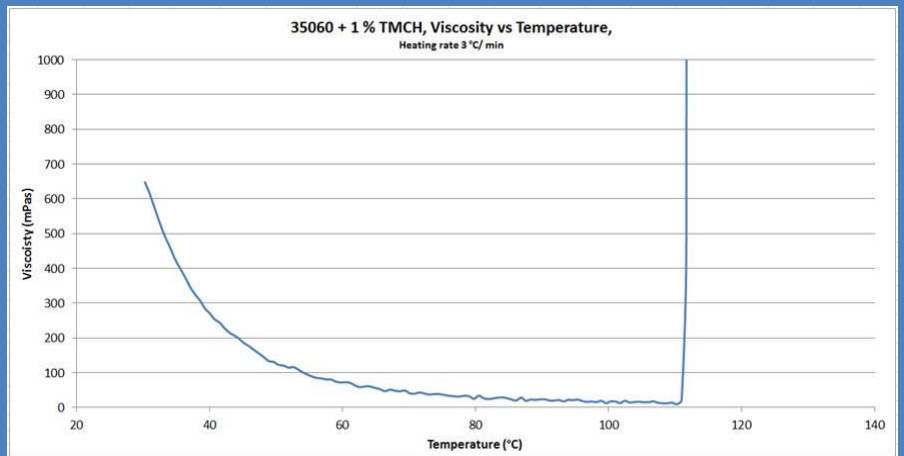
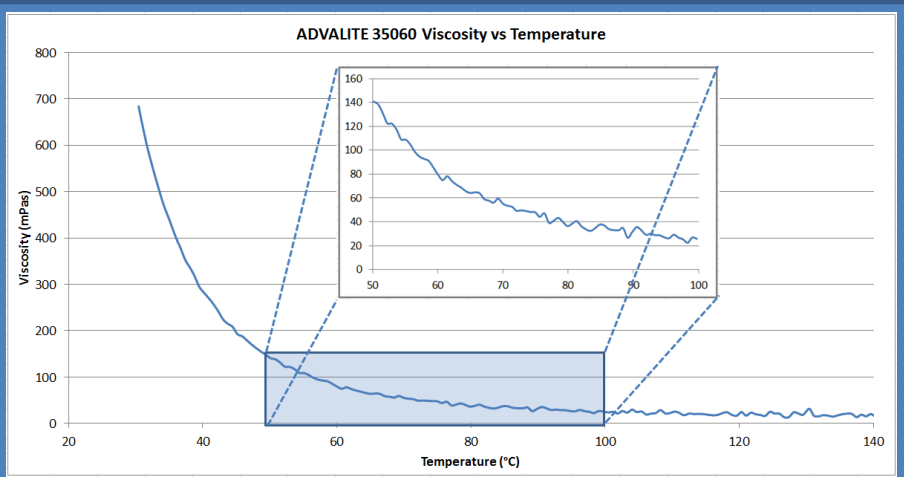
Contour Plot of TMCHP Cure vs Cure Temperature, Initiator Level



Robust stoichiometry, free radical cure is less sensitive to the mixing ratio

Blue regions are snap cure response - less than 120 seconds
With appropriate formulation work - Cure response can be lower than 60 seconds

ADVALITE™, Viscosity Profile (Liquid Range)

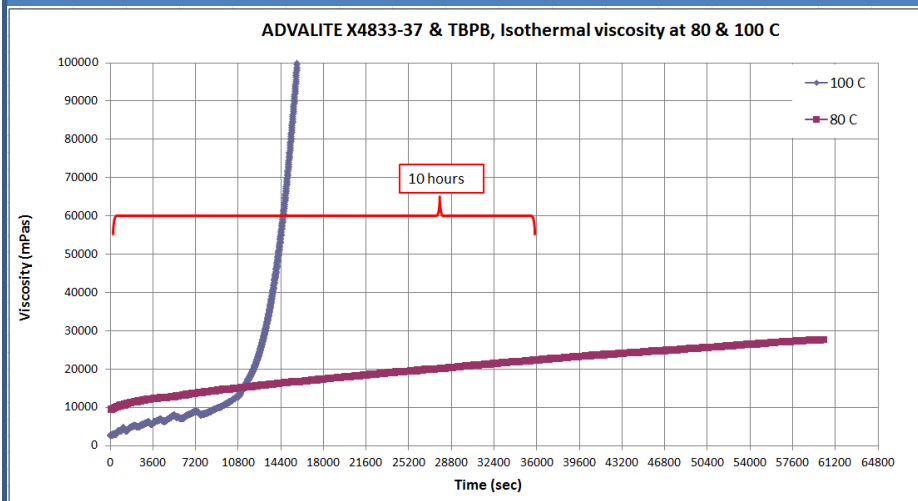
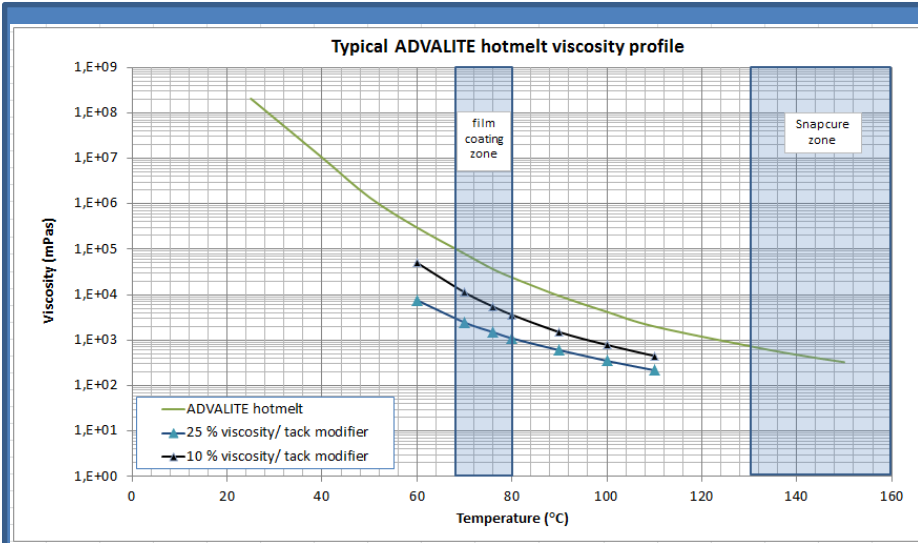


- Very low viscosity at the moulding temperature, with minimum drift prior to the gel point
- Full cure after 1 min @ 150 C (closing time) achievable
 - @ production conditions TBPB cured laminates, RR < 2,5 J/g measured (and after 2 min << 0,5 J/g)

Rheometer Study

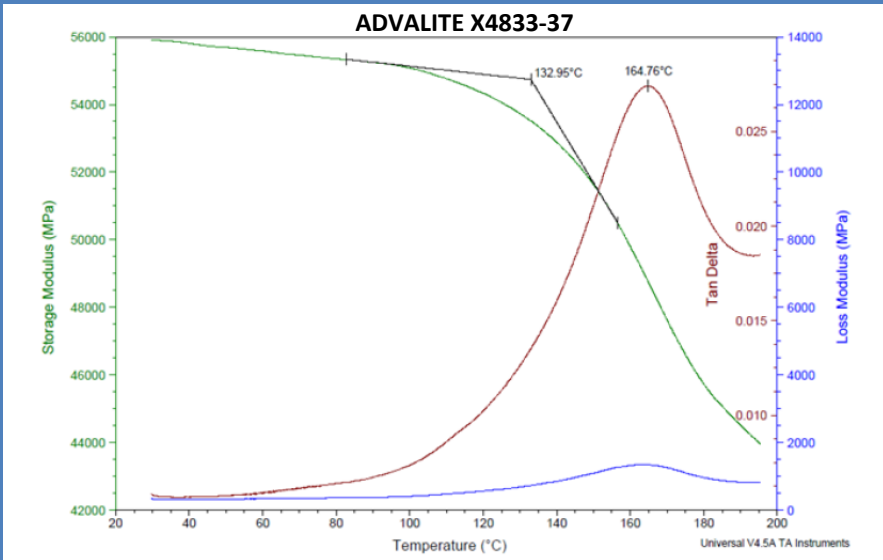
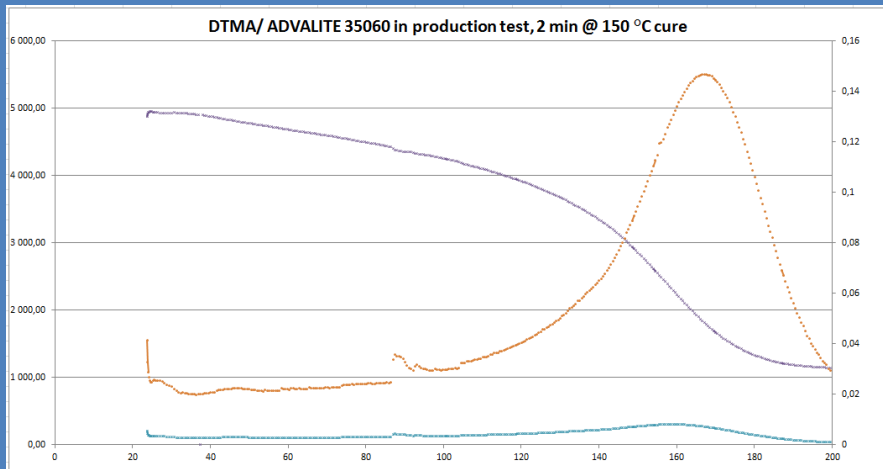
ADVALITE™ 35060-00 with and without 1% TMCH Initiator
 Processing viscosity against temperature sweep

ADVALITE™, Viscosity Profile (Hot Melt Range)



- Good process parameters with low viscosity @ the moulding temperature
- Non diluted Advalite hotmelts come with a low RT tack
 - Suitable for automatic room temperature lamination processes
- Adjustable viscosity & tack
- Snap cure system with no reaction at the room temperature
 - Enables a prepreg formulation with a very long ambient outlife

ADVALITE™ Thermo-Mechanical Properties



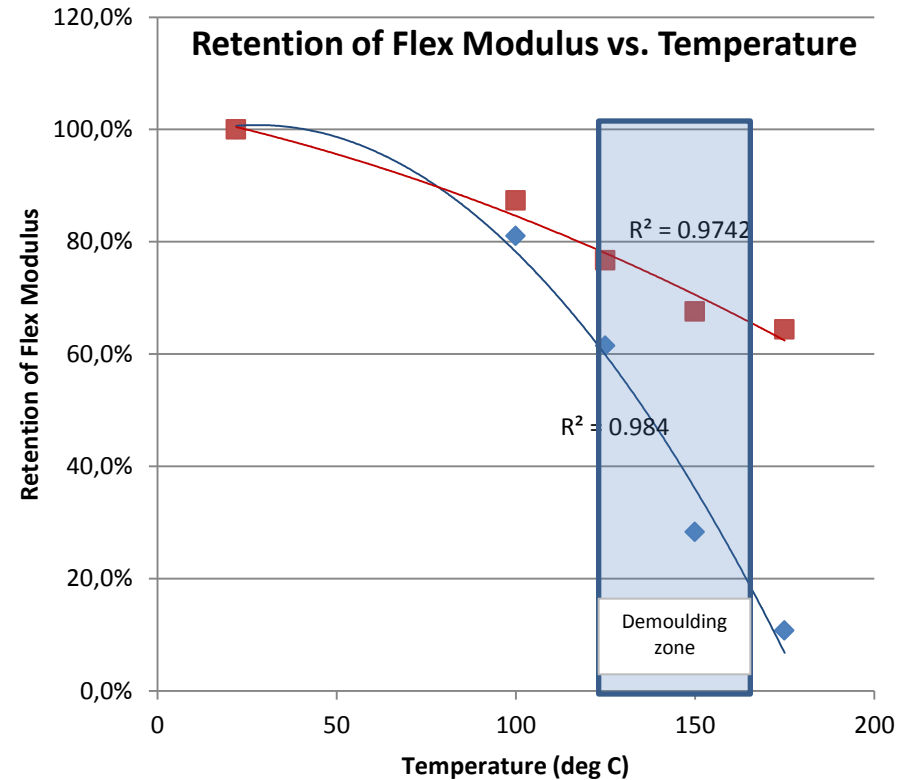
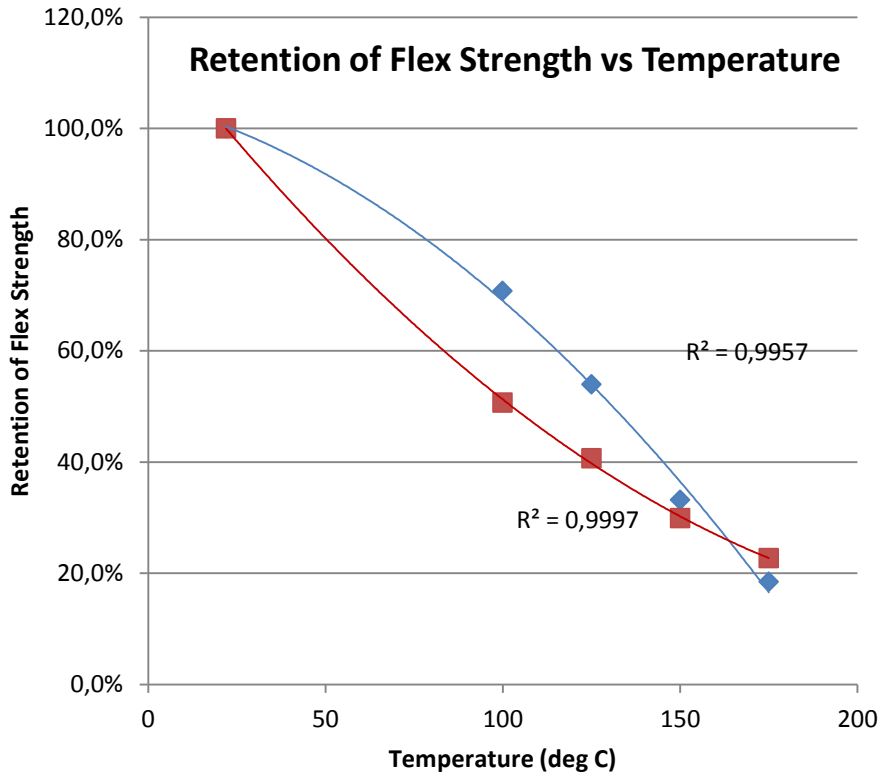
- Very versatile technology platform
- Very good retention of Tg in hot & wet conditions:

TYPE	GRADE	Tg	
		Dry (°C)	Wet (°C)
HOTMELT	35051	109	99
	X4833-37	154	149
	X4710-16	173	157
LIQUID	35065	104	93
	X4622-96	126	114
	35060	170	166

91- 97% Retention
89- 98% Retention

- High Tg grades suitable for e-coating

ADVALITE™ Thermo-Mechanical Properties



◆ Epoxy CF Prepreg
 ◆ X4710-16 Glass Uni Prepreg
 — Poly. (Epoxy CF Prepreg)
 — Poly. (X4710-16 Glass Uni Prepreg)

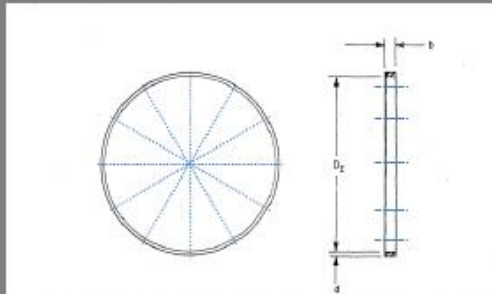
◆ Epoxy CF Prepreg
 ◆ X4710-16 Glass Uni Prepreg
 — Poly. (Epoxy CF Prepreg)
 — Poly. (X4710-16 Glass Uni Prepreg)

- Equivalent strength Performance to epoxy carbon fibre control
- Improved modulus retention at higher temperature
 - Advantage in hot demoulding

ADVALITE™ Carbon compatibility

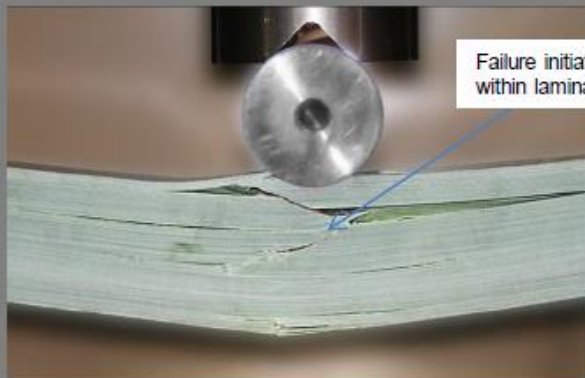
- “NOL Ring Testing”

ASTM D 2344-06
 Standard Test Method for Short Beam Strength of Polymer Matrix Composite Materials and Their Laminates



SPECIMEN DIMENSIONS			
TYPE OF SPECIMEN	D ₁ INSIDE DIAMETER	b WIDTH	d WALL THICKNESS
A	146.05 ±0.051 MM (5.750 ±0.002 IN.)	6.35 ±0.254 MM (0.250 ±0.010 IN.)	1.52 ±0.051 MM (0.060 ±0.002 IN.)
B	146.05 ±0.051 MM (5.750 ±0.002 IN.)	6.35 ±0.127 MM (0.250 ±0.005 IN.)	1.52 ±0.254 MM (0.060 ±0.010 IN.)
C	146.05 ±0.051 MM (5.750 ±0.002 IN.)	6.35 ±0.254 MM (0.250 ±0.010 IN.)	3.18 ±0.051 MM (0.125 ±0.002 IN.)

Three Point Bend-Short Span

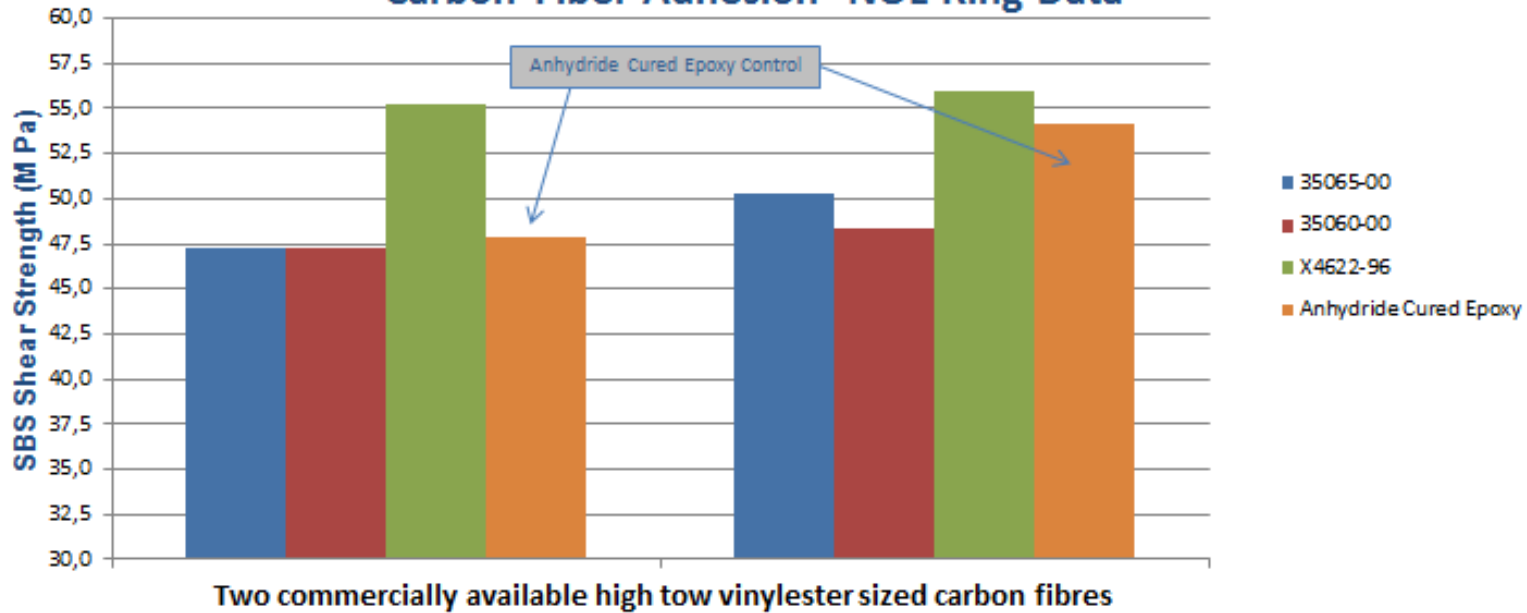


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- Typically best results with vinylester compatible sizings
 - Epoxy (only) compatible sizings can result lower ILSS
- Fibres tested include:
 - T700 FOE/ Toray
 - T-72 Size/ Zoltek
 - TRW 40 K-size / MRC
 - Toho Tenax, various grades
 - Dow Akxa, various grades
- ILSS > 50 MPa

ADVALITE™ Carbon Compatibility

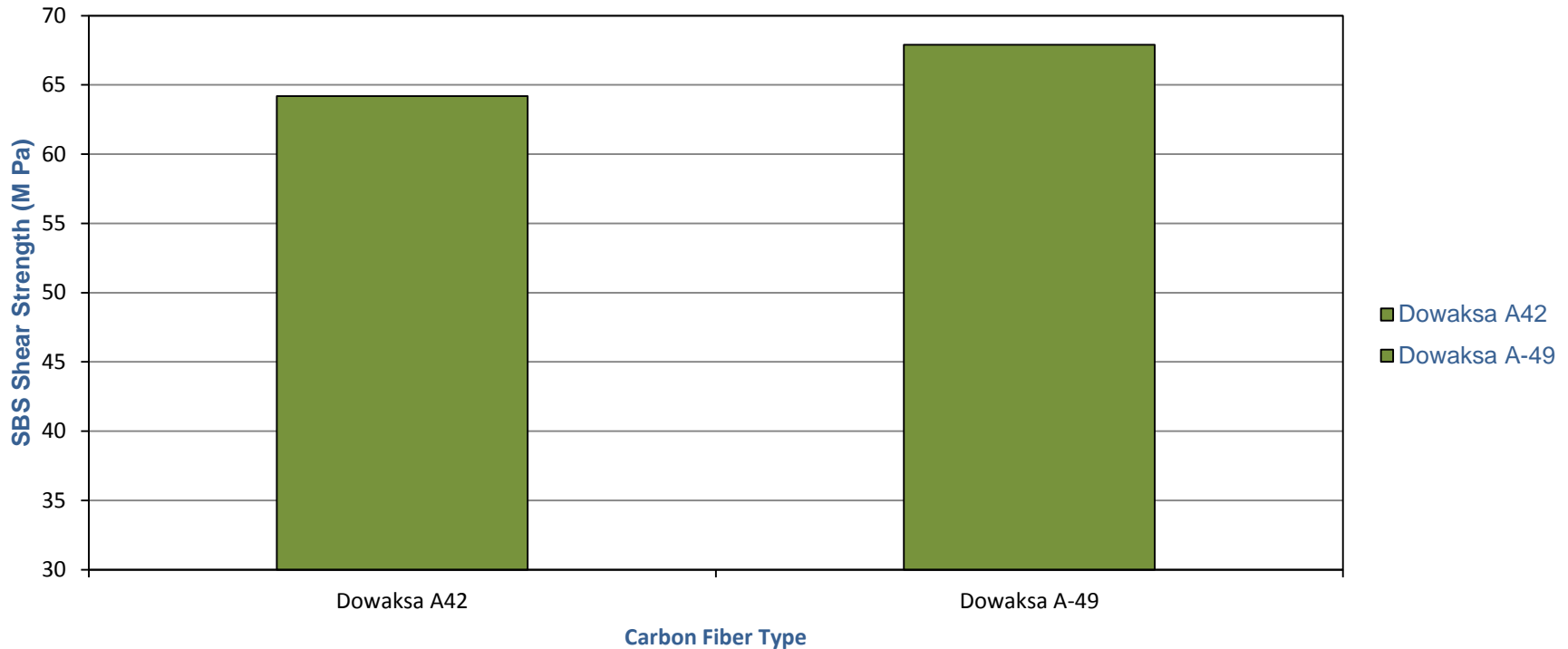
**ADVALITE™ Liquid Vinyl Hybrid Resins
Carbon Fiber Adhesion- NOL Ring Data**



- Equivalent adhesion to carbon fiber inputs based on ILSS of NOL ring samples
- Good adhesion across multiple carbon fiber sizings

ADVALITE™ Carbon Compatibility

ADVALITE™ Hot Melt Resin Carbon Fiber Adhesion
X4833-37:35051



- Exceeds ILSS fitness for use > 50 M Pa
- Good adhesion across multiple carbon fiber sizings

ADVALITE™ Vinyl Hybrid Hot Melt Range

CAST RESIN PROPERTIES

Properties	35000-00	35051-00	X4833-37	X4710-16
Description	FR Prepreg	Prepreg	Prepreg	Prepreg
Tensile Strength, MPa	57.8	82.5	65.4	62.1
Tensile Modulus, GPa	3.93	3.43	3.05	4.01
Tensile Elongation, %	1.64	4.0	2.5	1.8
Heat Distortion Temperature, °C	94	84	116	151
Water Absorption (24 hours @ RT), %			1.54	
Dry Tg, °C	123	109	154	173
Wet Tg, °C	157		149	

- Suitable for film coating / prepreg manufacture
- Different grades / properties available
 - Including high Tg grades
- Monomer / reactive diluent free
- Suitable for compression moulding
 - Can be demoulded hot
- Compatible with carbon fibre
- Snap cure & very long RT outlife



Prepreg: ADVALITE 35051
Battery tray

ADVALITE™ Vinyl Hybrid Liquid Range

CAST RESIN PROPERTIES

Properties	35065-00	X4622-96	35060-00	35070-00
Tensile Strength, MPa	80.5	95,7	45.7	34.1
Tensile Modulus, GPa	3.84	3,98	3.78	2.07
Tensile Elongation, %	2.8	3,4	1.5	35.9
Heat Distortion Temperature, °C	72	94	155	
Dry Tg, °C	104	126	170	
Wet Tg, °C	93	114	166	
Viscosity, cps	500	1 000	1 200	4 400

- Different grades / properties available
- Compatible styrene free in-mould coating available
- Suitable for HP-RTM & Liquid Compression Moulding
 - Can be demoulded hot
- Low viscosity
- Can be cured in 1min
- 100 % styrene free



Liquid moulding: ADVALITE 35065
Car Floorboard

Summary

- ADVALITE™ Vinyl Hybrid Resins meet the automotive serial production requirements
 - Snap cure/ TACT time
 - Carbon compatibility
 - Tg
- Liquid and Hot Melt ranges available
 - For prepreg and liquid moulding applications
 - Versatile platform, different properties available
- Radical cure
- Styrene free
- Excellent EHS profile
- Proven, commercial & available

Thank You

For more information, Please visit our stand:
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