

PRODUCT DATA SHEET

DESCRIPTION

Toray RS-1 is an epoxy prepreg resin that provides an excellent balance of mechanical properties, toughness, and modulus. RS-1 has been evaluated and qualified in areas ranging from marine to aerospace and dielectric structures. RS-1 is also available in a lower temperature curing formulation 80°C (176°F).

FEATURES

- ▶ **Minimum ambient work life of 4 weeks**
- ▶ **Excellent balance of mechanical properties, toughness, and modulus**
- ▶ **Formulated for compatibility with UHMWPE fiber for low dielectric applications**
- ▶ **Flexible, robust range of process cycles**
- ▶ **Vacuum bag, autoclave, and press consolidation**
- ▶ **Excellent matrix for sandwich structure skins**

TYPICAL APPLICATIONS

- ▶ Marine structures
- ▶ Dielectric structures
- ▶ Aerospace structures

PRODUCT FORMS

- ▶ UD tape to 610 mm (24") wide
- ▶ Fabric prepreg to 1270 mm (50") wide

SHELF LIFE

Out Life:	30 days at 24°C (75°F)
Frozen Storage Life:	6 months at -18°C (< 0°F)

Out life is the maximum time allowed at ambient temperature before cure.

TYPICAL NEAT RESIN PROPERTIES

Density	1.24 g/cm ³
T _g (by DSC)	107°C (225°F)
Coefficient of Thermal Expansion	57.6 ppm/°C (32 ppm/°F)
Viscosity 133,700 cps at 50°C (122°F)	1550 cps at 109°C (229°F)
Tensile Strength	79 MPa (11.5 ksi)
Tensile Modulus	3.0 GPa (0.44 Msi)
Compressive Strength	117 GPa (17 ksi)
Compressive Modulus	2.9 GPa (0.43 Msi)



Contact us for more information:

North America/Asia/Pacific

e explore@toraytac-usa.com

t +1 408 465 8500

Europe/Middle East/Africa

e explore@toraytac-europe.com

t +44 (0)1773 530899

PRODUCT DATA SHEET

TYPICAL CURE PARAMETERS

- ▶ Apply vacuum.
(If aerospace applications require autoclave or press cure, pressurize to 45–100 psi.)
- ▶ Heat to 93°C (200°F) (+10°F/-0°F) at 5°F ± 3°F/min.
- ▶ Hold at 93°C (200°F) for 3 hours (+15 min/-0 min). Cool.

LAMINATE DATA USED S2-GLASS/RS-1 UDPP LAMINATE

Property	Condition	Method	Results	
Tensile Strength 0°	RTD	ASTM D 3039	1937 MPa	281 ksi
Tensile Modulus 0°	RTD	ASTM D 3039	49 GPa	7.1 Msi
Tensile Strength 0°	ETW	ASTM D 3039	841 MPa	122 ksi
Tensile Modulus 0°	ETW	ASTM D 3039	52 GPa	7.49 Msi
Compressive Strength 0°	RTD	ASTM D 6641	717 MPa	104 ksi
Compressive Modulus 0°	RTD	ASTM D 6641	55 GPa	7.99 Msi
Compressive Strength 0°	RTW	ASTM D 6641	724 MPa	105 ksi
Compressive Modulus 0°	RTW	ASTM D 6641	52 GPa	7.48 Msi
Compressive Strength 0°	ETW	ASTM D 6641	114 MPa	16.5 ksi
Compressive Modulus 0°	ETW	ASTM D 6641	47 GPa	6.79 Msi
Interlaminar Shear Strength	RTD	ASTM D 2344	54 MPa	7.78 ksi
Interlaminar Shear Strength	ETW*	ASTM D 2344	2110 MPa	306 ksi

*Failure mode: plastic deformation
 S2-Glass panels: 130 g/m², tensile 14 plies, compressive and ILSS 20 plies
 All properties normalized to 56.8% FV
 RTW: Conditioned at 80°C (176°F), 98% RH for 5 days; ETW: Conditioned at 80°C (176°F), 98% RH for 18 days

LAMINATE DATA USED T-300 (12K)/RS-1 UDPP LAMINATE*

Property	Condition	Method	Results	
Tensile Strength 0°	RTD	ASTM D 3039	1716.8 MPa	249 ksi
Tensile Modulus 0°	RTD	ASTM D 3039	122.7 GPa	17.8 Msi
Compressive Strength [0,90 crossply]	RTD	ASTM D 695	572.3 MPa	83 ksi
Compressive Modulus [0,90 crossply]	RTD	ASTM D 695	55.8 GPa	8.1 Msi
Interlaminar Shear Strength [0,90 crossply]	RTD	ASTM D 2344	40.7 MPa	5.9 ksi

*Laminate was heated to 93°C (200°F) at 1°C/min (1.5°F/min), cured at 93°C (200°F) for 5.5 hours
 All properties normalized to 56.8% FV

PRODUCT DATA SHEET

LAMINATE DATA USED 7781 E-GLASS/RS-1 FABRIC LAMINATE

Property	Condition	Method	Cured at 82°C (180°F) for 5 hrs		Cured at 96°C (205°F) for 1.5 hrs		Cured at 71°C (160°F) for 1 hr/96°C (205°F) for 1.5 hrs	
			MPa	ksi	MPa	ksi	MPa	ksi
Tensile Strength 0°	RTD	ASTM D 3039	357.2	51.8	353.7	51.3	381.3	55.3
Tensile Modulus 0°	RTD	ASTM D 3039	21.4	3.1	20.7	3	20.7	3
Compression Strength 0°	RTD	ASTM D 695	357.8	51.9	369.6	53.6	385.4	55.9
Flexural Strength 0°	RTD	ASTM D 2344	488.2	70.8	473.0	68.6	491.6	71.3
All properties normalized to 60% FV T _g : With 82°C (180°F) 5-hour cure 93°C (200°F) After 72-hour water boil 73°C (163°F) With 96°C (205°F) 1-hour cure 105°C (221°F)								

TYPICAL RS-1 200°F CURE PARAMETERS

- ▶ Apply vacuum (If aerospace applications require autoclave or press cure, pressurize to 45–100 psi)
- ▶ Heat to 66°C (150°F) (+10°F/-0°F) at 4°F ± 3°F/min
- ▶ Hold at 66°C (150°F) for a minimum of 30 minutes
- ▶ Heat to 93°C (200°F) (+10°F/-0°F) at 4°F ± 3°F/min
- ▶ Hold at 93°C (200°F) for 6 hours (+15 min/-0 min). Cool under vacuum

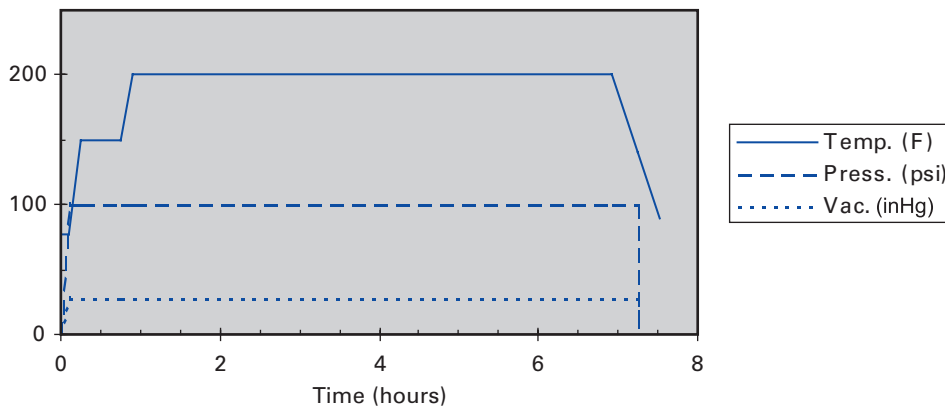
TYPICAL RS-1 176°F CURE PARAMETERS

- ▶ Apply vacuum (If aerospace applications require autoclave or press cure, pressurize to 45–100 psi)
- ▶ Heat to 66°C (150°F) (+10°F/-0°F) at 4°F ± 3°F/min.
- ▶ Hold at 66°C (150°F) for a minimum of 30 minutes.
- ▶ Heat to 80°C (176°F) (+10°F/-0°F) at 4°F ± 3°F/min
- ▶ Hold at 80°C (176°F) for 12 hours (+15 min/-0 min). Cool under vacuum.

RS-1: 200°F (93°C) CURE, LATENT TOUGHENED EPOXY RESIN

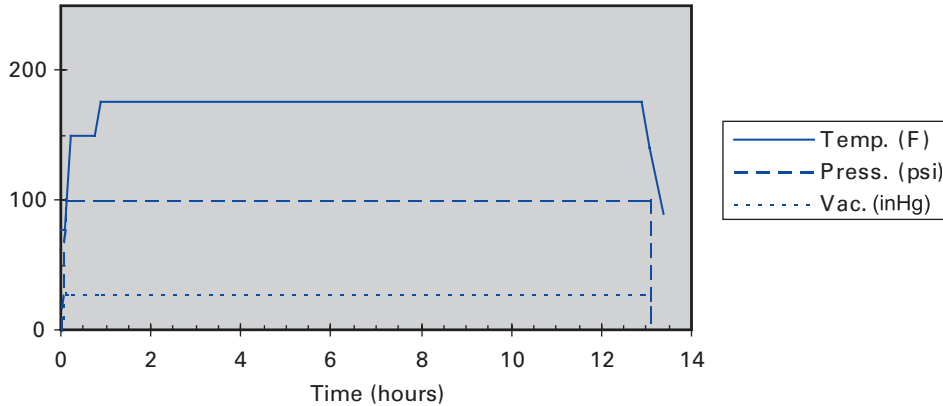
RS-1 epoxy resin provides an excellent balance of mechanical properties, toughness, and modulus with a flexible and robust range of process cycles. RS-1 may also be cured at temperatures as low as 80°C (176°F).

TYPICAL RS-1 93°C (200°F) CURE PROFILE

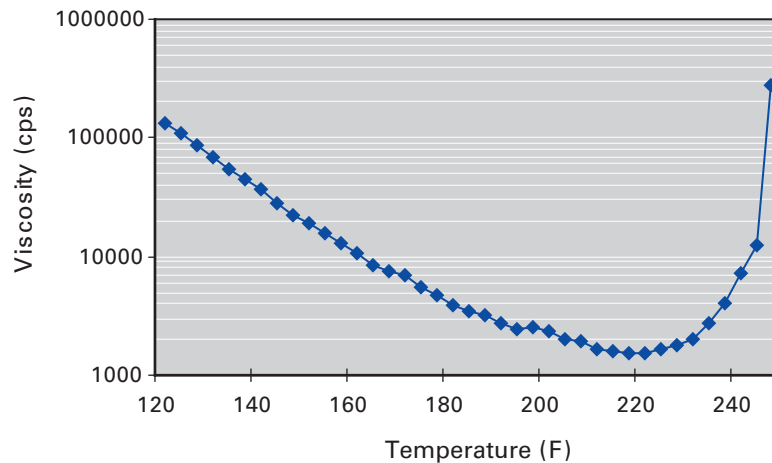


PRODUCT DATA SHEET

TYPICAL RS-1 80°C (176°F) CURE PROFILE



RS-1 Neat Resin Viscosity Profile



PROCESSING OF RS-1 PREPREG

RS-1 is a toughened epoxy resin that has an excellent work life (minimum of 30 days at ambient conditions) yet cures at 80°C (176°F) in 12 hours or 93°C (200°F) in 3–6 hours (other alternative cure schedules can be furnished by Toray). The catalyst requires elevated temperature for initiation of the cure reaction. RS-1 reaches minimum viscosity at 65–71°C (150–160°F), yet cure reaction rate is minimal, providing excellent conditions for dwell and consolidation.

Understanding the above processing characteristics and versatility of the RS-1 system provides users with excellent success in their own specific environments. Although RS-1 is a very flexible resin system with respect to processing, certain guidelines need to be followed in order to achieve optimal mechanical properties. Toray strongly recommends that sample/subscale work representative of the actual structure and process conditions be performed in the customer oven and shop environment with Toray technical input/assistance prior to using RS-1 on large structures.

PRODUCT DATA SHEET

RECOMMENDED RS-1 PROCESSING

1. Apply full vacuum (minimum of 28 inHg) to the debulked laminate. Toray recommends a warm debulk if practical, but room temperature debulks can be effective (please contact Toray for debulk recommendations on large parts). It is critical that the prepreg plies are layed-up such that wrinkling and voids are minimized. Toray recommends use of Teflon® rollers or squeegees to remove air pockets during lay-up of the individual plies.

Vacuum bag lay-up sequence is as follows:

- 1) Tool with appropriate mold release or release film and debulked prepreg laminate
 - 2) 0.1 kg/m² (3 oz/yd²) natural nylon peel ply, or equivalent
 - 3) Perforated film ("P3" type, or equivalent)
 - 4) 1.2 kg/m² (4 oz/ft²) polyester breather cloth
 - 5) 121°C (250°F) rated nylon bagging film (*PVA or cheap "poly" bag material is not recommended as it may easily leak or puncture*)
2. Apply thermocouples to the part and oven every 1.8–2.4 m (6–8 feet). Toray recommends some thermocouples be placed inside the laminate (near an edge) if at all possible, not just on top of the laminate or outside the vacuum bag. Embedded thermocouples are extremely useful as they provide an understanding of the actual temperature profile achieved in each region of the entire part.
 3. Place a vacuum port every 0.7 m² (8 ft²) or so over the part to ensure good vacuum and volatile egress over the entire part area.
 4. Ramp the oven at -17.2 – -13.8°C (1–7°F) per minute for thin laminates. The ramp rate may be adjusted, depending on the thickness of the part and the heating characteristics of the oven. For example, laminates greater than 50 plies will require a dwell at 71.0–76.6°C (160–170°F) for 3 hours using a slower ramp rate of -17.2 – -16.6°C (1–2°F) per minute. Always base the ramp rates and dwells on the "lagging" (i.e., the slowest) thermocouple.
 5. When the lagging thermocouple reaches 66–71°C (150–160°F) start the dwell, i.e.; leave the oven at this temperature for at least 30 minutes based on the thickness and number of plies of laminate as noted above. As a general rule, the thicker the laminate, the longer the dwell time. The goal is to achieve laminate consolidation, de-aeration, and compaction without too much cross-linking at this stage of the cure cycle. Again, always base the start of the dwell period on the lagging thermocouple.
 6. At the end of the dwell, ramp the oven at -17.2 – -13.8°C (1–7°F) per minute to either 80–293°C (176–200°F) and dwell for the appropriate time (12 hours minimum at 80°C/176°F) or 3 hours minimum at 93°C/200°F). The dwell times are again based on the lagging thermocouple. Dwell time does not begin until the last thermocouple has reached the dwell temperature. The part cannot be over cured. In most cases, the longer cures mean better parts as long as the tool can take the longer cure time without distortion.
 7. The HDT (heat deflection temperature, representing the amount of cure) will continue to advance the longer the part is cured and the higher the cure temperature, up to a final endpoint where it will no longer increase the HDT (again depending on part size and thickness). Thinner laminates and smaller parts tend to need less time, but it is important to achieve recommended minimums for temperatures and times.
 8. Allow the part to cool in the oven under vacuum by simply turning off the heat source and continuing to run whatever fans or blowers have been used during the cure. Do not open the oven doors. It is best to remove the part when it can be touched comfortably (less than 43°C/110°F). This can take up to 7 hours or longer for large structures, so be patient. If the part is pulled directly from the oven when at a high temperature it can be thermally shocked and warpage, prerelease, or separations between prepreg plies or between prepreg and cores ("delaminations") can occur.

PRODUCT DATA SHEET

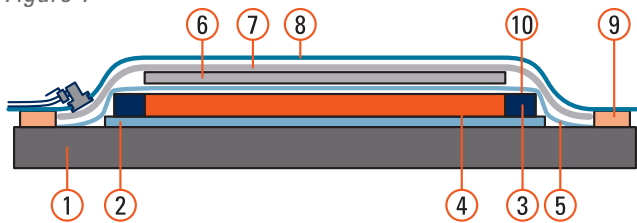
TYPICAL COMPOSITE LAMINATE STACKING SEQUENCE

List of Materials

1. Tool—aluminum, steel, Invar, composite (tool plates must be release coated or film covered). See the list below
2. Release coat or film—Frekote 700NC or 770NC, FEP, TEDLAR
Lay-up part using standard debulking procedures
3. Silicone edge dams for cure—slightly thicker than laminate
4. Laminate
5. Release coat or film—Frekote 700NC or 770NC, FEP, TEDLAR
6. Caul plate—aluminum, steel, Invar, silicone rubber sheet (metal caul plates must be release coated or wrapped)
7. 2.2 oz/yd² polyester breather, 1 or more
8. Vacuum bag
9. Vacuum sealant
10. Glass yarn string (alternatively or additionally breather may wrap over top of dam to contact edge)

Follow the provided Toray Advanced Composites cure cycle for the particular resin system.

Figure 1



Revised 07/2019

TORAY_RS-1_PDS_v2.0_2019-07-15 Page 6/6

© 2019. All data given is based on representative samples of the materials in question. Since the method and circumstances under which these materials are processed and tested are key to their performance, and Toray Advanced Composites has no assurance of how its customers will use the material, the corporation cannot guarantee these properties. Toray®, (Toray) AmberToo®, (Toray) Cetex®, (Toray) MicroPly™, and all other related characters, logos, and trade names are claims and/or registered trademarks of Toray Industries Inc. and/or its subsidiary companies in one or more countries. Use of trademarks, trade names, and other IP rights of Toray Industries Inc. without prior written approval by such is strictly prohibited.

TORAY Toray Advanced Composites

18255 Sutter Blvd.
Morgan Hill, CA 95037, USA
t +1 408 465 8500

2450 Cordelia Road
Fairfield, CA 94534, USA
t +1 707 359 3400

Amber Drive, Langley Mill
Nottingham, NG16 4BE, UK
t +44 (0)1773 530899

www.toraytac.com
explore@toraytac-usa.com (North America/Asia/Pacific)
explore@toraytac-europe.com (Europe/Middle East/Africa)