

# CYCOM<sup>®</sup> 977-20 RTM with PRIFORM<sup>™</sup> Technology Soluble Fiber Co-Woven Textile



## Description

CYCOM 977-20 RTM with PRIFORM Technology is a 177°C (350°F) cure toughened liquid epoxy resin system.

CYCOM 977-20 RTM with PRIFORM Technology is formulated as the RTM version of Cytec Engineered Materials' established CYCOM 977-2 toughened epoxy prepreg resin. CYCOM 977-2 is widely used in many aerospace applications including primary and secondary aircraft structures, space and ballistics structures, or any application requiring excellent impact resistance.

CYCOM 977-20 RTM resin has a low viscosity to allow injection at temperatures between 60 and 85°C (140 and 185°F) without the need for excessive heating of resin transfer pipe work or high injection pressures. After injection, the resin viscosity decreases to below 50 cP, thus helping to ensure full fiber wetting.

CYCOM 977-20 RTM resin is fully cured following a three hour dwell at 177°C (350°F), after which it has a service temperature of 135°C (275°F).

CYCOM 977-20 RTM resin must be used in conjunction with Cytec Engineered Materials' patented PRIFORM hybrid fabrics in order to achieve cured performance properties equivalent to CYCOM 977-2 prepreg materials.

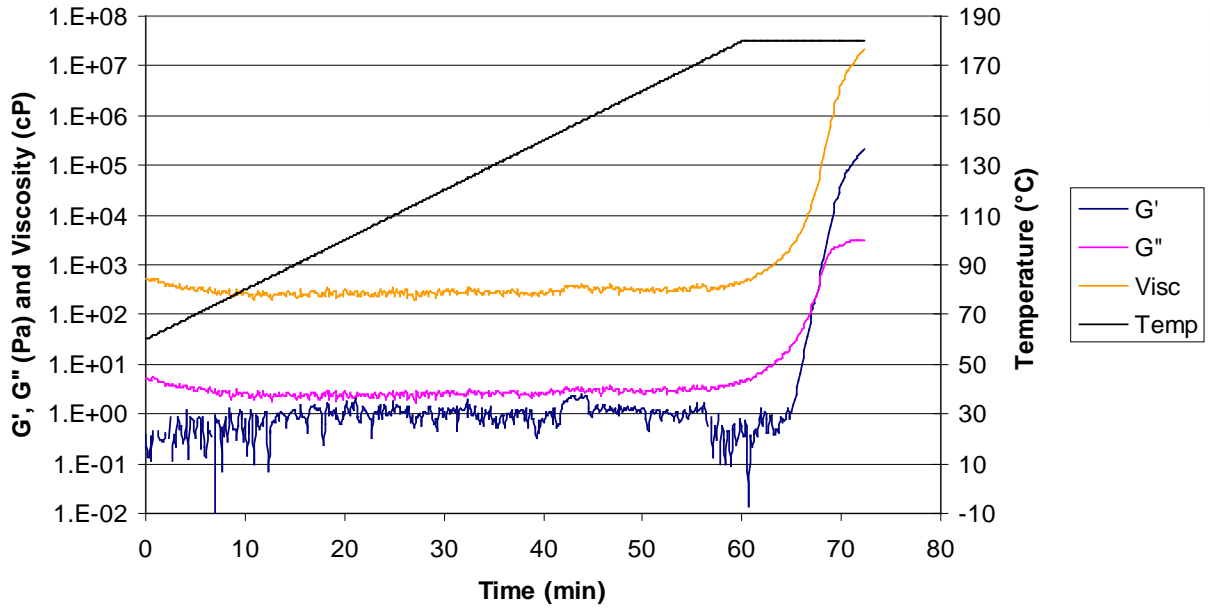
The unique self-binding aspect of PRIFORM reinforcements removes the need for ancillary binder products and allows the manufacture of high quality preforms. The level of self-binding can be tailored from lightly stabilized, to aid cutting and handling of single plies, to highly compacted for high fiber volume preform construction.

## Features and benefits

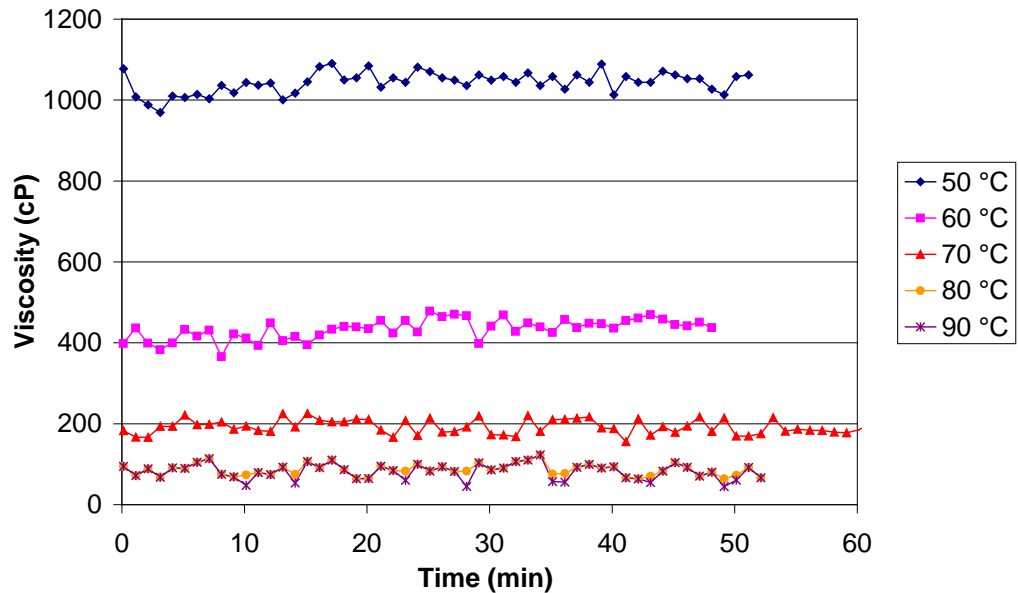
- **One part system, liquid at room temperature**
- **RTM version of CYCOM 977-2 prepreg resin, suitable for primary aircraft structures**
- **Excellent compression strength**
- **Excellent compression strength after impact**
- **Highest FST properties of all structural epoxy based composites**
- **Injectable at 60 to 85°C (140 - 185°F)**
- **Less than 200 cP initial injection viscosity**
- **Minimum viscosity < 50 cP**
- **177°C (350°F) cure giving service temperature of 135°C (275°F)**
- **Shelf life of 12 months at -18°C (0°F) and out life of 30 days at 22°C (72°F)**

CYCOM 977-20 RTM Rheometric Data

CYCOM 977-20 RTM Ramp 60°C to 180°C at 2°C per minute



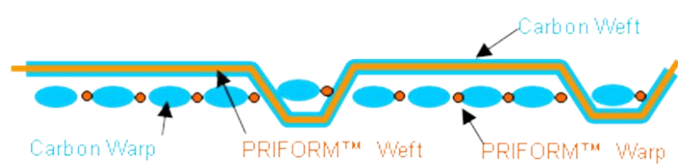
CYCOM 977-20 RTM Isothermal Viscosity Profiles



**Availability**

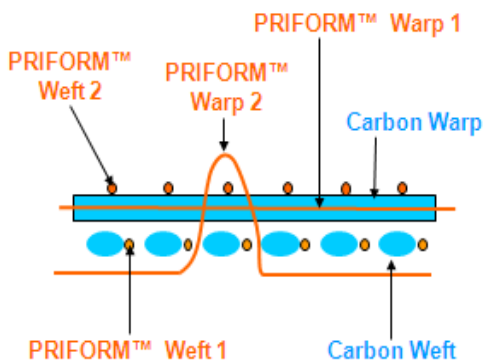
While the PRIFORM technology can be tailored to any textile of choice, three existing soluble-fiber-based product forms currently exist from CEM. Upon request CEM can design and manufacture other soluble fiber based product forms.

**6K HTA 5HS 370gsm**



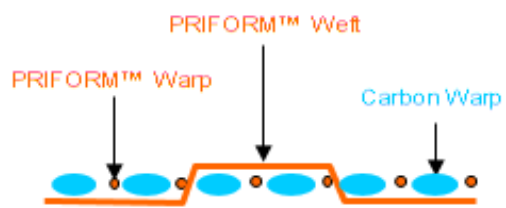
1270 mm wide 5 harness satin fabric made with Toho/Tenax HTA 6k 5131 carbon fibers and 54tex PRIFORM soluble yarn. A single PRIFORM yarn runs parallel to each carbon tow in warp and weft.

**24K IMS WNCF 550gsm**



A highly drapeable biaxial textile with no fiber crimping. 1270 mm wide 0/90 woven non-crimp made with Toho/Tenax IMS 24k 5131 carbon fibers and 54tex PRIFORM soluble yarn. The separate 0 and 90 carbon sheets are held together by a 54tex PRIFORM 5HS weave, returning tape like properties in each direction.

**24K IMS UW 200gsm**



Unidirectional textile 1000mm wide made with Toho/Tenax IMS 24k 5131 flattened carbon tows and 54tex PRIFORM.



This information is provided for informational purposes only and without legal responsibility. Users are expected to perform adequate verification and testing to ensure that materials meet required specifications.

## Mechanical Properties

Property	Textile Architecture					
	6K HTA 5HS 370gms		24K IMS WNCF 550gms		24K IMS UW 200gsm	
	24°C (75°F) Dry <sup>1</sup>	70°C (158°F) Wet <sup>2</sup>	24°C (75°F) Dry <sup>1</sup>	70°C (158°F) Wet <sup>2</sup>	24°C (75°F) Dry <sup>1</sup>	70°C (158°F) Wet <sup>2</sup>
<b>Tensile strength, MPa (ksi)*</b>	763 (111)	885 (128)	1050 (152)	1212 (176)	2119 (307)	-
<b>Tensile modulus, GPa (msi)*</b>	71 (10)	72 (11)	85 (12)	82 (12)	163 (24)	-
<b>Compression strength, MPa (ksi)*</b>	602 (87)	481 (70)	853 (124)	679 (99)	1379 (200)	-
<b>Compression modulus, GPa (msi)</b>	62 (9)	61 (9)	85 (12)	85 (12)	144 (21)	-
<b>In-plane shear strength, MPa (ksi)</b>	100 (15)	91 (13)	78 (11)	68 (10)	-	-
<b>In-plane shear modulus, GPa (msi)</b>	4.8 (0.70)	4.3 (0.62)	5.0 (0.73)	4.4 (0.64)	-	-
<b>Apparent interlaminar shear strength, MPa (ksi)</b>	73 (11)	55 (8)	61 (9)	-	98 (14)	-
<b>Open hole tensile strength, MPa (ksi)*</b>	302 (44)	-	-	-	-	-
<b>Open hole compression strength, MPa (ksi)*</b>	279 (40)	254 (37)	316 (46)	272 (39)	-	-
<b>Compression strength after impact, MPa (ksi)</b>	269 (39) [at 25J]	-	227 (33) [at 30J]	-	-	-

## Thermomechanical Properties

### CYCOM 977-20 RTM / 6K HTA 5HS woven carbon fabric

Property	Dry <sup>1</sup>	Wet <sup>2</sup>
<b>Tg (peak tan δ), °C (°F)</b>	218 (424)	176 (349)
<b>Tg (E' modulus intercept), °C (°F)</b>	199 (390)	154 (309)

1 Dried in vacuum oven for 48 hours at 105°C (221°F) prior to testing

2 Dried in vacuum oven for 48 hours at 105°C (221°F) then conditioned to equilibrium at 70°C (158°F)/85% R.H.  
Moister uptake ≈ 1.1%

\* Data are normalized to 60% fiber volume fraction

Test Method Relevant EN method used for 5HS and UW testing, ASTM used for WNCF



## Suggested Processing Parameters

### Stabilization for Single Ply Cutting and Handling

- Position ply on tool and bag-up with standard consumables utilizing release film where necessary to segregate multiple plies; pull vacuum to at least 70mb absolute (28" Hg)
- Maintaining vacuum, heat tool to 155±5°C (311±9°F) at maximum heat rate available
- Dwell at temperature for 25 ± 5 minutes
- Cool down to 60°C (140°F) maintaining vacuum
- De-bag for use

**NOTE:** Continuous stabilization can also be achieved with double-belt press type equipment, such as Meyer machines, at speeds of up to 5m/min depending on required stabilization levels.

### Preforming for Multiple Ply Compaction and Preform Construction

- Position lay-up on tool and bag-up with standard consumables; pull vacuum to at least 70mb absolute (28" Hg)
- Maintaining vacuum, heat tool to 155±5°C (311±9°F) at maximum heat rate available
- Dwell at temperature for 60 ± 5 minutes
- Cool down to 60°C (140°F) maintaining vacuum
- De-bag for use

### Suggested Infiltration Processing Parameters\*\*

- Preheat the resin to 75 ± 5°C (167°F) in its container for transfer to the RTM equipment injection system (i.e., pressure pot, piston ram, etc.). At this temperature the resin will achieve an initial viscosity of around 240 cps, and will stay below 350 cps for > 24 hours. The resin holding vessel and all transfer pipe work should be maintained at 75 ± 5°C (167°F) prior to injection.
- Degas resin in homogenizer for a minimum of 45 minutes under minimum of 175mb absolute (25" Hg) vacuum, prior to injecting. If observation is possible, degassing should continue until resin is seen not to contain any air bubbles. Apply full vacuum to tool containing the preformed reinforcement, ensuring that there is no vacuum loss
- Preheat tool to 75 ± 5°C (167°F)
- Inject resin using pressure if required (typically 1 – 2 bar) to fill the tool and achieve complete fiber wetting

Depending upon total cure cycle time requirements, degree of heating control on the tool, component size and geometry, etc. it is possible to inject the resin under alternative conditions in order to ensure full wet-out of the reinforcement.



**Suggested Infiltration Processing Parameters (cont'd)\*\***

- Once the tool is filled with resin and all trapped air is bled through the vents, close the injection gate valve
- Increase tool temperature to  $120 \pm 5^\circ\text{C}$  ( $261^\circ\text{F}$ ) at  $2 \pm 0.5^\circ\text{C}$  ( $4^\circ\text{F}$ ) per minute. Dwell at  $120 \pm 5^\circ\text{C}$  ( $261^\circ\text{F}$ ) for  $70 \pm 20$  minutes. The dwell step is a critical stage of the process and therefore it should be ensured that the actual part is subjected to outlined parameters. If discrepancies exist between thermocouples measuring part/tool temperature, it is recommended that the cycle is controlled using the leading thermocouple.
- Increase tool temperature to  $180 \pm 3^\circ\text{C}$  ( $355^\circ\text{F}$ ) at  $2.0 \pm 0.5^\circ\text{C}$  ( $4^\circ\text{F}$ ) per minute. Dwell at  $180 \pm 3^\circ\text{C}$  ( $355^\circ\text{F}$ ) for  $185 \pm 5$  minutes.
- Allow tool to cool to  $60^\circ\text{C}$  ( $140^\circ\text{F}$ ) or below at  $< 5^\circ\text{C}$  ( $9^\circ\text{F}$ ) per minute before releasing part from tool.

\*\*The above cure parameters have been defined using viscosity profile data and Cytec Engineered Materials' experience of molding panels (550mm x 300mm x 2mm) for process and mechanical performance evaluation of various RTM resin systems. A Plastech Hypaject system has been used to inject resin into an integrally heated RTM tool for such panel fabrication. Some parameters may require adjustment depending upon the nature of the part being molded and the equipment being used.

For larger or thicker parts, some parameters may require adjustment to avoid the risk of exotherm. Injection pressure for larger part/alternative tooling may require adjustment to ensure filling of the tool cavity within an acceptable time and to ensure full consolidation of the component. Different injection equipment may require alternative conditions for degassing.



## Health and Safety Information

### Warning

CYCOM 977-20 RTM contains epoxy resin and may cause allergic skin reaction or primary skin irritation. Avoid prolonged or repeated contact with skin. Wash thoroughly after handling. Over exposure to vapor during heat curing may cause irritation or injury of the respiratory tract and eye irritation.

### First aid

In case of skin contact, wash skin with soap and water. In case of eye contact immediately irrigate with plenty of water for 15 minutes. If heated vapor is inhaled remove from exposure. Administer oxygen if there is difficulty breathing.

### Ventilation required

Use mechanical exhaust ventilation when heat curing resin system.

### Detailed handling instructions

Refer to the Material Safety Datasheet and product labels for this material.

## Important Notice

The information and statements herein are believed to be reliable but are not to be construed as a warranty or representation for which Cytec Engineered Materials assumes legal responsibility or as an assumption of a duty on our part. Users should undertake sufficient verification and testing to determine the suitability for their own particular purpose of any information or products referred to herein. **NO WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE IS MADE.** Nothing herein is to be taken as permission, inducement or recommendation to practice any patented invention without license.

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