



Advanced General Aviation Transport Experiments

B – Basis Design Allowables for Epoxy – Based Prepreg

FiberCote Graphite Unitape T700 24K / E765

AGATE-WP3.3-033051-104
[Revision 1]

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1.0 INTRODUCTION

1.1 Scope

The test methods and results described in this document are intended to provide basic composite properties essential to most methods of analysis. These properties are considered to provide the initial base of the “building block” approach. Additional coupon level tests and subelement tests may be required to fully substantiate the full-scale design.

The test methods and results contained in this document are consistent with MIL-HDBK-17-1E,2D,3E - Military Handbook for Polymer Matrix Composites. All material, specimens, fixtures and test results contained within this document were traceable and conformed by the Federal Aviation Administration (FAA). It should be noted that before application of the basis values presented in this document to design, demonstration of the ability to consistently produce equivalent material properties as that evaluated during this program should be substantiated through an acceptable test program.

1.2 Symbols Used

ν_{12}^{tu}	major Poisson's ratio, tension
$\mu\epsilon$	micro-strain
E_1^c	compressive modulus, longitudinal
E_1^t	tensile modulus, longitudinal
E_2^c	compressive modulus, transverse
E_2^t	tensile modulus, transverse
F_{12}^{su}	in – plane shear strength
F_{13}^{su}	apparent interlaminar shear strength
F_1^{cu}	compressive strength, longitudinal
F_1^{tu}	tensile strength, longitudinal
F_2^{cu}	compressive strength, transverse
F_2^{tu}	tensile strength, transverse
G_{12}^s	in – plane shear modulus

Superscripts

c	compression
cu	compression ultimate
s	shear
su	shear ultimate
t	tension
tu	tension ultimate

Subscripts

1	1 – axis; longitudinal (parallel to warp direction of reinforcement)
2	2 – axis; transverse (parallel to fill direction of reinforcement)
12	in – plane shear
13	interlaminar shear (apparent)

1.3 Acronyms and Definitions

A – Basis	95% lower confidence limit on the first population percentile
AGATE	Advanced General Aviation Transport Experiments
ASTM	American Society for Testing and Materials
B – Basis	95% lower confidence limit on the tenth population percentile
C. V.	coefficient of variation
CTD	cold temperature dry
CPT	cured ply thickness
DMA	dynamic mechanical analysis
dry	specimen tested with an “as fabricated” moisture content
ETD	elevated temperature dry
ETW	elevated temperature wet
FAR	Federal Aviation Regulations
FAW	fiber areal weight
Gr/Ep	graphite/epoxy
NASA	National Aeronautics and Space Administration
RTD	room temperature dry
SACMA	Suppliers of Advanced Composite Materials Association
SRM	SACMA Recommended Method
T_g	glass transition temperature
t_{ply}	cured ply thickness
wet	specimen tested with an equilibrium moisture content per section 1.5.2

1.4 References

ASTM Standards

D3039-95	Tensile Properties of Polymer Matrix Composite Materials
D5379-93	Shear Properties of Composite Materials by the V-Notched Beam Method
D2344-89	Apparent Interlaminar Shear Strength of Parallel Fiber Composites by Short – Beam Method
D792-91	Density and Specific Gravity (Relative Density) of Plastics by Displacement
D2734-94	Void Content of Reinforced Plastics
D3171-90	Fiber Content of Resin – Matrix Composites by Matrix Digestion
D695-91	Compressive Properties of Rigid Plastics

SACMA Standards

SRM 1-94	Compressive Properties of Oriented Fiber-Resin Composites
SRM 8-94	Short Beam Shear Strength of Oriented Fiber-Resin Composites
SRM 18-94	Glass Transition Temperature (T_g) Determination by DMA of Oriented Fiber-Resin Composites

Other Documents

FiberCote Document Number E765 MS100, Material Specification: Carbon Fiber Reinforced Epoxy Resin, Rev. N/A

FiberCote Document Number E765 PS1000, Process Specification: Layup and Cure of Epoxy Prepreg Materials, 270-280°F Curing, Rev. N/A

FAA Document DOT/FAA/AR-00/47: Material Qualification and Equivalency for Polymer Matrix Composite Material Systems, J.S. Tomblin, Y.C. Ng and K.S. Raju, 2001.

MIL-HDBK-17 1E, 2D, 3E – Military Handbook for Polymer Matrix Composites

1.5 Methodology

1.5.1 Test Matrix

Testing was performed according to the test methods delineated in the test matrix, with modifications as referenced in the AGATE report, *Material Qualification and Equivalency for Polymer Matrix Composite Material Systems*. The test matrix for properties included in this document is listed on the next page, with the following notation cited in each column:

x

where the first # represents the required number of prepreg batches, defined as: Prepreg containing T700 24K graphite fibers from one mill roll, impregnated with one batch of resin in one continuous manufacturing operation with traceability to all components. The second # represents the required number of replicates per prepreg batch. For example, “3 x 6” refers to three prepreg batches of material and six specimens per prepreg batch for a total requirement of 18 test specimens.

Table 1.5.1: Test Matrix and Standards Used

TEST	METHOD	NO. OF REPLICATES PER TEST CONDITION			
		CTD ¹	RTD ²	ETW ³	ETD ⁴
0° (warp) Tension Strength	ASTM D3039-95	1x4	3x4	3x4	3x4
0° (warp) Tension Modulus, Strength and Poisson's Ratio	ASTM D3039-95	1x2	3x2	3x2	3x2
90° (fill) Tension Strength	ASTM D3039-95	1x4	3x4	3x4	3x4
90° (fill) Tension Modulus and Strength	ASTM D3039-95	1x2	3x2	3x2	3x2
0° (warp) Compression Strength	SACMA SRM 1-94	1x6	3x6	3x6	3x6
0° (warp) Compression Modulus	SACMA SRM 1-94	1x2	3x2	3x2	3x2
90° (fill) Compression Strength	SACMA SRM 1-94	1x6	3x6	3x6	3x6
90° (fill) Compression Modulus	SACMA SRM 1-94	1x2	3x2	3x2	3x2
In-Plane Shear Strength	ASTM D5379-93	1x4	3x4	3x4	3x4
In-Plane Shear Modulus and Strength	ASTM D5379-93	1x2	3x2	3x2	3x2
Short Beam Shear	ASTM D2344-89	1x6	3x6	3x6	3x6
Fiber Volume	ASTM D3171-90	One sample per panel			
Resin Volume	ASTM D3171-90	One sample per panel			
Void Content	ASTM D2734-94	One sample per panel			
Cured Neat Resin Density	---	Supplied by manufacturer for material			
Glass Transition Temperature	SACMA SRM 18-94	3 dry, 3 wet per prepreg batch			

Notes :

- 1 CTD: One prepreg batch of material tested (test temperature = $-65 \pm 5^{\circ}$ F, moisture content = as fabricated, soak time at -65 was 3 min.)
- 2 RTD: Three prepreg batches of material tested (test temperature = $70 \pm 10^{\circ}$ F, moisture content = as fabricated)
- 3 ETW: Three prepreg batches of material tested (test temperature = $180 \pm 5^{\circ}$ F, moisture content = equilibrium per section 1.5.2, soak time at 180 was 2 min.)
- 4 ETD: Three prepreg batches of material tested (test temperature = $180 \pm 5^{\circ}$ F, moisture content = as fabricated, soak time at 180 was 2 min.)

1.5.2 Environmental Conditioning

All 'wet' conditioned samples were exposed to elevated temperature and humidity conditions to establish moisture saturation of the material. Specimens were exposed to 85 ± 5 % relative humidity and 145 ± 5 °F until an equilibrium moisture weight gain of traveler, or witness coupons (1" x 1" x specimen thickness) was achieved. ASTM D5229 and SACMA SRM 11 were used as guidelines for environmental conditioning and moisture absorption.

Effective moisture equilibrium was achieved when the average moisture content of the traveler specimen changed by less than 0.05% for two consecutive readings within a span of 7 ± 0.5 days and was expressed by:

$$\frac{W_i - W_{i-1}}{W_b} < 0.0005$$

where W_i = weight at current time
 W_{i-1} = weight at previous time
 W_b = baseline weight prior to conditioning

It is common to see small fluctuations in an unfitted plot of the weight gain vs. time curve. There were no fluctuations that made significant errors in results or caused rejection in the moisture equilibrium criteria. Once the traveler coupons passed the criteria for two consecutive readings, the samples were removed from the environmental chamber and placed in a sealed bag with a moist paper or cotton towel for a maximum of 14 days until mechanical testing. Strain gauged specimens were removed from the controlled environment for a maximum of 2 hours for application of gages in ambient laboratory conditions.

1.5.3 Fluid Sensitivity Screening

Although epoxy-based materials historically have not been shown to be sensitive to fluids other than water or moisture, the influence of some fluids other than water or moisture on the mechanical properties were characterized. These fluids fell into two exposure classifications. The first class was considered to be in contact with the material for an extended period of time, and the second class was considered to be wiped on and off (or evaporate) with relatively short exposure times.

To assess the degree of sensitivity of fluids other than water or moisture, Table 1.5.2 shows the fluids which were used in this qualification plan.

Table 1.5.2: Fluid Types Used for Sensitivity Studies

Fluid Type	Specification	Exposure Classification
Jet Fuel (JP-4)	MIL-T-5624	Extended Period
Hydraulic Fluid (Tri-N-butyl phosphate ester)	MIL-H-5606G	Extended Period
Solvent (Methyl Ethyl Ketone)	Laboratory Grade	Wipe On and Off

To assess the influence of various fluids types, a test method sensitive to matrix degradation was used as an indicator of fluid sensitivity and compared to the unexposed results at both room temperature dry and elevated temperature dry conditions. Table 1.5.3 describes the fluid sensitivity-testing matrix with respect to the fluids defined in Table 1.5.2. Engineering judgment and statistical tests were used to assess the degree of material degradation. The results of this screening are included following the data sheets in section 3.2.2.

Table 1.5.3: Material Qualification Program for Fluid Resistance

Fluid Type	Test Method	Test Temp. (° F)	Exposure ¹	Number of Replicates ²
Jet Fuel JP-4	ASTM D5379 ³	180	See note 4	5
Hydraulic Fluid	ASTM D5379 ³	180	See note 5	5
Solvent (MEK)	ASTM D5379 ³	Ambient	See note 5	5

Notes :

- 1 Soaking in fluid at ambient temperature (immersion).
- 2 Only a single batch of material is required.
- 3 Shear strength only.
- 4 Immersion duration = 500 hours ± 50 hours
- 5 Immersion duration = 60 to 90 minutes

1.5.4 Normalization Procedures

The normalization procedure attempts to reduce variability in fiber-dominated material properties by adjusting raw test values to a specified fiber volume content. Only the following properties were normalized:

- 0° (warp) Tensile Strength and Modulus
- 0° (warp) Compression Strength and Modulus

The normalization procedure was adopted from MIL-HDBK-17-1E, section 2.4.3.3. The procedure which was used to normalize the data is based on two primary assumptions:

- The relationship between fiber volume fraction and ultimate laminate strength is linear over the entire range of fiber/resin ratios. (It neglects the effects of resin starvation at high fiber contents.)
- Fiber volume is not commonly measured for each test sample, so this method accounts for the fiber volume variation between individual test specimens by utilizing a relationship between fiber volume fraction and laminate cured ply thickness. This relationship is virtually linear in the 0.45 to 0.65 fiber volume fraction range.

Additional information is detailed in FAA Document DOT/FAA/AR-00/47: Material Qualification and Equivalency for Polymer Matrix Composite Material Systems. For all normalized data contained in this document, the test values are normalized by cured ply thickness according to:

$$\text{Normalized Value} = \text{Test Value} \times \frac{CPT_{\text{specimen}}}{CPT_{\text{normalizing}}}$$

where:

$$CPT_{\text{specimen}} = \frac{\text{Average Sample Thickness}}{\# \text{ of plies}}$$

1.5.5 Statistical Analysis

When compared to metallic materials, fiber reinforced composite materials exhibit a high degree of material property variability. This variability is due to many factors, including but not limited to: raw material and prepreg manufacture, material handling, part fabrication techniques, ply stacking sequence, environmental conditions, and testing techniques. This inherent variability drives up the cost of composite testing and tends to render smaller data sets than those produced for metallic materials. This necessitates the usage of statistical techniques for determining reasonable design allowables for composites.

The analyses and design allowable generation for both A and B basis values were performed using the procedure detailed in section 5.3 of FAA Document DOT/FAA/AR-00/47: *Material Qualification and Equivalency for Polymer Matrix Composite Material Systems.*

1.5.6 Material Performance Envelope and Interpolation

Using the B-basis numbers, a material performance envelope may be generated for the material system by plotting these values as a function of temperature. Figure 1.5.1 shows an example material performance envelope using B-basis values.

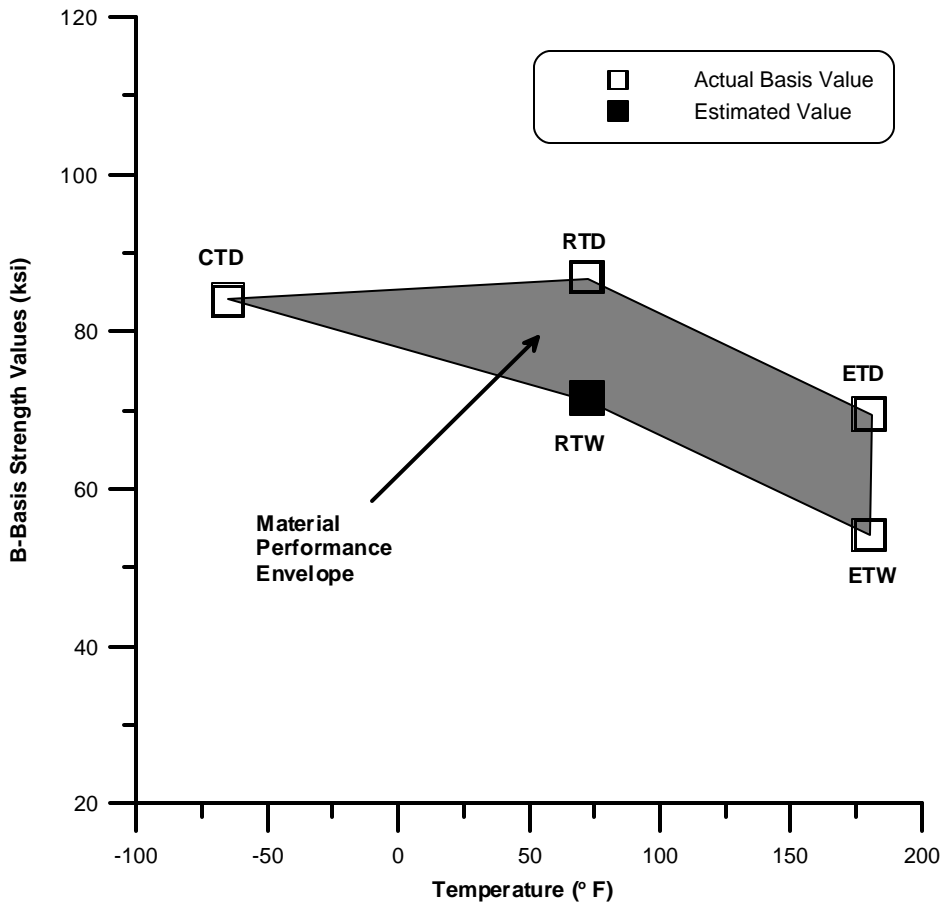


Figure 1.5.1 Material performance envelope.

Since each specific aircraft application of the qualified material may have different Material Operational Limits (MOL) than those tested in the material qualification (which is usually the upper limit), some applications may require a reduced MOL. In this case, simple linear interpolation may be used to obtain the corresponding basis values at the new application MOL.

This interpolation may be accomplished using the following simple relationships assuming $T_{RTD} < T_{MOL} < T_{ETD}$:

For the corresponding MOL “dry” basis value, the “interpolated” basis value using the qualification data is

$$B_{MOL} = B_{RTD} - \frac{(B_{RTD} - B_{ETD})(T_{RTD} - T_{MOL})}{(T_{RTD} - T_{ETD})}$$

where

- B_{MOL} = new application basis value interpolated to T_{MOL}
- B_{RTD} = basis RTD strength value
- B_{ETD} = basis ETD strength value
- T_{RTD} = RTD test temperature
- T_{ETD} = ETD test temperature
- T_{MOL} = new application MOL temperature

For the corresponding MOL “wet” basis value, an estimated Room Temperature Wet (RTW) value must be calculated. This may be accomplished by the simple relation

$$B_{RTW} = B_{RTD} - (B_{ETD} - B_{ETW})$$

The “interpolated” wet basis value using the qualification data may then be obtained by

$$B_{MOL} = B_{RTW} - \frac{(B_{RTW} - B_{ETW})(T_{RTW} - T_{MOL})}{(T_{RTW} - T_{ETW})}$$

where:

- B_{MOL} = new application basis value interpolated to T_{MOL}
- B_{RTW} = estimated basis RTW strength value
- B_{ETW} = basis ETW strength value
- T_{RTW} = RTW (i.e., RTD) test temperature
- T_{ETW} = ETW test temperature
- T_{MOL} = new application MOL temperature

These equations may also be used for interpolated mean strengths as well as A-basis values with the appropriate substitutions. It should be noted that because unforeseen material property drop-offs with respect to temperature and environment can occur, *extrapolation* to a higher MOL should not be attempted without additional testing and verification. In addition, the interpolation equations shown above are practical for materials obeying *typical* mechanical behavior. In most cases, some minimal amount of testing may also be required to verify the interpolated values.

1.5.6.1 Interpolation Example

This section provides an example of linear interpolations to a specific application environment less than the tested upper material limit used in qualification. Assuming a specific application environment of 150° F, Figure 1.5.2 depicts the linear interpolation of the B-basis design allowable to this environment. Using the above

equations along with the nominal testing temperatures (see Table 1.5.1), the interpolated basis values at 150° F become

$$\text{ETD} : B_{\text{MOL}} = 75.106 \text{ ksi}$$

$$\text{ETW} : B_{\text{MOL}} = 59.746 \text{ ksi}$$

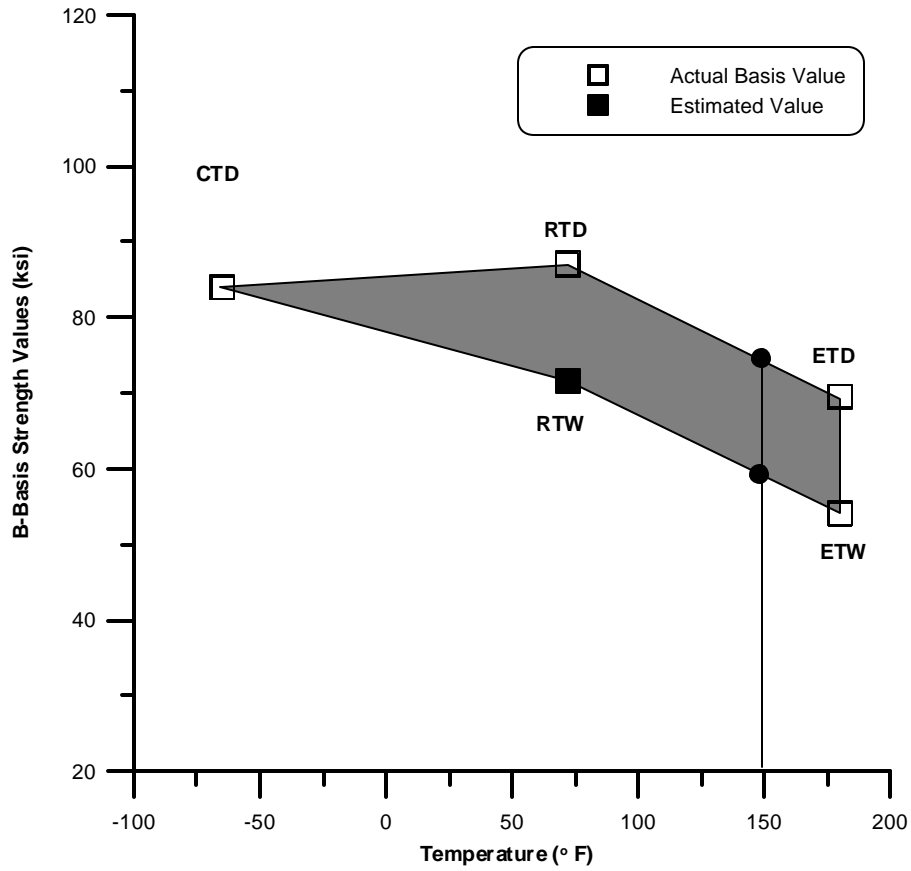


Figure 1.5.2 Example of 150° F interpolation for B-basis values.

2.0 FIBERCOTE T700 24K/E765 PREPREG PROPERTIES

2.1 Prepreg Documentation by Prepreg Lot

Prepreg Documentation	Prepreg Manufacturer & Product ID: FiberCote E765 T700		
	Material Identification (weave, form, class, etc.): T700		
	Impregnation Method: Hot Melt		
Prepreg Batch or Lot #	121897-IT2	121997-IT2	123097-IT2
Batch (Lot) ID as labeled on samples	1	2	3
Date of Manufacture	12/18/97	12/19/97	12/30/97
Expiration Date	12/18/98	12/19/98	12/30/98
Resin Content [%]	35.0	34.5	32.9
Reinforcement Areal Weight & Test Method	150.6 gsm	150.0 gsm	148.7 gsm
Resin Flow & Test Conditions	11.5%	9.2%	10.3%
Gel Time & Test Conditions	327 seconds	400 seconds	347 seconds
Volatile Content	0.2%	0.2%	0.1%
Reinforcement Documentation	Fiber/Fabric Manufacturer & Product ID: Toray T700 24K		
	Precursor Type: PAN		
	Nominal Filament Count: 24K		
	Finish/Sizing Type and %: S - 1% nom.		
	Nominal tow or yarn count/inch: 2.4		
	Twist: 0		
Fabric Batch or Lot #	717024	717024	717013
Date of Manufacture	2/97	2/97	2/97
Average Fiber Density per Lot & Test Method	1.80	1.80	1.80
Matrix Documentation	Resin Manufacturer & Product ID: FiberCote E765		
Matrix Batch or Lot #	1217971M1	1216975M1	1216974M2
Date of Manufacture	12/17/97	12/16/97	12/16/97
Average Neat Resin Density by Lot & Test Method	1.23	1.23	1.23

Notes: (1) Test methods to determine resin content, reinforcement areal weight, resin flow, gel time, and volatile content are defined in FiberCote Material Specification E765 MS1001. (2) These information and test results were submitted to NIAR by FiberCote Industries Inc.

2.2 Process Specification

2.2.1 Storage

When not in use, all prepreg materials were stored at or below 0°F.

2.2.2 Out Times

Maximum cumulative out time units did not exceed 180 as defined by the following equations:

- N = Cumulative Units
- N1 = Days at 0°F (180 max., N2 and N3 equal to zero)
- N2 = Days between 1°F and 59°F (90 max., N1 and N3 equal to zero)
- N3 = Days between 60°F and 85°F (28 max., N1 and N2 equal to zero)
- N = N1 + 2 x N2 + 6 x N3

This time included shipping time, storage on-the-roll, out time for cutting, and any storage time as a kit of pre-cut plies.

2.2.3 Working Environment

All handling and lay-up of prepreg materials was conducted in a reasonably clean environment. No tool preparation, drilling, grinding, trimming, sanding, or other process creating particles was conducted in the same room as the lay-up of prepreps. There were no solvents, lubricants, mold release agents, or other potential contaminants used or stored in the same room with prepreg materials.

Unless otherwise validated for the material system in use, the area was temperature and humidity controlled such that the minimum temperature was 65°F with a corresponding relative humidity not greater than 63 percent. The maximum temperature was 75°F with a corresponding relative humidity not greater than 46 percent. The temperature and relative humidity values between the minimum and maximum acceptable values listed above formed a straight-line relationship. Procedures for Quality Control to verify and record temperature and humidity conditions were established to ensure environmental stability.

A continuous recording device was used.

Sensors and recording devices maintained calibrations traceable to NIST. Re-calibration frequency was in accordance with manufacturers' recommendations.

Quality Assurance will maintain a file of all continuous records for a minimum of three (3) years.

2.2.4 Mold Preparation

Each mold or lay-up surface was cleaned prior to lay-up, using non-contaminating cleaners, such as Acetone or alcohol. Mold preparation was performed outside the lay-up room.

After cleaning, each mold was treated with non-contaminating release agents in accordance with the supplier's instructions.

Thermocouple quantity and location have been specified on the shop traveler.

Witness panels, when required, were fabricated to specific instructions on the shop traveler and represented at least one zone of the part.

2.2.5 Cutting and Lay-up

The cutting and lay-up area was kept free of contaminants.

Prepreg laminations were pre-cut and grouped into kits for lay-up and cure, therefore, the poly-film backing provided by FiberCote was not be removed until each ply was ready to be placed in the lay-up mold. Kits were stored in sealed, moisture-proof containers until lay-up.

Before lay-up, the prepreg material was near ambient temperature. Upon removal from storage, the prepreg materials were allowed to warm to room temperature inside the sealed moisture-proof bag for 3 1/2 hours.

Any peel ply requirements are specified on the drawing and/or shop traveler.

Because of no other specifications on the drawing, splices were allowed. They overlapped by at least one inch and no two splices in a single ply were placed closer than 24 inches. Minimum distance between splices in adjacent plies was six inches. Butt splices were generally avoided. If butt splices were used, the maximum gap at any point was 0.030 inches. Butt splices had one additional ply of material, the same as the base laminate, which extended for at least one inch on either side of the splice joint. There were at least three plies of unspliced material between any two butt splices.

Splicing was not allowed on material qualification specimens.

White, lint-free cotton gloves were required for hand / personal protection. Talc-free latex or nitrile gloves were acceptable alternates.

No cutting of prepreg materials was permitted on the tool.

Debulking was performed in order to achieve appropriate compaction.

Debulking according to the following procedure was required no less frequently than every eight (8) plies of woven fabric.

- a. One layer of porous release fabric was applied over the prepreg lay-up.
- b. One layer of breather was applied on top of the porous release film. If the breather was not contaminated with resin or other foreign material, the breather was re-used.
- c. Nylon bagging film was installed over the laminate or a silicone rubber bag and was form-fit and edge sealed to the tool with vacuum bag sealant; the vacuum connector was installed through the bag. Multiple vacuum connectors were used so that no point on the part was more than 60 inches from a vacuum source.

Note: The vacuum connectors were installed on the tool surface outside the perimeter of the laminate wherever possible. Placing the connector in a bag pleat was an acceptable alternate.

- d. Vacuum of at least 18 inches Hg was applied for at least 15 minutes at a rate that did not cause the prepreg to shift. When specified by the applicable shop traveler, the laminate was heated to 100°F maximum and held for 10-15 minutes during vacuum application but there were no more than six (6) debulks at 100°F on any lay-up.

Before lay-up, the prepreg material was equilibrated near ambient temperature. Upon removal from storage, the prepreg materials were allowed to warm to room temperature inside the sealed moisture-proof bag for 3 1/2 hours.

2.2.6 Bagging

The procedure was as follows:

- a. One layer of porous release fabric was applied over the prepreg lay-up.
- b. When specified on the shop traveler, bleeder cloth the same size as the laminate was applied over the release film. All wrinkles were smoothed out.

For laminates of six (6) plies or greater, such as qualification panels, two (2) or four (4) bleeder plies were added to aid in volatiles removal from the relatively tight weaves of E-765 6K 5HS and E-765 7781 materials.

Note: Porous release film and bleeder cloth were not used on Test Panels

- c. Breather strings were applied from each corner of the part to contact the breather fabric.
- d. One layer on non-porous release film was applied over the lay-up; extending at least 1/2 inch past each edge of the part.
- e. One layer of breather fabric was applied over the lay-up ensuring that it formed a path to the breather.
- f. Vacuum sources were not on the surface of the part. There were at least two (2) sources for any part larger than four (4) square ft. For larger parts, at least one vacuum connection was provided for every 18 square ft. of laminate surface. Where possible, the maximum distance to any point on the laminate surface did not exceed 60 inches. Applying extra breather under the vacuum port protected against resin clogging.
- g. Nylon bagging film was applied and edge sealed to the tool with vacuum bag sealant.
- h. The bag was evacuated to at least 18 inches Hg and was adjusted to eliminate wrinkles and bridging.
- i. A vacuum gauge was installed at the vacuum probe connector. The bagged assembly was allowed to stand for at least 15 minutes with an applied vacuum of at least 18 inches Hg. The vacuum source was removed and the bag vacuum monitored. Leakage did not exceed

three (3) inches Hg in the first five (5) minutes after the vacuum source was removed.

2.2.7 Cure Cycle

All prepreg materials were cured according to tightly controlled time, temperature and vacuum requirements as shown in Table 2.2.1. Further details are clarified in FiberCote Process Specification E765 PS11000.

Table 2.2.1: Cure Cycles

Temperature Ramp rate	Cure Temperature	Pressure	Cooling Rate	Dwell Time At Cure
°F/Min.	°F (as defined by slowest heating part)	In. Hg	°F/Min.	Minutes
1 - 6	270 - 280	20 - 28	3 - 10	110 - 130

3.0 FIBERCOTE T700 24K/E765 LAMINA PROPERTIES

3.1 Test Results

3.1.1 Summary

MATERIAL: FiberCote E765/T700 24K Unidirectional Graphite	E765/T700 24K
PREPREG: FiberCote E765 T700	Summary
FIBER: Toray T700 24K	RESIN: FiberCote E765
T_g (dry): 304.4°F	T_g (wet): 208.0°F
T_g METHOD: DMA (SRM 18-94)	
PROCESSING: Vacuum bag cure (18+ in. Hg): 270-280°F for 110-130 min.	

Date of fiber manufacture 2/97	Date of testing 12/7/98 – 1/13/99
Date of resin manufacture 12/16/97 – 12/17/97	Date of data submittal 2/8/99
Date of prepreg manufacture 12/18/97 – 12/30/97	Date of analysis 12/9/98 – 1/13/99
Date of composite manufacture 6/30/98 – 7/22/98	

LAMINA MECHANICAL PROPERTY SUMMARY

Data Reported as: Measured
 (Normalized by CPT= 0.0056 in)

	CTD		RTD		ETD		ETW	
	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean	B-Basis	Mean
F₁^{tu} (ksi)	303.81 (317.54)	369.99 (379.82)	313.01 (323.67)	370.31 (377.17)	294.75 (304.93)	348.71 (355.33)	283.94 (290.39)	333.18 (335.89)
E₁^t (Msi)	---	18.75 (19.29)	---	18.71 (19.02)	---	18.15 (18.44)	---	18.61 (18.71)
ν₁₂^{tu}	---	0.358	---	0.319	---	0.286	---	0.314
F₂^{tu} (ksi)	4.92	6.82	4.64	6.12	3.93	5.16	1.84	2.39
E₂^t (Msi)	---	1.48	---	1.36	---	1.08	---	0.98
F₁^{cu} (ksi)	165.43 (172.16)	210.75 (211.88)	147.22 (150.30)	179.72 (178.43)	143.87 (149.22)	176.73 (178.09)	88.03 (90.00)	107.09 (106.52)
E₁^c (Msi)	---	17.89 (18.14)	---	18.05 (18.16)	---	18.44 (18.39)	---	18.04 (17.71)
F₂^{cu} (ksi)	32.03	40.78	23.56	28.94	19.17	23.54	10.85	13.20
E₂^c (Msi)	---	2.21	---	1.68	---	1.39	---	1.25
F₁₂^{su} (ksi)	21.26	25.59	17.05	19.97	13.43	15.73	9.14	10.66
G₁₂^s (Msi)	---	0.64	---	0.65	---	0.54	---	0.38
F₁₃^{su*} (ksi)	---	---	12.67	13.67	---	---	---	---

* *Apparent* interlaminar shear strength

3.1.2 Individual Test Summaries

3.1.2.1 Tension, 1-axis

Material:		FiberCote-E765/T700 24K Unidirectional Graphite		Resin content:		31 - 36 wt%		Comp. density:		1.53 - 1.59 g/cc		Tension, 1-axis Gr/Ep FiberCote-E765/T700 24K Graphite Uni [0]₈			
Fiber volume:		54 - 59 vol%		Void content:		0.0 to 1.9 %		Ply thickness:		0.0052 - 0.0060 in.		Ply range:		8 plies	
Test method:		D3039-95		Modulus calculation:		linear fit from 1000 - 3000 $\mu\epsilon$		Normalized by:		0.0056 in. ply thickness					
		CTD (B)		RTD (A)		ETD (G)		ETW (F)							
Test Temperature [°F]		-65		75		180		180							
Moisture Conditioning		dry		dry		dry		equilibrium							
Equilibrium at T, RH		as fabricated		as fabricated		as fabricated		145 F, 85 %							
Source code		TAJXXXXB		TAJXXXXA		TAJXXXXG		TAJXXXXF							
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured				
F_1^{tu} (ksi)	Mean	379.82	369.99	377.17	370.31	355.33	348.71	335.89	333.18						
	Minimum	368.12	360.92	327.68	307.98	268.84	258.92	265.41	258.95						
	Maximum	393.70	379.58	408.34	403.95	401.59	384.44	373.99	364.64						
	C.V.(%)	2.48	2.19	5.57	7.09	10.66	11.30	8.73	9.37						
	B-value	317.54	303.81	323.67	313.01	304.93	294.75	290.39	283.94						
	A-value	282.92	267.01	288.44	275.27	271.74	259.21	258.63	249.58						
	No. Specimens	6		18		18		30							
No. Prepreg Lots	1		3		3		3								
E_1^t (Msi)	Mean	19.29	18.75	19.02	18.71	18.44	18.15	18.71	18.61						
	Minimum	19.19	18.50	17.86	18.32	17.27	16.92	17.49	18.12						
	Maximum	19.39	19.00	19.51	19.87	19.21	18.94	19.53	18.85						
	C.V.(%)	0.73	1.89	3.30	3.12	3.79	4.78	4.16	1.41						
	No. Specimens	2		6		6		6							
No. Prepreg Lots	1		3		3		3								
η_{12}^t	Mean	0.358		0.319		0.286		0.314							
	No. Specimens	2		6		6		6							
	No. Prepreg Lots	1		3		3		3							

3.1.2.2 Tension, 2-axis

Material: FiberCote-E765/T700 24K Unidirectional Graphite Resin content: 27 - 37 wt% Comp. density: 1.52 - 1.57 g/cc Fiber volume: 54 - 62 vol% Void content: 0.0 to 1.7 % Ply thickness: 0.0054 - 0.0060 in. Ply range: 18 plies Test method: D3039-95 Modulus calculation: linear fit from 1000 - 3000 $\mu\epsilon$ Normalized by: N/A						Tension, 2-axis Gr/Ep FiberCote-E765/T700 24K Graphite Uni [0]₁₈					
		CTD (B)		RTD (A)		ETD (G)		ETW (F)			
Test Temperature [°F]		-65		75		180		180			
Moisture Conditioning		dry		dry		dry		equilibrium			
Equilibrium at T, RH		as fabricated		as fabricated		as fabricated		145 F, 85 %			
Source code		TAUXXXXB		TAUXXXXA		TAUXXXXG		TAUXXXXF			
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured		
F₂^{tu} (ksi)	Mean		6.82		6.12		5.16		2.39		
	Minimum		5.94		4.76		4.15		1.86		
	Maximum		7.66		7.84		6.72		2.89		
	C.V.(%)		9.50		16.99		16.48		10.96		
	B-value		4.92		4.64		3.93		1.84		
	A-value		3.86		3.67		3.11		1.46		
	No. Specimens		6		18		18		30		
No. Prepreg Lots		1		3		3		3			
E₂^t (Msi)	Mean		1.48		1.36		1.08		0.98		
	Minimum		1.46		1.32		1.02		0.83		
	Maximum		1.49		1.43		1.16		1.09		
	C.V.(%)		1.51		2.78		4.78		8.74		
	No. Specimens		2		6		6		6		
	No. Prepreg Lots		1		3		3		3		

3.1.2.3 Compression, 1-axis

Material: FiberCote-E765/T700 24K Unidirectional Graphite		Compression, 1-axis									
Resin content: 32 - 37 wt%		Comp. density: 1.51 - 1.60 g/cc		FiberCote-E765/T700 24K Graphite Uni [0]₇							
Fiber volume: 54 - 59 vol%		Void content: 0.0 to 2.4 %									
Ply thickness: 0.0051 - 0.0060 in.											
Ply range: 7 plies											
Test method: SRM 1-94, D695-91 (mod)		Modulus calculation: linear fit from 1000 - 3000 $\mu\epsilon$									
Normalized by: 0.0056 in. ply thickness											
	CTD (B)		RTD (A)		ETD (G)		ETW(F)				
Test Temperature [°F]	-65		75		180		180				
Moisture Conditioning	dry		dry		dry		equilibrium				
Equilibrium at T, RH	as fabricated		as fabricated		as fabricated		145 F, 85 %				
Source code	TAKXXXXB		TAKXXXXA		TAKXXXXG		TAKXXXXF				
	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	
F₁^{cu} (ksi)	Mean	211.88	210.75	178.43	179.72	178.09	176.73	106.52	107.09		
	Minimum	201.90	200.27	142.55	137.80	153.57	147.73	80.74	84.51		
	Maximum	225.27	223.99	217.87	226.54	208.02	202.72	126.42	131.01		
	C.V.(%)	4.57	4.57	10.60	12.80	7.72	8.38	10.19	11.39		
	B-value	172.16	165.43	150.30	147.22	149.22	143.87	90.00	88.03		
	A-value	150.13	140.29	131.18	125.13	130.27	122.29	78.53	74.81		
	No. Specimens	6		24		18		29			
	No. Prepreg Lots	1		3		3		3			
	E₁^c (Msi)	Mean	18.14	17.89	18.16	18.05	18.39	18.44	17.71	18.04	
		Minimum	17.78	17.66	16.78	17.07	17.37	16.97	16.73	17.25	
Maximum		18.49	18.13	20.74	19.85	21.29	21.41	18.22	19.59		
C.V.(%)		2.78	1.85	7.78	5.97	7.99	8.66	2.96	5.24		
No. Specimens		2		6		6		6			
No. Prepreg Lots		1		3		3		3			

3.1.2.4 Compression, 2-axis

Material: FiberCote-E765/T700 24K Unidirectional Graphite Resin content: 34 - 37 wt% Fiber volume: 52 - 57 vol% Ply thickness: 0.0053 - 0.0061 in. Ply range: 7 plies Test method: SRM 1-94, D695-91 (mod) Normalized by: N/A						Compression, 2-axis Gr/Ep FiberCote-E765/T700 24K Graphite Uni [0]₇					
			Comp. density: 1.52 - 1.55 g/cc Void content: 0.0 to 1.2 %								
			Modulus calculation: linear fit from 1000 - 3000 $\mu\epsilon$								
		CTD (B)		RTD (A)		ETD (G)		ETW(F)			
Test Temperature [°F]		-65		75		180		180			
Moisture Conditioning		dry		dry		dry		equilibrium			
Equilibrium at T, RH		as fabricated		as fabricated		as fabricated		145 F, 85 %			
Source code		TAWXXXXB		TAWXXXXA		TAWXXXXG		TAWXXXXF			
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured		
F₂^{cu} (ksi)	Mean		40.78		28.94		23.54		13.20		
	Minimum		33.85		23.08		19.95		10.58		
	Maximum		50.29		33.40		26.62		15.51		
	C.V.(%)		16.72		11.52		8.56		10.42		
	B-value		32.03		23.56		19.17		10.85		
	A-value		27.16		20.02		16.29		9.22		
	No. Specimens		6		18		18		29		
No. Prepreg Lots		1		3		3		3			
E₂^c (Msi)	Mean		2.21		1.68		1.39		1.25		
	Minimum		2.07		1.54		1.21		1.16		
	Maximum		2.34		1.79		1.57		1.32		
	C.V.(%)		8.60		6.90		9.46		4.76		
	No. Specimens		2		5		6		6		
	No. Prepreg Lots		1		3		3		3		

3.1.2.5 Shear, 12 axis

Material: FiberCote-E765/T700 24K Unidirectional Graphite						Shear, 12-axis Gr/Ep FiberCote-E765/T700 24K Graphite Uni [0/90]_{6S}					
Resin content: 34 - 36 wt%		Comp. density: 1.54 - 1.57 g/cc		Void content: 0.0 to 1.1 %							
Fiber volume: 55 - 57 vol%		Ply thickness: 0.0055 - 0.0059 in.		Ply range: 24 plies							
Test method: D5379-93		Modulus calculation: linear fit from 1000 - 6000 $\mu\epsilon$									
Normalized by: N/A											
		CTD (B)		RTD (A)		ETD (G)		ETW(F)			
Test Temperature [°F]		-65		75		180		180			
Moisture Conditioning		dry		dry		dry		equilibrium			
Equilibrium at T, RH		as fabricated		as fabricated		as fabricated		145 F, 85 %			
Source code		TANXXXXB		TANXXXXA		TANXXXXG		TANXXXXF			
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured
F₁₂^{su} (ksi)		Mean		25.59		19.97		15.73		10.66	
		Minimum		22.90		18.05		13.77		8.18	
		Maximum		27.62		21.73		17.20		12.71	
		C.V.(%)		6.10		4.24		6.13		12.32	
		B-value		21.26		17.05		13.43		9.14	
		A-value		18.85		15.12		11.91		8.10	
		No. Specimens		6		18		18		23	
		No. Prepreg Lots		1		3		3		3	
G₁₂^s (Msi)		Mean		0.64		0.65		0.54		0.38	
		Minimum		0.60		0.61		0.48		0.26	
		Maximum		0.69		0.70		0.61		0.49	
		C.V.(%)		10.07		6.09		8.46		26.09	
		No. Specimens		2		6		6		6	
		No. Prepreg Lots		1		3		3		3	

3.1.2.6 Shear, 13 axis

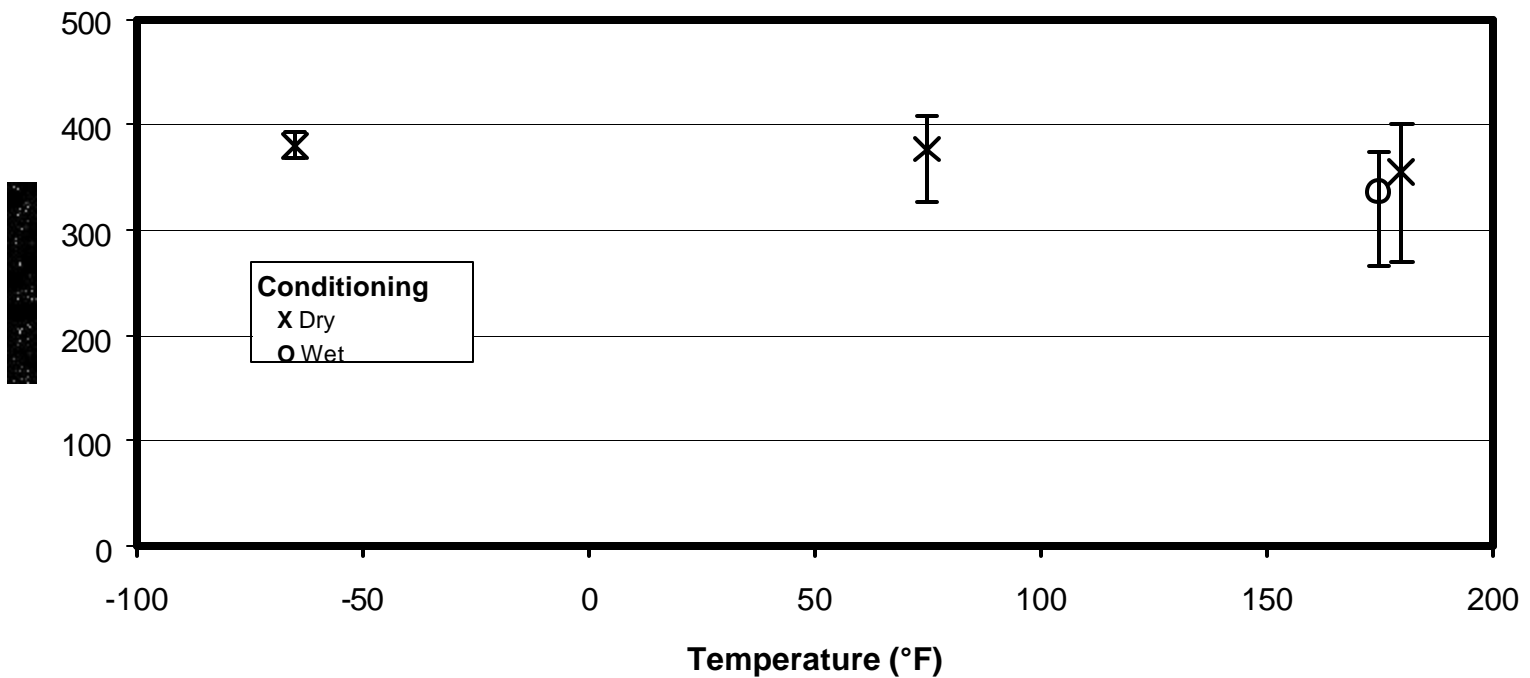
Material: FiberCote-E765/T700 24K Unidirectional Graphite						Shear, 13-axis Gr/Ep FiberCote-E765/T700 24K Graphite Uni [0]₁₈							
Resin content: 33 - 35 wt%		Comp. density: 1.54 - 1.57 g/cc		Fiber volume: 56 - 59 vol%		Void content: 0.0 to 0.4 %		Ply thickness: 0.0054 - 0.0058 in.		Ply range: 18 plies			
Test method: D2344-89						Modulus calculation: N/A							
Normalized by: N/A						RTD (A)							
Test Temperature [°F]			75			Moisture Conditioning			dry				
Equilibrium at T, RH			as fabricated			Source code			TAQXXXXA				
		Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured	Normalized	Measured		
F₁₃^{su} (ksi)		Mean		13.67		Minimum		12.22		Maximum		14.31	
		C.V.(%)		3.83		B-value		12.67		A-value		11.95	
		No. Specimens		21		No. Prepreg Lots		3					

NOTES: These values represent the apparent interlaminar shear properties and are to be used for quality control purposes only. Do not use these values for interlaminar shear strength design values.

3.1.3 Individual Test Charts

3.1.3.1 Tension, 1-axis

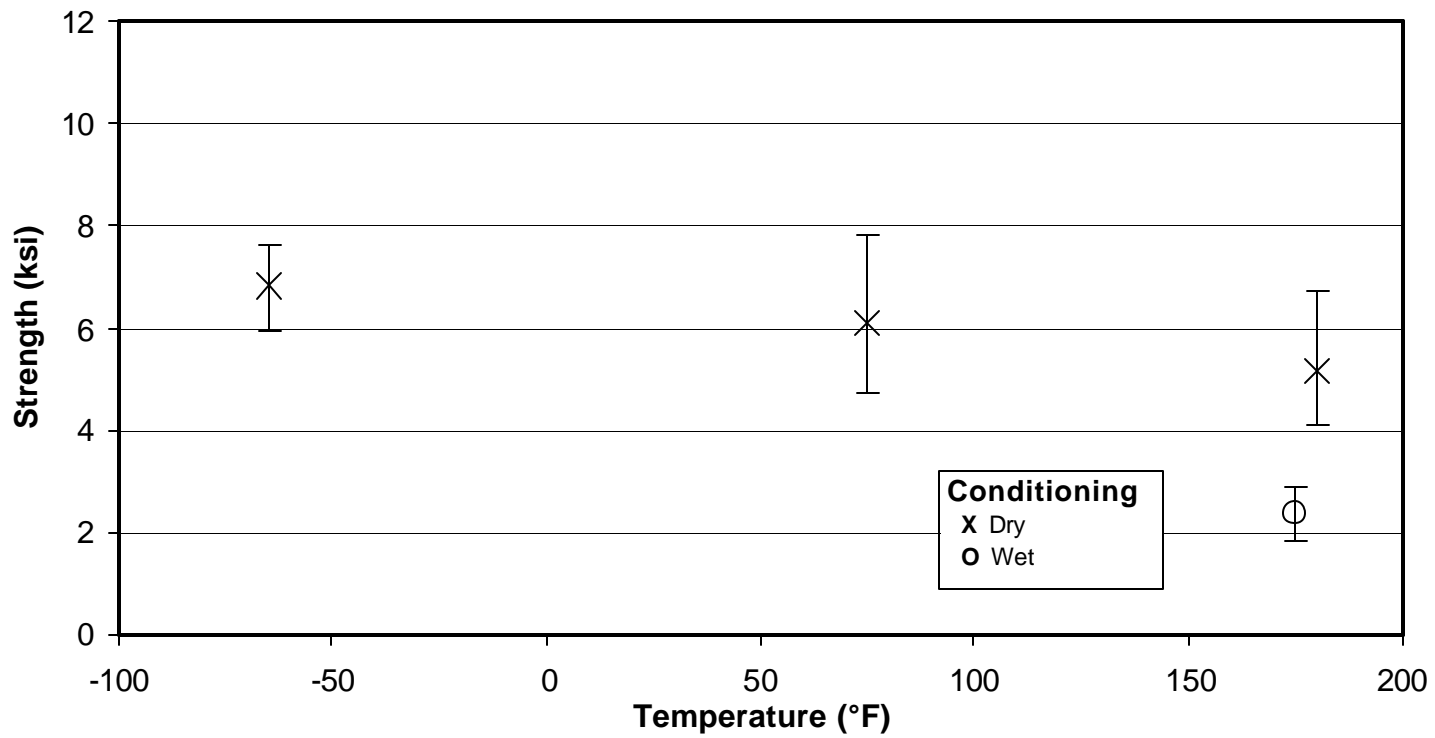
0° Tension -- Normalized Strength Fibercote-E765/T700 24K Unidirectional Graphite



NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data has been staggered for clarity

3.1.3.2 Tension, 2-axis

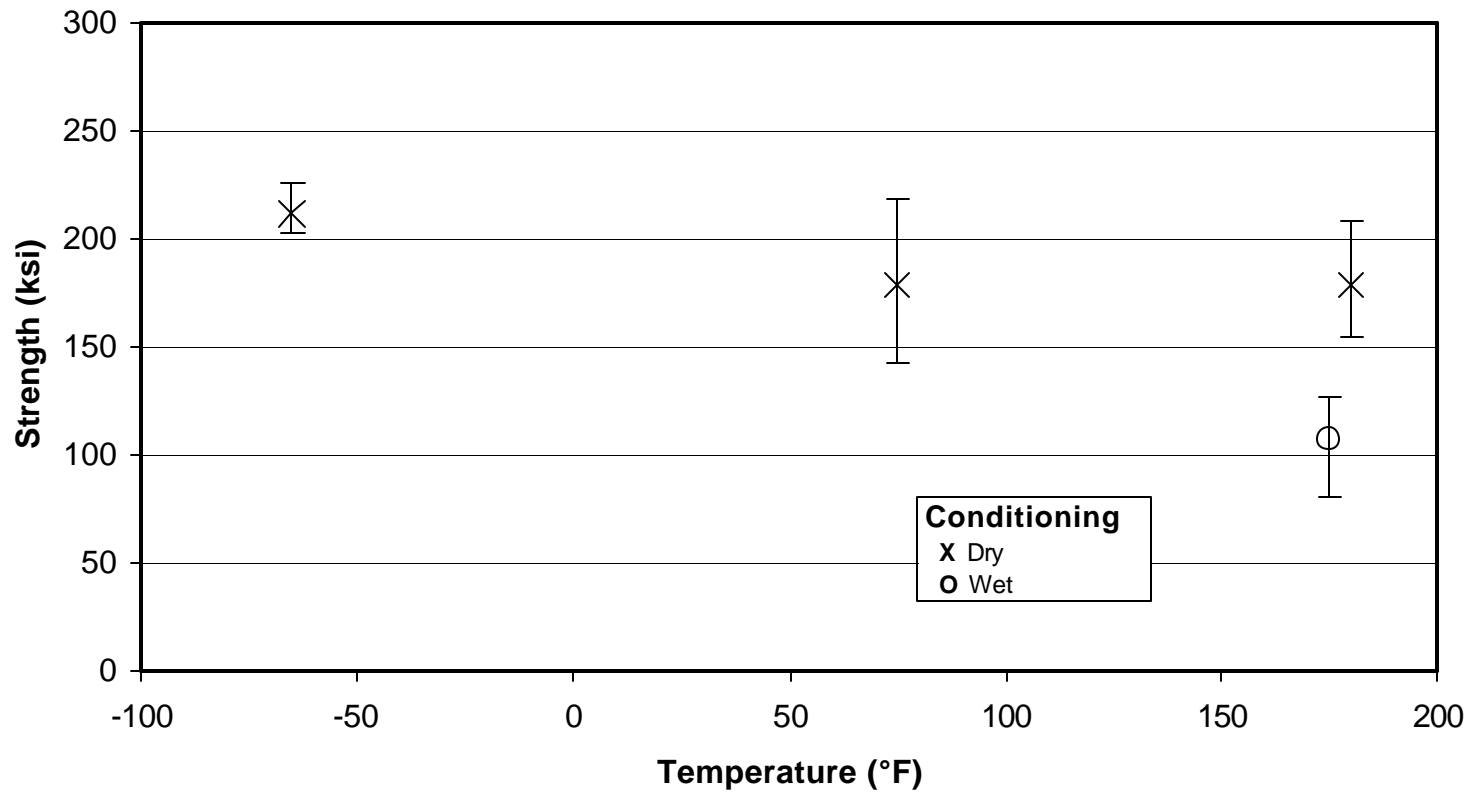
90° Tension -- Measured Strength Fibercote-E765/T700 24K Unidirectional Graphite



NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data has been staggered for clarity.

3.1.3.3 Compression, 1-axis

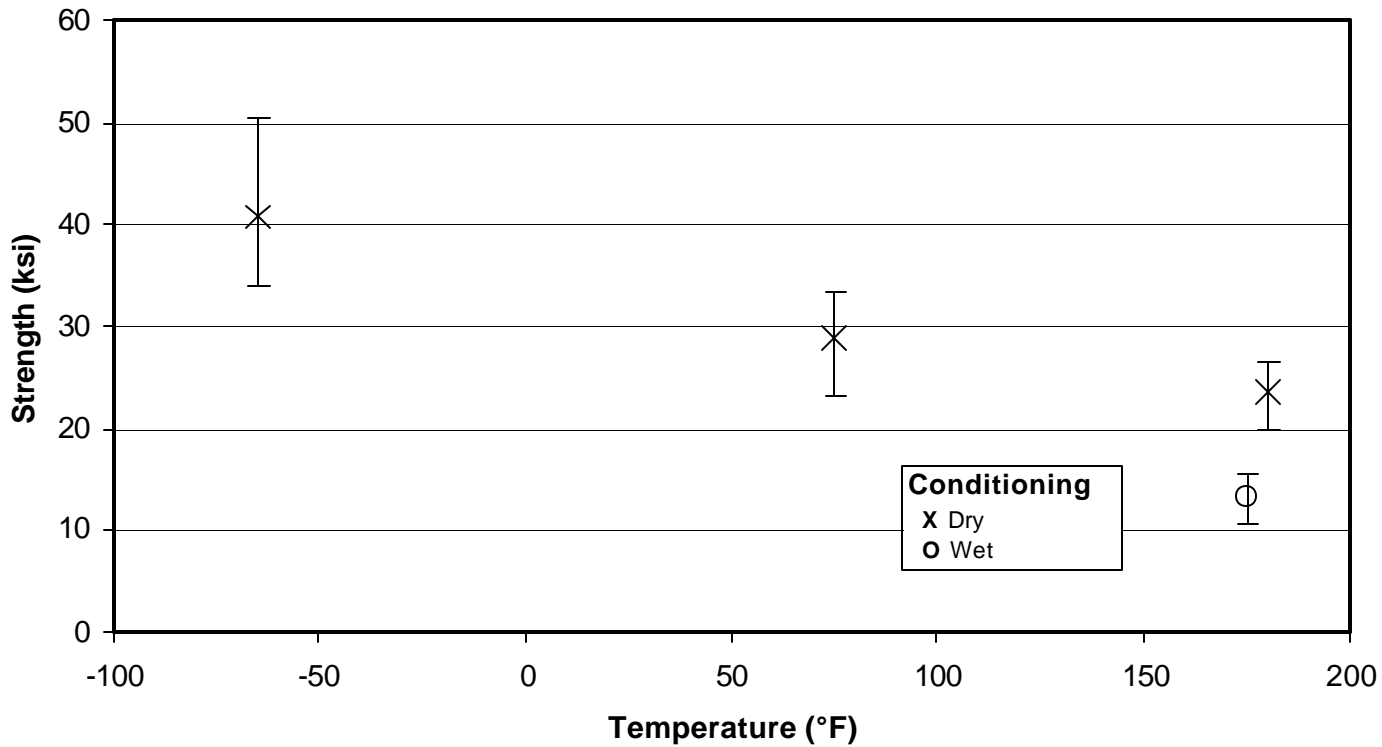
0° Compression -- Normalized Strength
Fibercote-E765/T700 24K Unidirectional Graphite



NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data has been staggered for clarity.

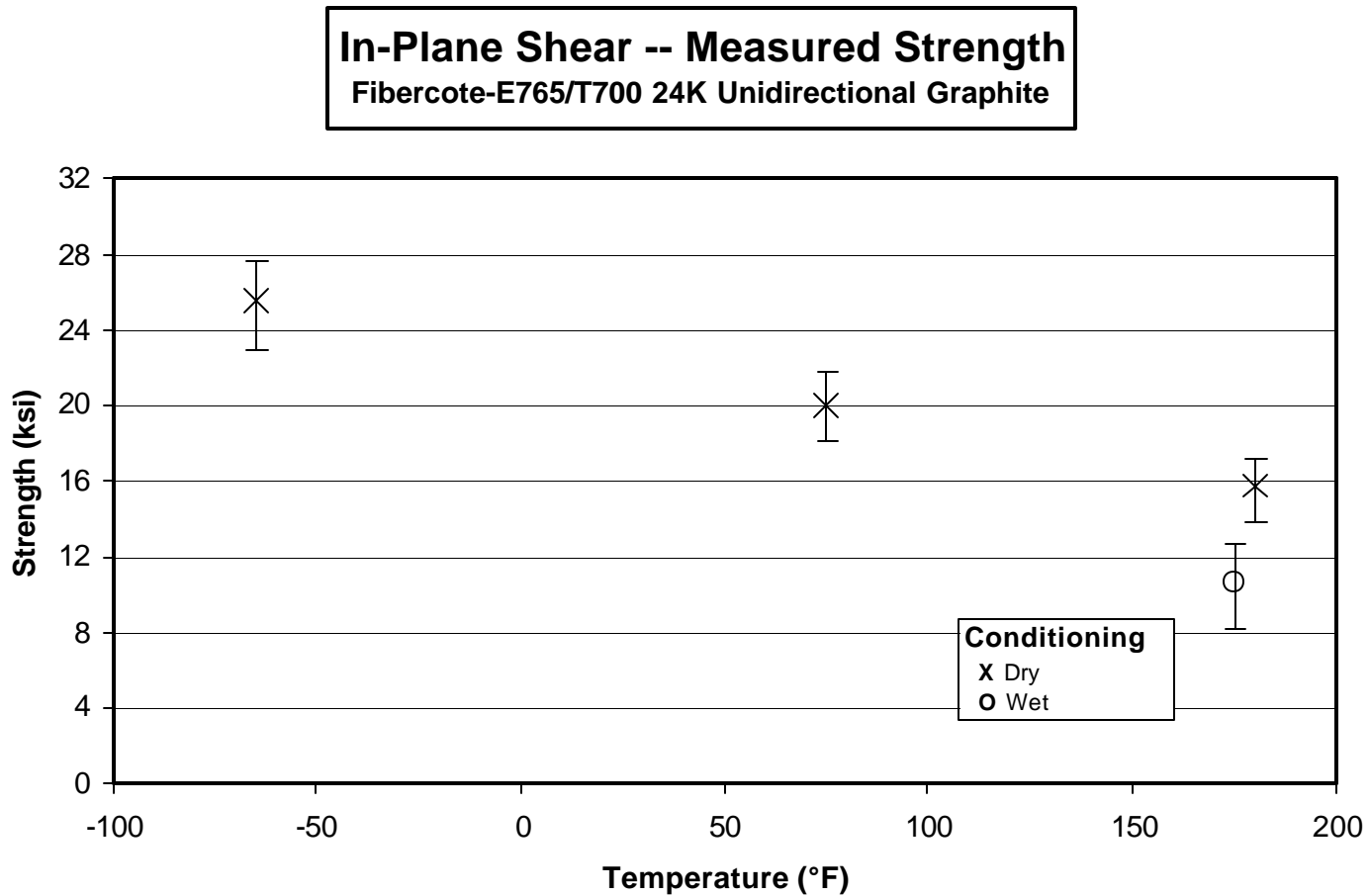
3.1.3.4 Compression, 2-axis

90° Compression -- Measured Strength Fibercote-E765/T700 24K Unidirectional Graphite



NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data has been staggered for clarity.

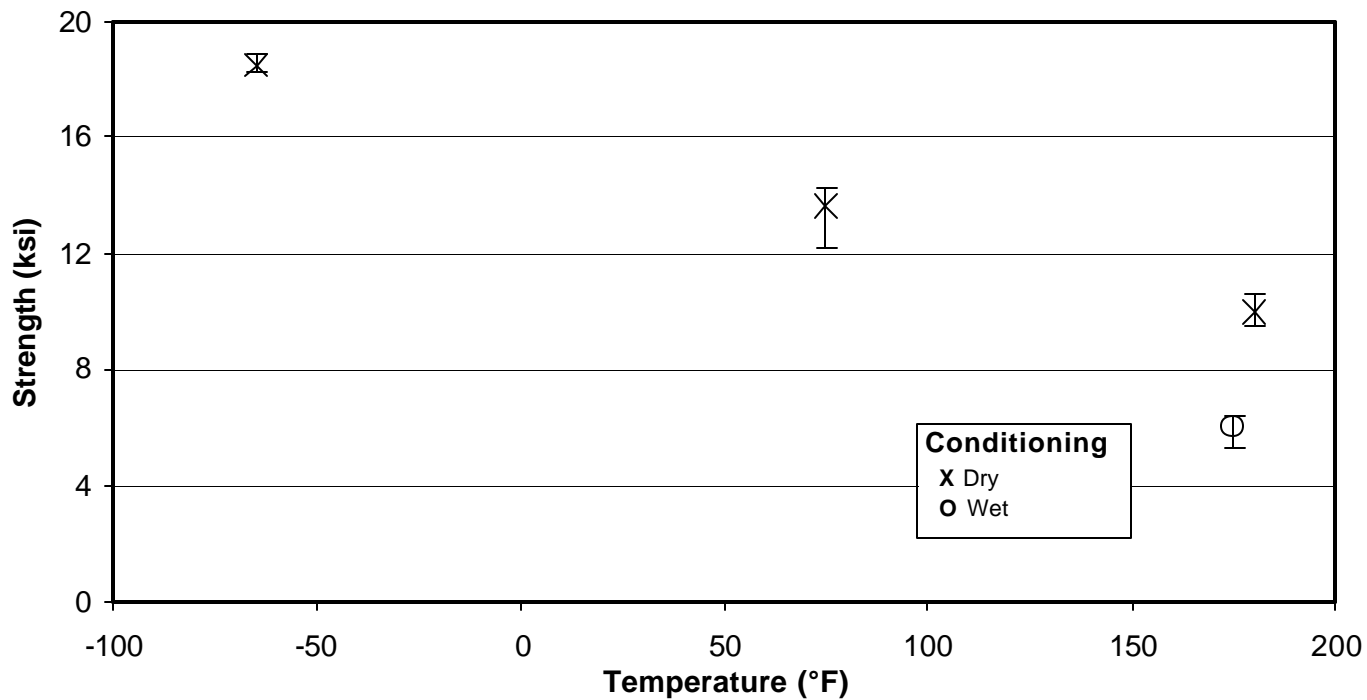
3.1.3.5 Shear, 12 axis



NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data has been staggered for clarity

3.1.3.6 Shear, 13 axis

Apparent Interlaminar Shear -- Measured Strength Fibercote-E765/T700 24K Unidirectional Graphite



NOTE: The symbols represent the 'pooled' average of all tests, and the bars represent the upper and lower limit of the data. The 180° dry and wet data has been staggered for clarity.

3.2 Raw Data

Specimen Naming Convention

Test coupons were identified using an eight-digit specimen code, with the significance of each digit delineated below. A representative sample ID is shown for reference purposes.

T A J 2 1 2 5 F

1st Character: Fabricator

'T' designates Fibercote

2nd Character: Material System

'A' designates T700 24K / E 765

3rd Character: Test Type

'J' designates 0° Tension
Strength and Modulus, other
test types will be clearly labeled
at the top of each sheet

4th Character: Prepreg Batch ID

See Table 2.1 for FiberCote Batch ID /
Sample Batch ID correlation.

5th Character: Panel Number

The panel(s) fabricated for a specific test method.

6th Character: Subpanel Number

The sub-panel(s) cut from each panel, with subpanel
numbers labeled increasing from reference edge.

7th Character: Sample Number

The sample(s) cut from each subpanel, with sample
numbers labeled increasing from reference edge.

8th Character: Test Condition

'A' --- RTD

'B' --- CTD

'F' --- ETW

'G' --- ETD

See Table 1.5.1 for condition parameters.

3.2.1 Raw Data Spreadsheets and Scatter Charts

0° Tension -- (RTD)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

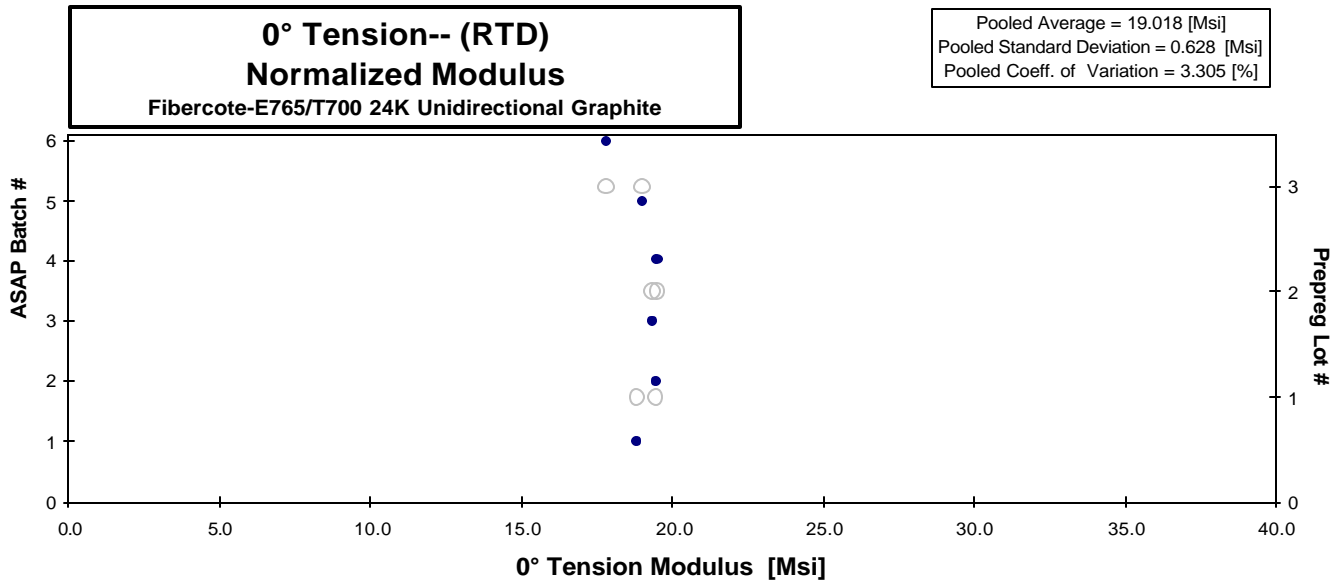
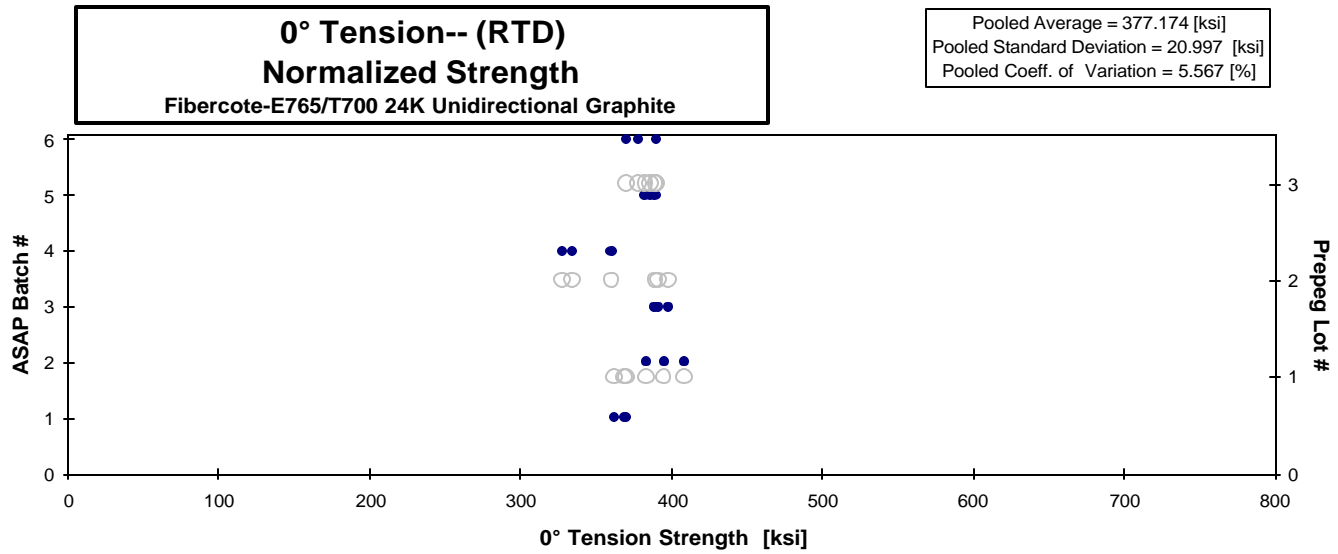
normalizing t_{ply}
 [in]
 0.0056

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate
TAJ1311A	1	1	1	364.159	18.564	0.340	0.046	8
TAJ1312A	1	1	1	355.743			0.046	8
TAJ1313A	1	1	1	364.219			0.045	8
TAJ1415A	2	1	2	375.630	18.516	0.321	0.047	8
TAJ1416A	2	1	2	376.452			0.046	8
TAJ1417A	2	1	2	395.962			0.046	8
TAJ24X1A	1	2	3	383.747	18.655	0.320	0.047	8
TAJ24X2A	1	2	3	369.437			0.047	8
TAJ24X3A	1	2	3	371.585			0.047	8
TAJ23X1A	2	2	4	314.356	18.318	0.324	0.048	8
TAJ23X2A	2	2	4	307.976			0.048	8
TAJ23X3A	2	2	4	343.497			0.047	8
TAJ3217A	1	3	5	403.954	19.875	0.307	0.043	8
TAJ3218A	1	3	5	395.951			0.044	8
TAJ3219A	1	3	5	387.824			0.044	8
TAJ33X1A	2	3	6	380.442	18.349	0.304	0.044	8
TAJ33X2A	2	3	6	384.541			0.044	8
TAJ33X3A	2	3	6	390.193			0.045	8

Avg. t_{ply} [in]	Strength _{norm} [ksi]	Modulus _{norm} [Msi]
0.00569	369.984	18.861
0.00571	362.890	
0.00567	368.690	
0.00590	395.474	19.495
0.00570	383.314	
0.00578	408.336	
0.00582	398.738	19.383
0.00591	389.640	
0.00590	391.215	
0.00596	334.821	19.510
0.00596	327.683	
0.00588	360.620	
0.00535	386.221	19.002
0.00551	389.617	
0.00553	382.918	
0.00545	370.252	17.857
0.00551	378.532	
0.00560	390.193	

Average 370.315 18.713 0.319
 Standard Dev. 26.264 0.584 0.013
 Coeff. of Var. [%] 7.092 3.119 4.084
 Min. 307.976 18.318 0.304
 Max. 403.954 19.875 0.340
 Number of Spec. 18 6 6

Average_{norm} 0.00571 377.174 19.018
 Standard Dev._{norm} 20.997 0.628
 Coeff. of Var. [%]_{norm} 5.567 3.305
 Min. 0.0054 327.683 17.857
 Max. 0.0060 408.336 19.510
 Number of Spec. 18 6



**0° Tension-- (CTD)
 Strength & Modulus**
 Fibercote-E765/T700 24K Unidirectional Graphite

normalizing t_{ply}
 [in]
 0.0056

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate
TAJ1315B	1	1	1	379.410	19.002	0.394	0.046	8
TAJ1316B	1	1	1	371.209			0.046	8
TAJ1317B	1	1	1	364.189			0.045	8
TAJ1411B	2	1	2	379.583	18.502	0.321	0.046	8
TAJ1412B	2	1	2	364.632			0.046	8
TAJ1413B	2	1	2	360.924			0.046	8

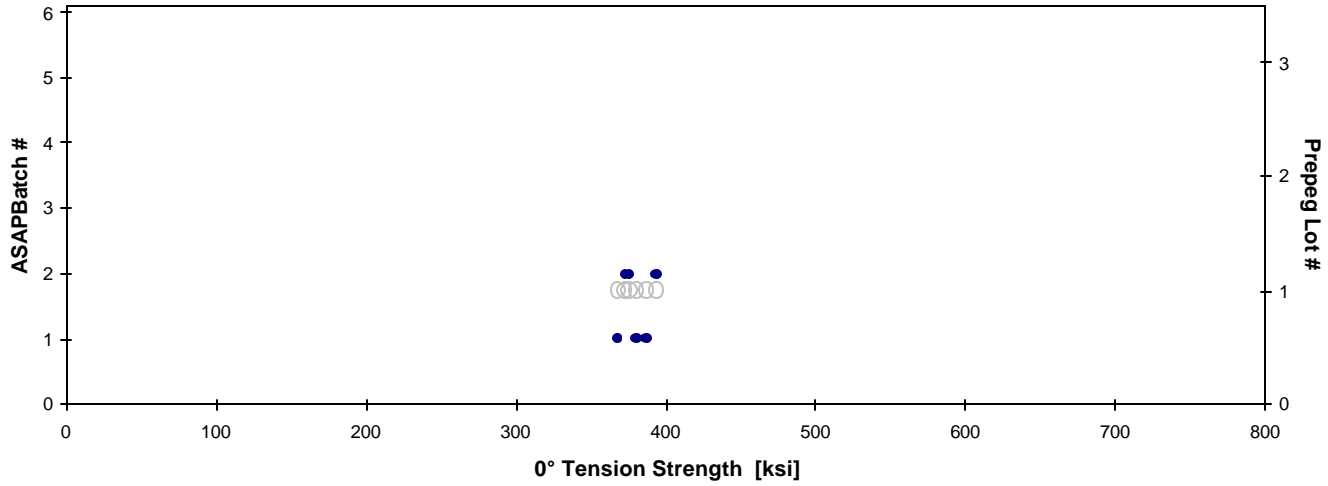
Avg. t _{ply} [in]	Strength _{norm} [ksi]	Modulus _{norm} [Msi]
0.00571	387.174	19.391
0.00574	380.600	
0.00566	368.118	
0.00581	393.705	19.190
0.00578	376.569	
0.00578	372.739	

Average	369.991	18.752	0.358
Standard Dev.	8.085	0.354	0.052
Coeff. of Var. [%]	2.185	1.885	14.439
Min.	360.924	18.502	0.321
Max.	379.583	19.002	0.394
Number of Spec.	6	2	2

Average_{norm}	0.00575	379.817	19.291
Standard Dev._{norm}		9.435	0.142
Coeff. of Var. [%]_{norm}		2.484	0.735
Min.	0.0057	368.118	19.190
Max.	0.0058	393.705	19.391
Number of Spec.		6	2

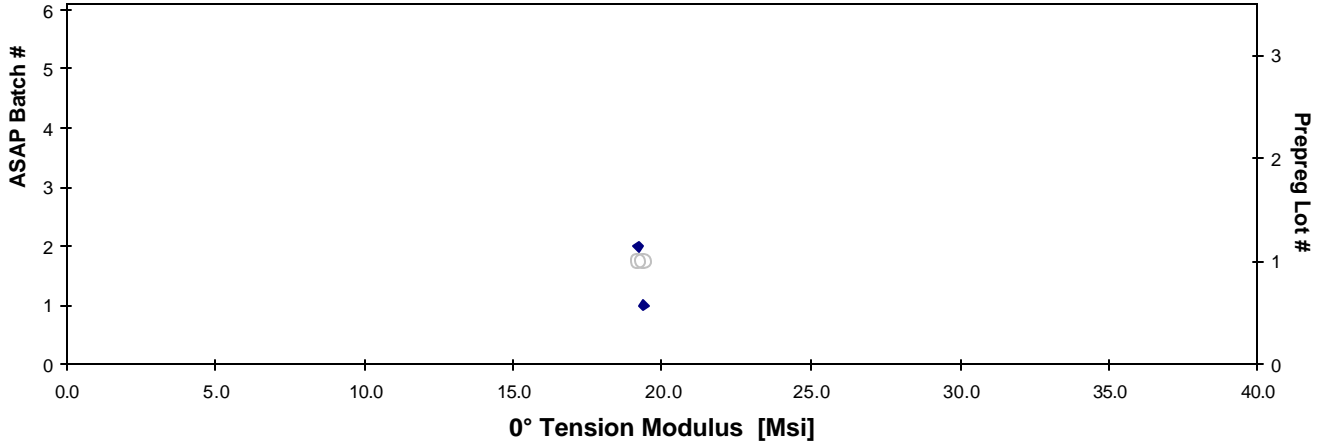
**0° Tension -- (CTD)
 Normalized Strength**
 Fibercote-E765/T700 24K Unidirectional Graphite

Pooled Average = 379.817 [ksi]
 Pooled Standard Deviation = 9.435 [ksi]
 Pooled Coeff. of Variation = 2.484 [%]



**0° Tension -- (CTD)
 Normalized Modulus**
 Fibercote-E765/T700 24K Unidirectional Graphite

Pooled Average = 19.291 [Msi]
 Pooled Standard Deviation = 0.142 [Msi]
 Pooled Coeff. of Variation = 0.735 [%]



**0° Tension-- (ETW)
 Strength & Modulus**
 Fibercote-E765/T700 24K Unidirectional Graphite

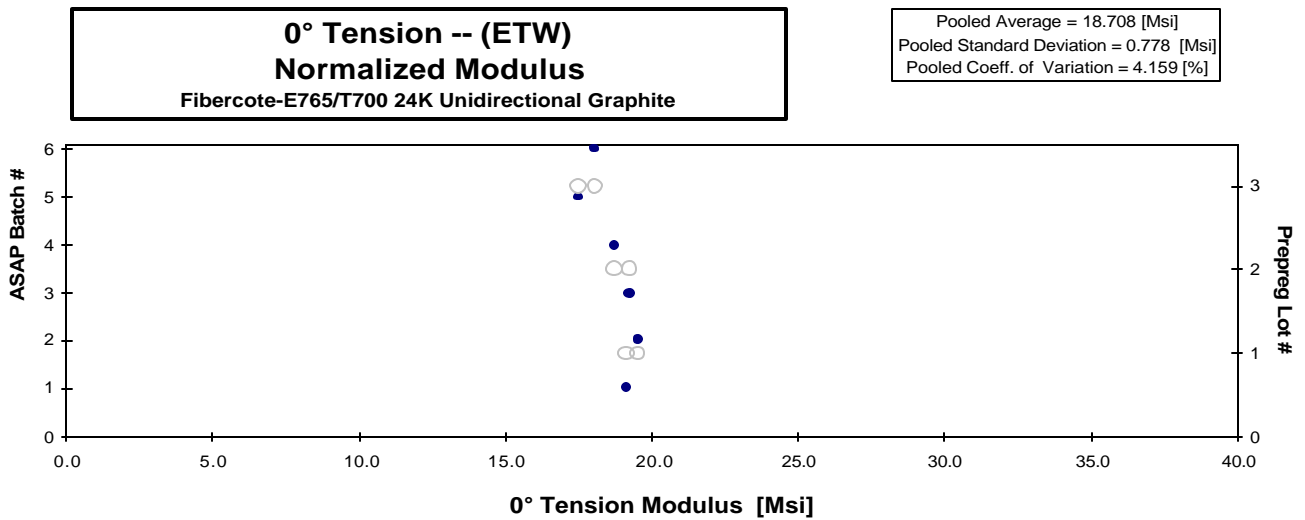
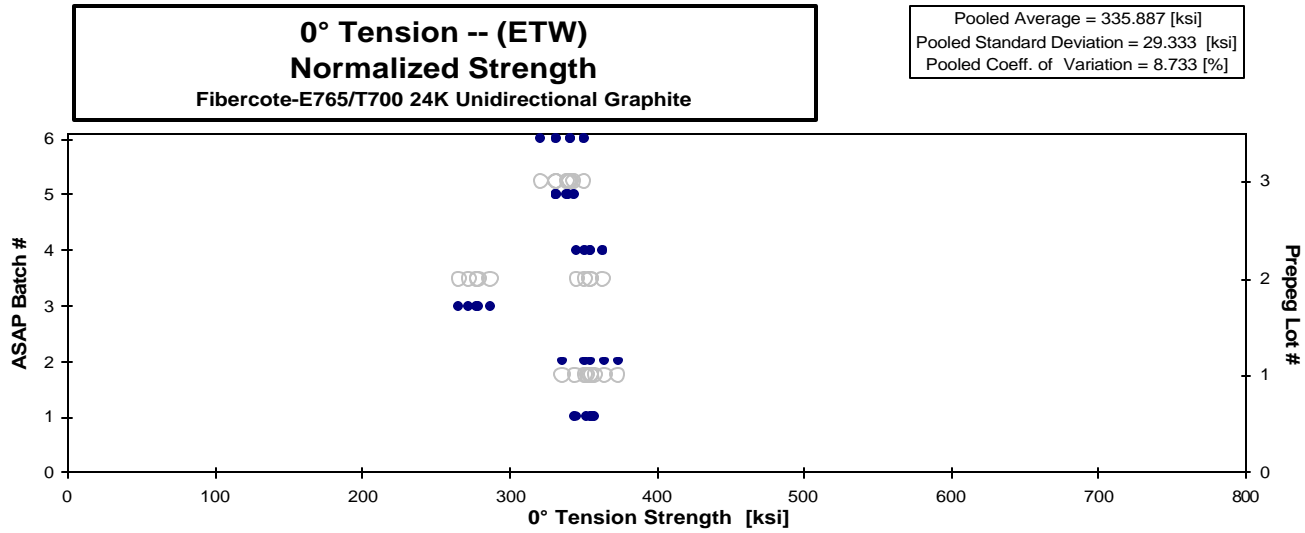
normalizing t_{ply}
 [in]
 0.0056

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate
TAJ1111F	1	1	1	337.035	18.117	0.329	0.047	8
TAJ1112F	1	1	1	331.856			0.048	8
TAJ1113F	1	1	1	339.304			0.047	8
TAJ1114F	1	1	1	339.145			0.047	8
TAJ1115F	1	1	1	330.990			0.047	8
TAJ1211F	2	1	2	352.475	18.845	0.293	0.046	8
TAJ1212F	2	1	2	358.950			0.044	8
TAJ1213F	2	1	2	358.773			0.047	8
TAJ1214F	2	1	2	350.565			0.045	8
TAJ1215F	2	1	2	325.177			0.046	8
TAJ2211F	1	2	3	277.265	18.614	0.357	0.046	8
TAJ2212F	1	2	3	272.285			0.046	8
TAJ2213F	1	2	3	268.684			0.046	8
TAJ2214F	1	2	3	263.182			0.046	8
TAJ2215F	1	2	3	258.954			0.046	8
TAJ2111F	2	2	4	342.546	18.574	0.324	0.045	8
TAJ2112F	2	2	4	344.481			0.046	8
TAJ2113F	2	2	4	344.154			0.046	8
TAJ2114F	2	2	4	354.703			0.046	8
TAJ2115F	2	2	4	337.291			0.047	8
TAJ3212F	1	3	5	355.029	18.704	0.317	0.042	8
TAJ3213F	1	3	5	364.635			0.042	8
TAJ3214F	1	3	5	352.939			0.042	8
TAJ3215F	1	3	5	361.001			0.043	8
TAJ3216F	1	3	5	352.825			0.043	8
TAJ3111F	2	3	6	334.691	18.801	0.261	0.043	8
TAJ3112F	2	3	6	348.585			0.044	8
TAJ3113F	2	3	6	345.962			0.044	8
TAJ3114F	2	3	6	354.768			0.044	8
TAJ3115F	2	3	6	337.061			0.044	8

Avg. t_{ply} [in]	Strength _{norm} [ksi]	Modulus _{norm} [Msi]
0.00591	355.717	19.121
0.00599	354.695	
0.00592	358.618	
0.00582	352.519	
0.00584	345.397	
0.00580	365.326	19.532
0.00553	354.677	
0.00584	373.989	
0.00561	351.478	
0.00578	335.822	
0.00579	286.755	19.251
0.00575	279.781	
0.00580	278.080	
0.00579	272.288	
0.00574	265.408	
0.00566	346.114	18.768
0.00577	355.118	
0.00578	354.909	
0.00574	363.676	
0.00584	351.972	
0.00524	331.915	17.486
0.00523	340.489	
0.00526	331.405	
0.00533	343.676	
0.00538	338.912	
0.00539	321.991	18.088
0.00548	341.193	
0.00553	341.715	
0.00554	350.941	
0.00552	332.046	

High Panel Variability – see section 4.3 for discussion

Average	333.177	18.609	0.314	Average _{norm}	0.00565	335.887	18.708
Standard Dev.	31.224	0.263	0.033	Standard Dev _{norm}		29.333	0.778
Coeff. of Var. [%]	9.372	1.412	10.513	Coeff. of Var. [%] _{norm}		8.733	4.159
Min.	258.954	18.117	0.261	Min.	0.0052	265.408	17.486
Max.	364.635	18.845	0.357	Max.	0.0060	373.989	19.532
Number of Spec.	30	6	6	Number of Spec.		30	6



0° Tension -- (ETD)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

normalizing t_{ply}

[in]

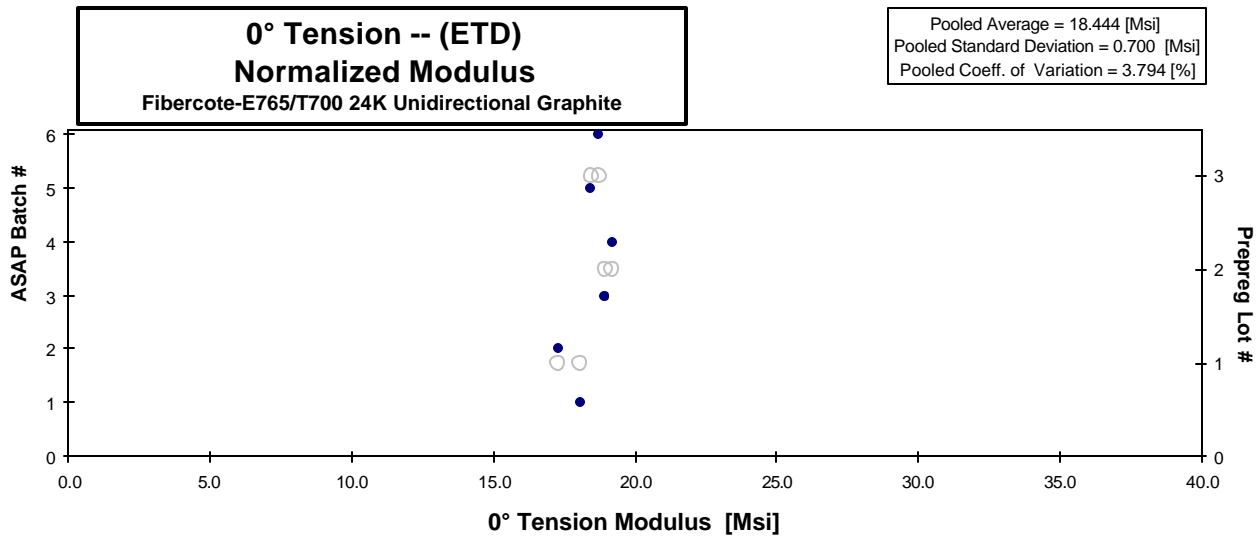
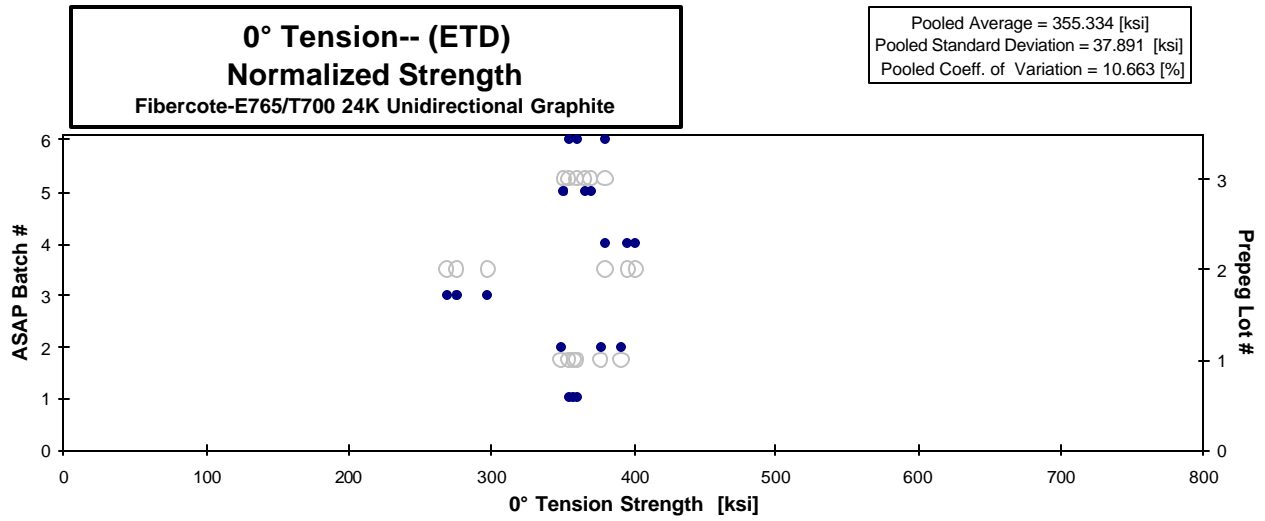
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Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Poisson's Ratio	Avg. Specimen Thickn. [in]	# Plies in Laminate
TAJ1116G	1	1	1	337.774	17.208	0.281	0.047	8
TAJ1117G	1	1	1	341.092			0.047	8
TAJ1118G	1	1	1	340.250			0.047	8
TAJ1216G	2	1	2	342.272	16.918	0.293	0.046	8
TAJ1217G	2	1	2	369.706			0.046	8
TAJ1218G	2	1	2	375.129			0.047	8
TAJ2216G	1	2	3	290.340	18.457	0.272	0.046	8
TAJ2217G	1	2	3	258.917			0.047	8
TAJ2218G	1	2	3	263.351			0.047	8
TAJ2116G	2	2	4	380.723	18.487	0.289	0.047	8
TAJ2117G	2	2	4	377.046			0.048	8
TAJ2118G	2	2	4	353.722			0.048	8
TAJ321BG	1	3	5	380.425	18.943	0.268	0.044	8
TAJ321CG	1	3	5	380.480			0.043	8
TAJ321DG	1	3	5	373.382			0.042	8
TAJ3116G	2	3	6	363.658	18.877	0.310	0.044	8
TAJ3117G	2	3	6	384.435			0.044	8
TAJ3118G	2	3	6	364.108			0.044	8

Avg. t_{ply} [in]	Strength _{norm} [ksi]	Modulus _{norm} [Msi]
0.00588	354.486	18.060
0.00588	358.096	
0.00593	360.376	
0.00572	349.402	17.270
0.00571	376.858	
0.00585	391.876	
0.00575	298.225	18.958
0.00581	268.839	
0.00586	275.500	
0.00582	395.595	19.209
0.00596	401.593	
0.00602	380.172	
0.00545	370.518	18.450
0.00539	366.325	
0.00527	351.435	
0.00555	360.546	18.715
0.00555	380.860	
0.00546	355.303	

High Panel Variability – see section 4.3 for discussion

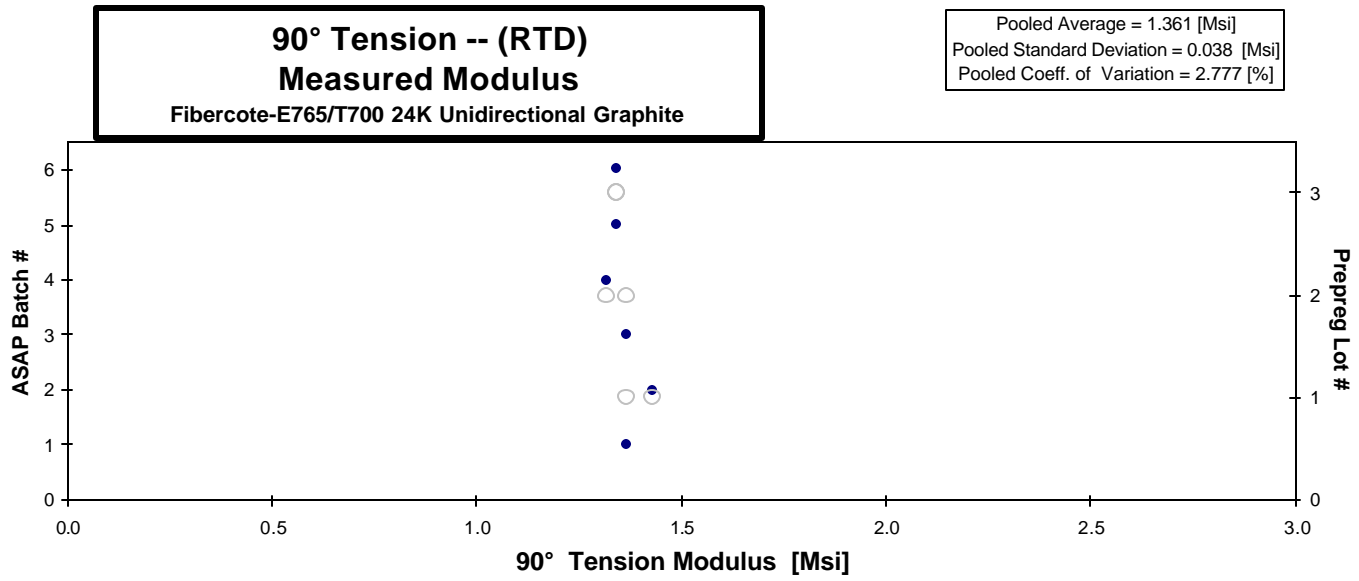
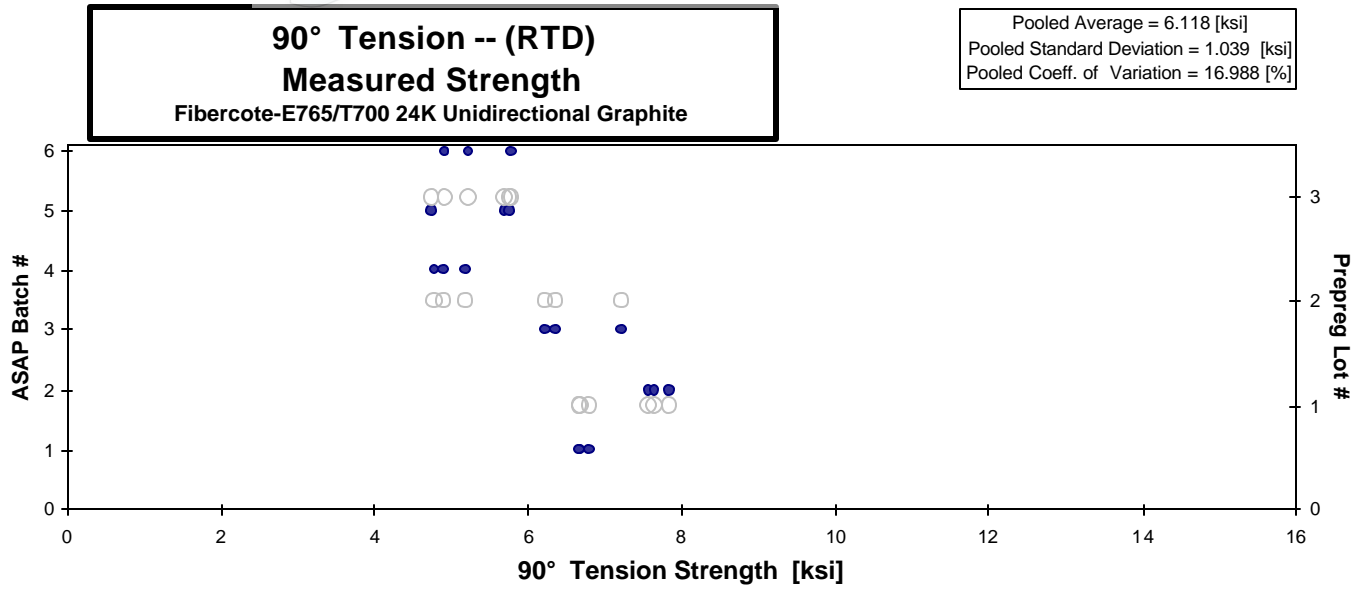
Average	348.712	18.148	0.286	Average _{norm}	0.00572	355.334	18.444
Standard Dev.	39.407	0.868	0.015	Standard Dev _{norm}		37.891	0.700
Coeff. of Var. [%]	11.301	4.785	5.317	Coeff. of Var. [%] _{norm}		10.663	3.794
Min.	258.917	16.918	0.268	Min.	0.0053	268.839	17.270
Max.	384.435	18.943	0.310	Max.	0.0060	401.593	19.209
Number of Spec.	18	6	6	Number of Spec.		18	6



**90° Tension -- (RTD)
 Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite**

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{div} [in]
TAU1411A	1	1	1	6.699	1.368	0.100	18	0.00556
TAU1412A	1	1	1	6.809		0.099	18	0.00552
TAU1414A	1	1	1	6.666		0.101	18	0.00559
TAU1311A	2	1	2	7.575	1.428	0.098	18	0.00544
TAU1312A	2	1	2	7.655		0.099	18	0.00549
TAU1313A	2	1	2	7.836		0.099	18	0.00548
TAU2116A	1	2	3	7.219	1.365	0.104	18	0.00579
TAU2117A	1	2	3	6.229		0.103	18	0.00574
TAU2118A	1	2	3	6.374		0.104	18	0.00577
TAU2216A	2	2	4	5.185	1.317	0.106	18	0.00586
TAU2217A	2	2	4	4.895		0.106	18	0.00587
TAU2218A	2	2	4	4.799		0.105	18	0.00585
TAU3216A	3	3	5	4.760	1.343	0.101	18	0.00559
TAU3217A	3	3	5	5.693		0.101	18	0.00562
TAU3218A	3	3	5	5.760		0.101	18	0.00563
TAU3111A	4	3	6	4.934	1.343	0.102	18	0.00564
TAU3112A	4	3	6	5.246		0.102	18	0.00568
TAU3113A	4	3	6	5.795		0.102	18	0.00564

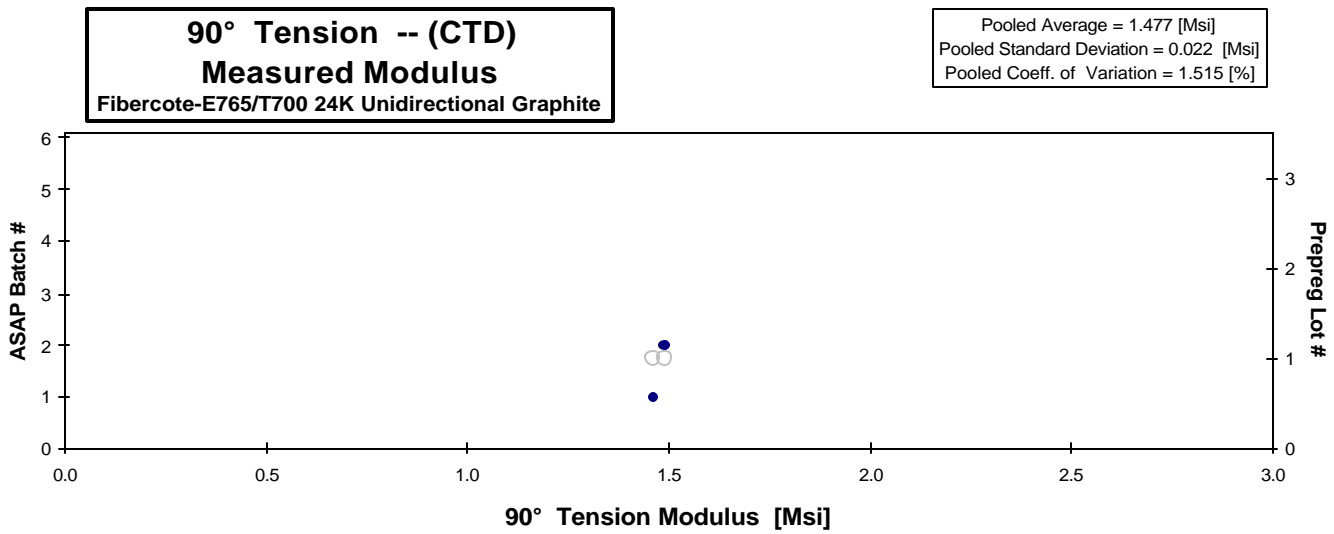
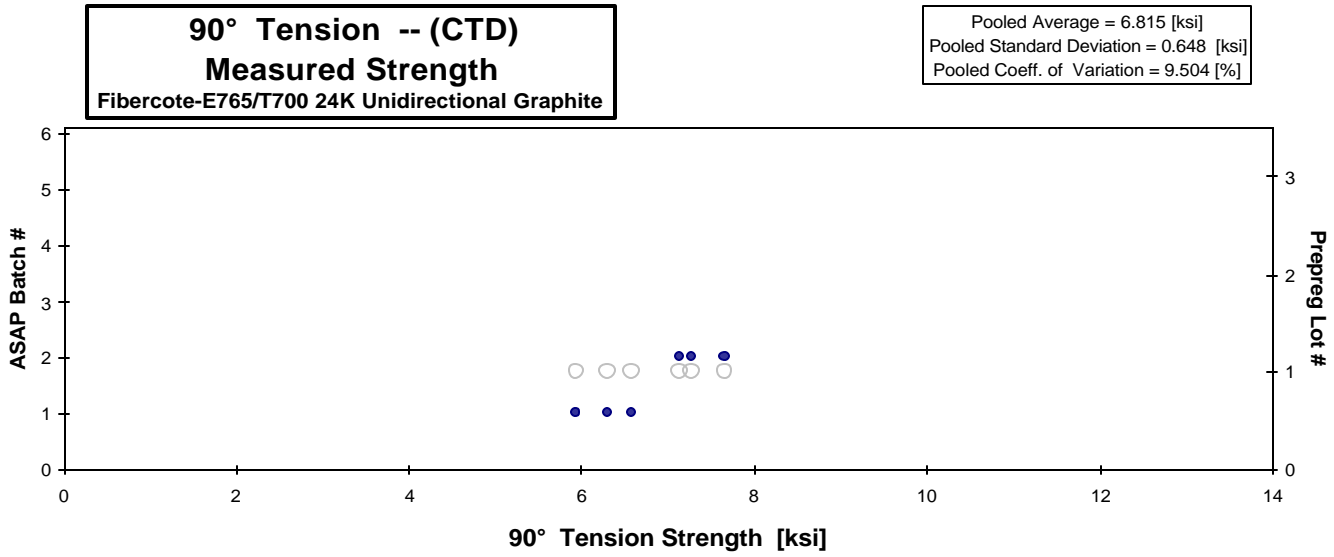
Average	6.118	1.361	0.0057
Standard Dev.	1.039	0.038	
Coeff. of Var. [%]	16.988	2.777	
Min.	4.760	1.317	Min. 0.0054
Max.	7.836	1.428	Max. 0.0059
Number of Spec.	18	6	



90° Tension -- (CTD) Strength & Modulus Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{ply} [in]
TAU1416B	1	1	1	6.312	1.461	0.100	18	0.00554
TAU1417B	1	1	1	6.574		0.100	18	0.00554
TAU1418B	1	1	1	5.940		0.101	18	0.00561
TAU1314B	2	1	2	7.265	1.493	0.099	18	0.00550
TAU1315B	2	1	2	7.659		0.099	18	0.00552
TAU1316B	2	1	2	7.140		0.099	18	0.00548

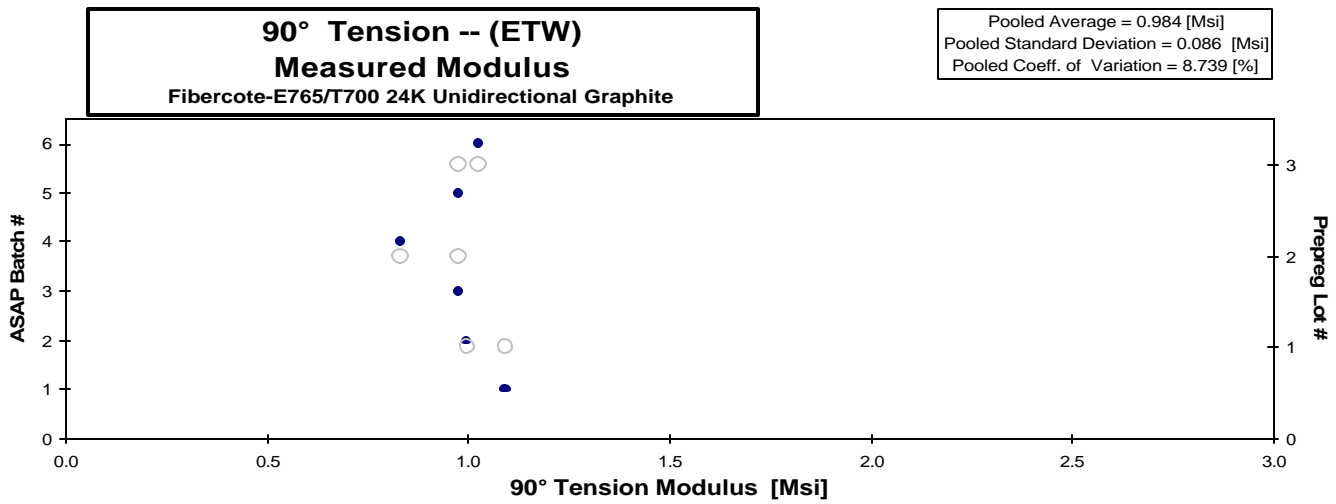
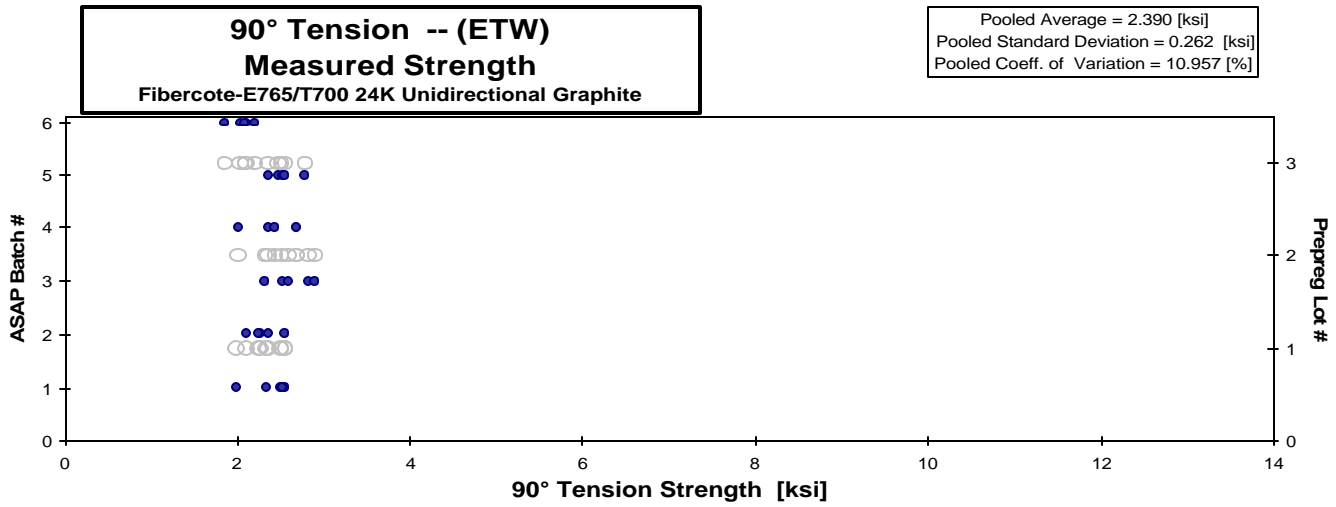
Average	6.815	1.477		0.0055
Standard Dev.	0.648	0.022		
Coeff. of Var. [%]	9.504	1.515		
Min.	5.940	1.461	Min.	0.0055
Max.	7.659	1.493	Max.	0.0056
Number of Spec.	6	2		



90° Tension -- (ETW)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{blv} [in]
TAU1211F	1	1	1	1.991	1.094	0.101	18	0.00559
TAU1212F	1	1	1	2.332		0.100	18	0.00556
TAU1213F	1	1	1	2.557		0.101	18	0.00560
TAU1214F	1	1	1	2.501		0.101	18	0.00559
TAU1215F	1	1	1	2.523		0.101	18	0.00561
TAU1111F	2	1	2	2.270	0.997	0.106	18	0.00590
TAU1113F	2	1	2	2.235		0.104	18	0.00578
TAU1115F	2	1	2	2.351		0.106	18	0.00587
TAU1116F	2	1	2	2.546		0.105	18	0.00584
TAU1117F	2	1	2	2.100		0.107	18	0.00593
TAU2111F	1	2	3	2.513	0.977	0.104	18	0.00580
TAU2112F	1	2	3	2.326		0.105	18	0.00584
TAU2113F	1	2	3	2.821		0.105	18	0.00584
TAU2114F	1	2	3	2.594		0.105	18	0.00584
TAU2115F	1	2	3	2.891		0.105	18	0.00581
TAU2211F	2	2	4	2.688	0.833	0.107	18	0.00593
TAU2212F	2	2	4	2.352		0.106	18	0.00587
TAU2213F	2	2	4	2.431		0.106	18	0.00589
TAU2214F	2	2	4	2.020		0.106	18	0.00587
TAU2215F	2	2	4	2.679		0.106	18	0.00587
TAU3211F	3	3	5	2.775	0.977	0.100	18	0.00558
TAU3212F	3	3	5	2.368		0.101	18	0.00561
TAU3213F	3	3	5	2.474		0.101	18	0.00563
TAU3214F	3	3	5	2.512		0.101	18	0.00562
TAU3215F	3	3	5	2.546		0.101	18	0.00564
TAU3311F	4	3	6	2.040	1.027	0.101	18	0.00559
TAU3312F	4	3	6	2.201		0.101	18	0.00562
TAU3313F	4	3	6	2.107		0.100	18	0.00555
TAU3314F	4	3	6	2.091		0.101	18	0.00559
TAU3315F	4	3	6	1.856		0.101	18	0.00562

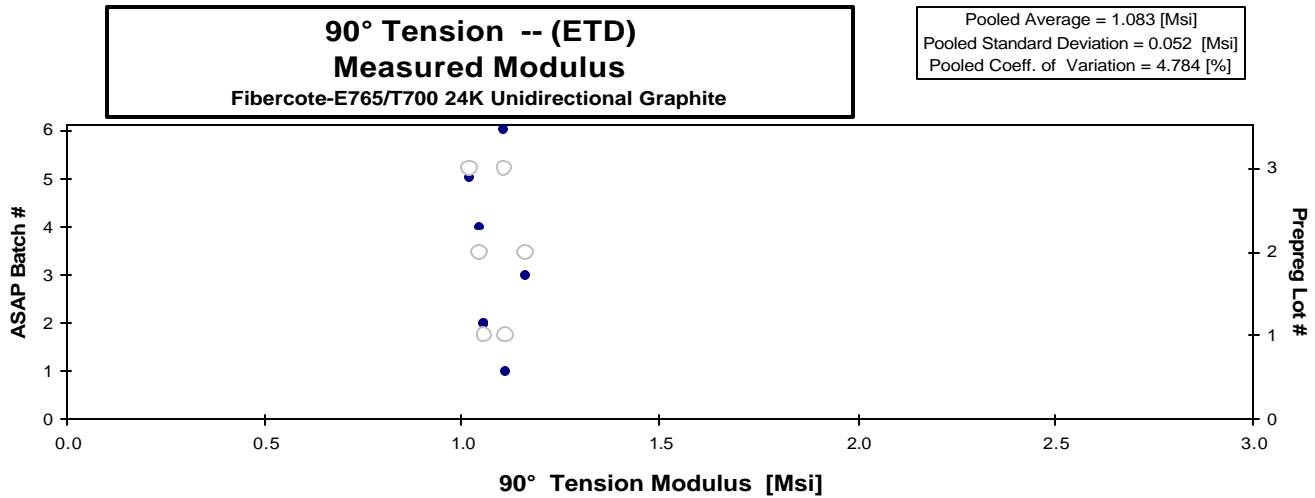
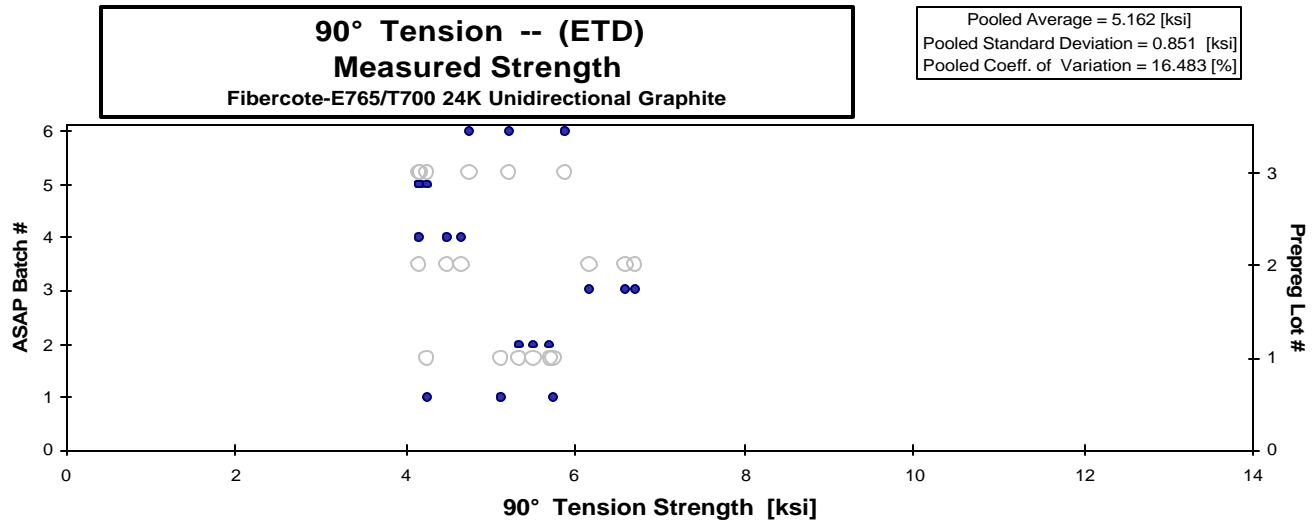
Average	2.390	0.984	0.0057
Standard Dev.	0.262	0.086	
Coeff. of Var. [%]	10.957	8.739	
Min.	1.856	0.833	Min. 0.0056
Max.	2.891	1.094	Max. 0.0059
Number of Spec.	30	6	



90° Tension -- (ETD)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{div} [in]
TAU1216G	1	1	1	4.263	1.110	0.100	18	0.00556
TAU1217G	1	1	1	5.743		0.101	18	0.00558
TAU1218G	1	1	1	5.130		0.101	18	0.00559
TAU1112G	2	1	2	5.506	1.055	0.106	18	0.00588
TAU1114G	2	1	2	5.334		0.106	18	0.00586
TAU1118G	2	1	2	5.707		0.106	18	0.00590
TAU2611G	B	2	3	6.175	1.159	0.103	18	0.00575
TAU2612G	B	2	3	6.716		0.105	18	0.00581
TAU2613G	B	2	3	6.589		0.105	18	0.00582
TAU2411G	2	2	4	4.657	1.045	0.106	18	0.00591
TAU2412G	2	2	4	4.492		0.105	18	0.00583
TAU2413G	2	2	4	4.152		0.105	18	0.00585
TAU3411G	3	3	5	4.171	1.020	0.107	18	0.00595
TAU3412G	3	3	5	4.259		0.106	18	0.00589
TAU3413G	3	3	5	4.148		0.107	18	0.00592
TAU3116G	4	3	6	5.887	1.108	0.102	18	0.00565
TAU3117G	4	3	6	5.225		0.103	18	0.00573
TAU3118G	4	3	6	4.763		0.100	18	0.00558

Average	5.162	1.083		0.0058
Standard Dev.	0.851	0.052		
Coeff. of Var. [%]	16.483	4.784		
Min.	4.148	1.020	Min.	0.0056
Max.	6.716	1.159	Max.	0.0060
Number of Spec.	18	6		



**0° Compression -- (RTD)
 Strength & Modulus**
 Fibercote-E765/T700 24K Unidirectional Graphite

normalizing t_{ply}
 [in]

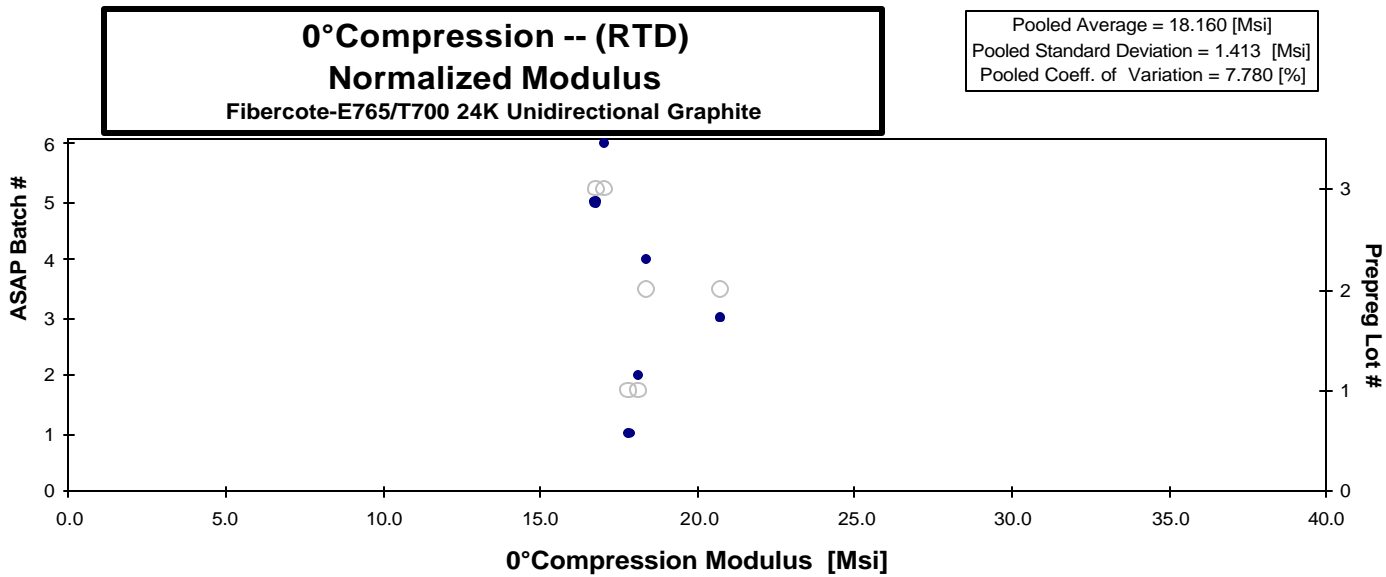
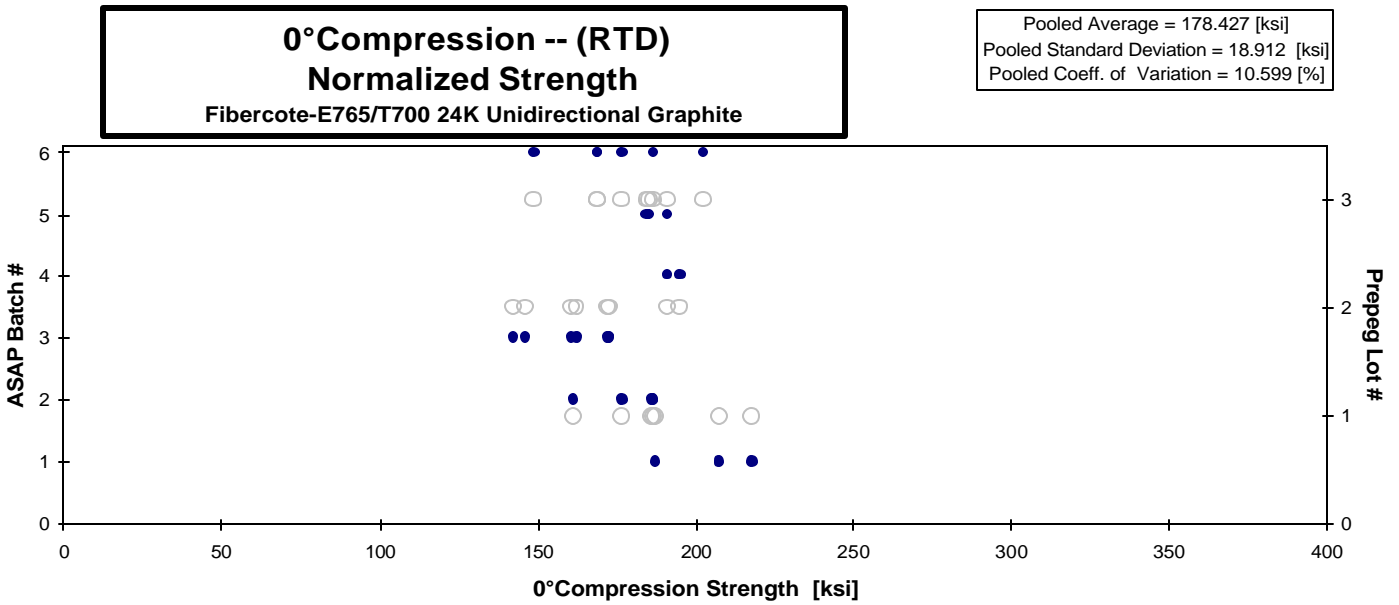
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Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate
TAK1116A	3	1	1	226.541		0.038	7
TAK1117A	3	1	1	215.629		0.038	7
TAK1118A	3	1	1	190.363		0.039	7
TAL1115A	3	1	1		18.557	0.038	7
TAK1216A	4	1	2	153.179		0.041	7
TAK1217A	4	1	2	175.426		0.042	7
TAK1218A	4	1	2	170.614		0.041	7
TAK1219A	4	1	2	181.238		0.040	7
TAL1211A	4	1	2		17.289	0.041	7
TAK2221A	3	2	3	137.801		0.041	7
TAK2222A	3	2	3	140.477		0.041	7
TAK2223A	3	2	3	165.690		0.041	7
TAK2225A	3	2	3	157.766		0.040	7
TAK2217A	3	2	3	157.224		0.040	7
TAK2218A	3	2	3	169.670		0.040	7
TAL2216A	3	2	3		19.853	0.041	7
TAK2128A	4	2	4	189.156		0.040	7
TAK2116A	4	2	4	182.560		0.041	7
TAL2111A	4	2	4		17.214	0.042	7
TAK3116A	3	3	5	198.892		0.036	7
TAK3117A	3	3	5	198.947		0.037	7
TAK3118A	3	3	5	206.531		0.036	7
TAL3116A	3	3	5		18.295	0.036	7
TAK3216A	4	3	6	157.019		0.037	7
TAK3217A	4	3	6	179.828		0.037	7
TAK3218A	4	3	6	193.689		0.038	7
TAK3219A	4	3	6	209.733		0.038	7
TAK3226A	4	3	6	174.571		0.038	7
TAK3228A	4	3	6	180.842		0.038	7
TAL3216A	4	3	6		17.067	0.039	7

Avg. t_{ply} [in]	Strength _{norm} [ksi]	Modulus _{norm} [Msi]
0.00539	217.872	
0.00538	207.240	
0.00551	187.449	
0.00538		17.835
0.00590	161.385	
0.00597	186.949	
0.00581	176.925	
0.00575	186.092	
0.00588		18.138
0.00579	142.547	
0.00583	146.300	
0.00585	173.087	
0.00576	162.395	
0.00572	160.633	
0.00569	172.267	
0.00585		20.739
0.00578	195.308	
0.00587	191.292	
0.00599		18.422
0.00519	184.432	
0.00522	185.371	
0.00518	191.121	
0.00514		16.778
0.00531	148.907	
0.00528	169.391	
0.00540	186.895	
0.00540	202.243	
0.00543	169.227	
0.00548	176.920	
0.00559		17.045

Average 179.724 18.046
 Standard Dev. 23.011 1.078
 Coeff. of Var. [%] 12.803 5.973
 Min. 137.801 17.067
 Max. 226.541 19.853
 Number of Spec. 24 6

Average_{norm} 0.00559 178.427 18.160
 Standard Dev._{norm} 18.912 1.413
 Coeff. of Var. [%]_{norm} 10.599 7.780
 Min. 0.0051 142.547 16.778
 Max. 0.0060 217.872 20.739
 Number of Spec. 24 6



**0° Compression -- (CTD)
 Strength & Modulus**
 Fibercote-E765/T700 24K Unidirectional Graphite

normalizing t_{ply}
 [in]
 0.0056

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate
TAK1335B	3	1	1	201.502		0.040	7
TAK1336B	3	1	1	200.269		0.040	7
TAK1337B	3	1	1	219.184		0.040	7
TAL1118B	3	1	1		18.126	0.038	7
TAK1222B	4	1	2	223.987		0.039	7
TAK1223B	4	1	2	212.941		0.039	7
TAK1224B	4	1	2	206.643		0.038	7
TAL1214B	4	1	2		17.658	0.041	7

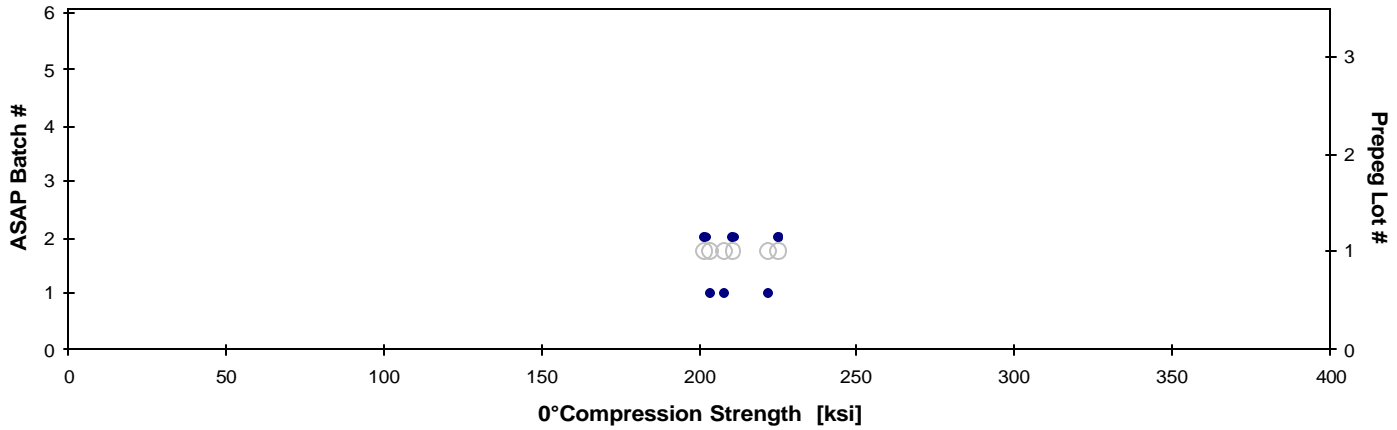
Avg. t_{ply} [in]	Strength _{norm} [ksi]	Modulus _{norm} [Msi]
0.00578	207.928	
0.00569	203.462	
0.00567	221.979	
0.00549		17.779
0.00563	225.273	
0.00554	210.768	
0.00547	201.899	
0.00586		18.492

Average 210.754 17.892
 Standard Dev. 9.627 0.331
 Coeff. of Var. [%] 4.568 1.848
 Min. 200.269 17.658
 Max. 223.987 18.126
 Number of Spec. 6 2

Average_{norm} 0.00564 211.885 18.135
 Standard Dev._{norm} 9.682 0.504
 Coeff. of Var. [%]_{norm} 4.570 2.778
 Min. 0.0055 201.899 17.779
 Max. 0.0059 225.273 18.492
 Number of Spec. 6 2

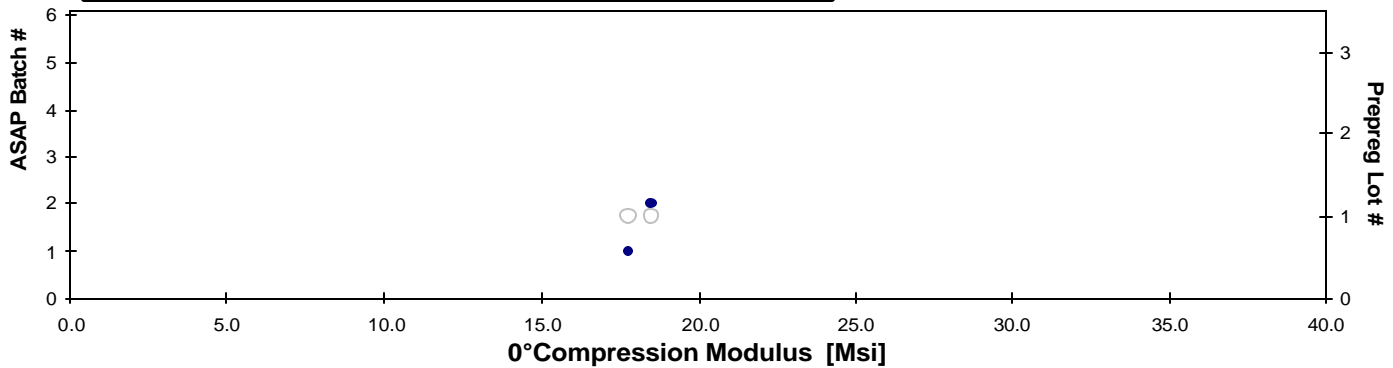
**0° Compression -- (CTD)
 Normalized Strength**
 Fibercote-E765/T700 24K Unidirectional Graphite

Pooled Average = 211.885 [ksi]
 Pooled Standard Deviation = 9.682 [ksi]
 Pooled Coeff. of Variation = 4.570 [%]



**0° Compression -- (CTD)
 Normalized Modulus**
 Fibercote-E765/T700 24K Unidirectional Graphite

Pooled Average = 18.135 [Msi]
 Pooled Standard Deviation = 0.504 [Msi]
 Pooled Coeff. of Variation = 2.778 [%]



0° Compression-- (ETW)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

normalizing t_{ply}
 [in]
 0.0056

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thicken. [in]	# Plies in Laminate	Avg. t _{ply} [in]	Strength _{norm} [ksi]	Modulus _{norm} [Msi]
TAK1112F	3	1	1	131.011		0.038	7	0.00540	126.416	
TAK1113F	3	1	1	126.503		0.037	7	0.00535	120.936	
TAK1114F	3	1	1	114.431		0.038	7	0.00545	111.366	
TAK1115F	3	1	1	113.058		0.039	7	0.00555	112.121	
TAL1111F	3	1	1		17.248	0.038	7	0.00543		16.731
TAK1211F	4	1	2	100.300		0.040	7	0.00574	102.730	
TAK1212F	4	1	2	109.170		0.041	7	0.00588	114.531	
TAK1213F	4	1	2	107.134		0.041	7	0.00586	112.054	
TAK1214F	4	1	2	113.709		0.041	7	0.00580	117.842	
TAK1215F	4	1	2	96.785		0.041	7	0.00587	101.414	
TAL1217F	4	1	2		17.254	0.041	7	0.00582		17.936
TAK2211F	3	2	3	97.922		0.039	7	0.00550	96.174	
TAK2212F	3	2	3	106.922		0.040	7	0.00571	109.104	
TAK2213F	3	2	3	84.673		0.040	7	0.00566	85.537	
TAK2214F	3	2	3	96.139		0.039	7	0.00556	95.525	
TAK2215F	3	2	3	102.907		0.039	7	0.00561	103.038	
TAL2211F	3	2	3		17.950	0.040	7	0.00569		18.225
TAK2111F	4	2	4	104.155		0.041	7	0.00583	108.339	
TAK2112F	4	2	4	97.752		0.042	7	0.00593	103.550	
TAK2113F	4	2	4	93.856		0.041	7	0.00591	99.003	
TAK2114F	4	2	4	102.705		0.041	7	0.00587	107.683	
TAK2115F	4	2	4	99.600		0.041	7	0.00579	102.903	
TAL2117F	4	2	4		17.456	0.040	7	0.00578		18.001
TAK3111F	3	3	5	125.053		0.038	7	0.00540	120.507	
TAK3112F	3	3	5	109.447		0.037	7	0.00530	103.654	
TAK3113F	3	3	5	104.035		0.039	7	0.00555	103.040	
TAK3114F	3	3	5	113.825		0.037	7	0.00534	108.453	
TAK3115F	3	3	5	102.965		0.037	7	0.00530	97.514	
TAL3112F	3	3	5		19.595	0.035	7	0.00507		17.733
TAK3211F	4	3	6	84.513		0.037	7	0.00535	80.740	
TAK3212F	4	3	6	127.595		0.038	7	0.00539	122.794	
TAK3213F	4	3	6	129.659		0.037	7	0.00531	123.044	
TAK3214F	4	3	6	106.422		0.037	7	0.00535	101.671	
TAK3215F	4	3	6	103.444		0.037	7	0.00528	97.507	
TAL3212F	4	3	6		18.712	0.037	7	0.00527		17.614

Average	107.093	18.036	Average_{norm}	0.00557	106.524	17.707
Standard Dev.	12.193	0.945	Standard Dev._{norm}		10.856	0.523
Coeff. of Var. [%]	11.385	5.239	Coeff. of Var. [%]_{norm}		10.191	2.955
Min.	84.513	17.248	Min.	0.0051	80.740	16.731
Max.	131.011	19.595	Max.	0.0059	126.416	18.225
Number of Spec.	29	6	Number of Spec.		29	6

0° Compression -- (ETD) Strength & Modulus Fibercote-E765/T700 24K Unidirectional Graphite

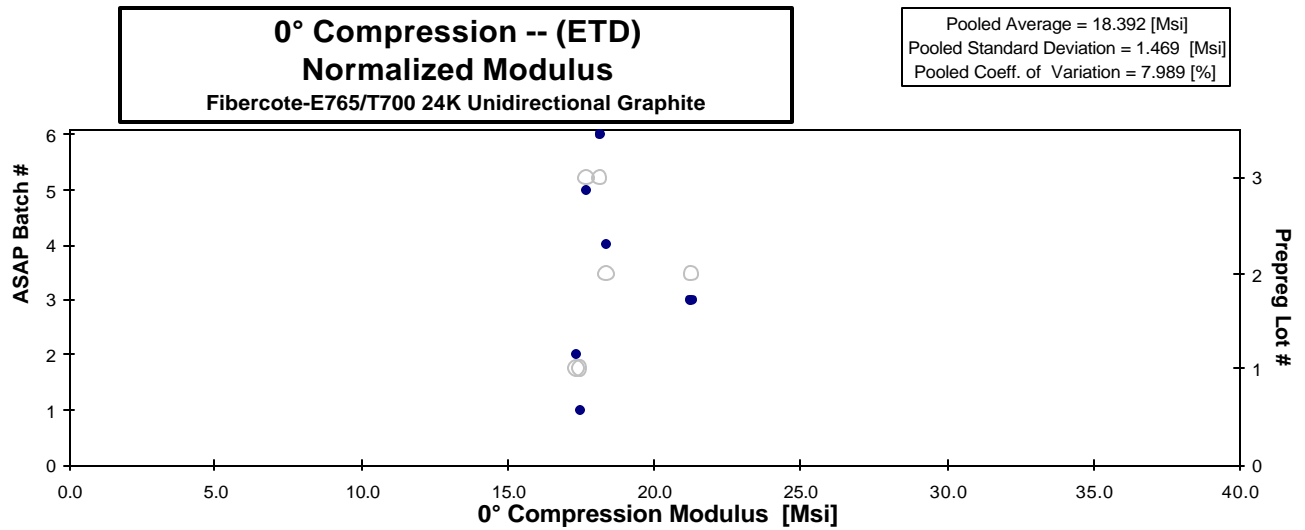
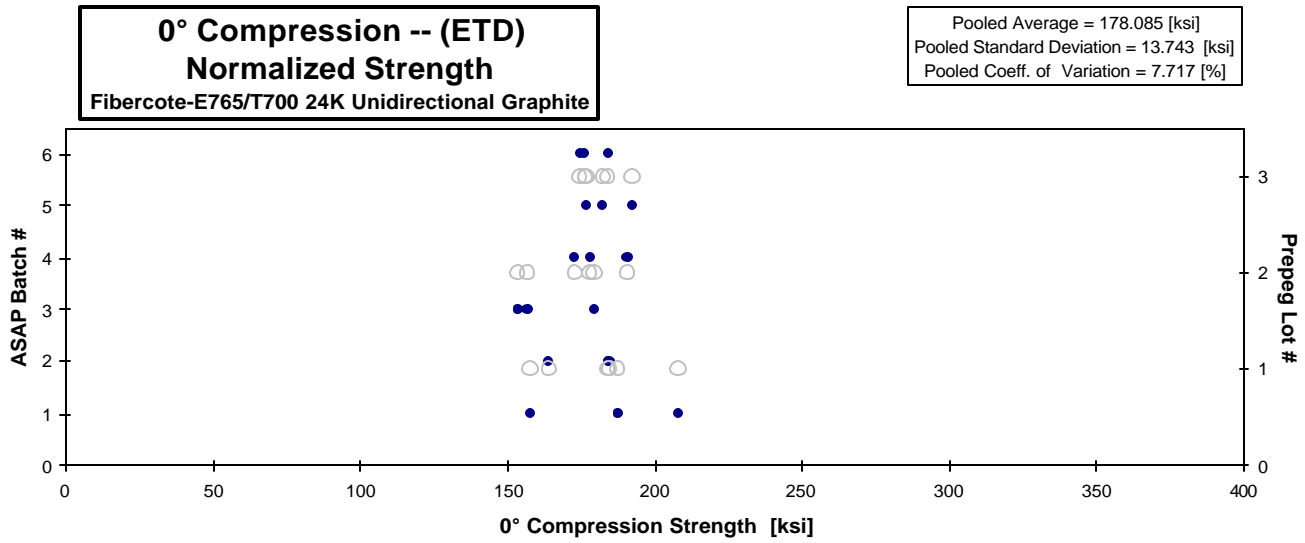
normalizing t_{ply}
 [in]
0.0056

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate
TAK1321G	3	1	1	202.721		0.040	7
TAK1322G	3	1	1	185.319		0.040	7
TAK1323G	3	1	1	156.775		0.039	7
TAL111BG	3	1	1		18.139	0.038	7
TAK1226G	4	1	2	185.294		0.039	7
TAK1227G	4	1	2	167.077		0.038	7
TAK1228G	4	1	2	183.543		0.039	7
TAL121BG	4	1	2		16.969	0.040	7
TAK2216G	3	2	3	178.163		0.040	7
TAK2226G	3	2	3	147.726		0.041	7
TAK2227G	3	2	3	149.942		0.041	7
TAL2219G	3	2	3		21.414	0.039	7
TAK2125G	4	2	4	170.041		0.041	7
TAK2126G	4	2	4	182.519		0.041	7
TAK2127G	4	2	4	164.587		0.041	7
TAL2114G	4	2	4		17.378	0.041	7
TAK3122G	3	3	5	180.656		0.038	7
TAK3123G	3	3	5	185.408		0.039	7
TAK3125G	3	3	5	193.948		0.039	7
TAL3119G	3	3	5		18.890	0.037	7
TAK3221G	4	3	6	177.822		0.039	7
TAK3222G	4	3	6	179.151		0.039	7
TAK3223G	4	3	6	190.367		0.038	7
TAL3219G	4	3	6		17.865	0.040	7

Avg. t_{ply} [in]	Strength _{norm} [ksi]	Modulus _{norm} [Msi]
0.00575	208.022	
0.00566	187.446	
0.00564	157.875	
0.00540		17.503
0.00556	184.112	
0.00549	163.881	
0.00564	184.714	
0.00573		17.369
0.00565	179.753	
0.00582	153.568	
0.00585	156.636	
0.00557		21.291
0.00587	178.283	
0.00586	190.900	
0.00588	172.880	
0.00592		18.364
0.00549	177.084	
0.00551	182.452	
0.00556	192.587	
0.00525		17.698
0.00551	174.873	
0.00551	176.295	
0.00542	184.175	
0.00568		18.127

Average	176.726	18.442
Standard Dev.	14.807	1.598
Coeff. of Var. [%]	8.378	8.662
Min.	147.726	16.969
Max.	202.721	21.414
Number of Spec.	18	6

Average _{norm}	0.00563	178.085	18.392
Standard Dev. _{norm}		13.743	1.469
Coeff. of Var. [%] _{norm}		7.717	7.989
Min.	0.0052	153.568	17.369
Max.	0.0059	208.022	21.291
Number of Spec.		18	6

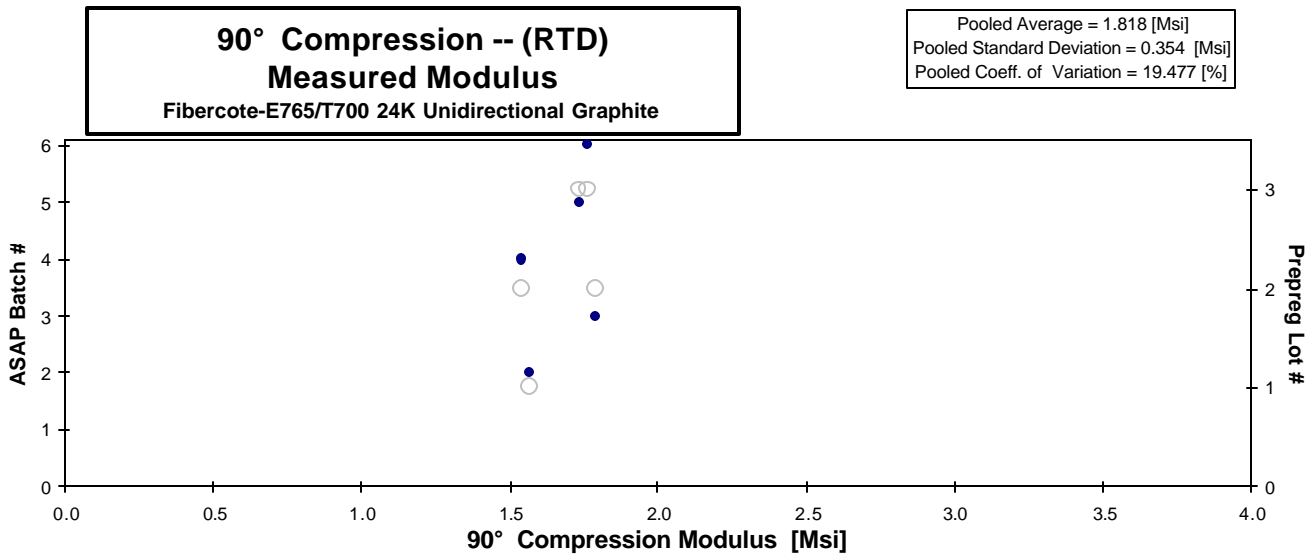
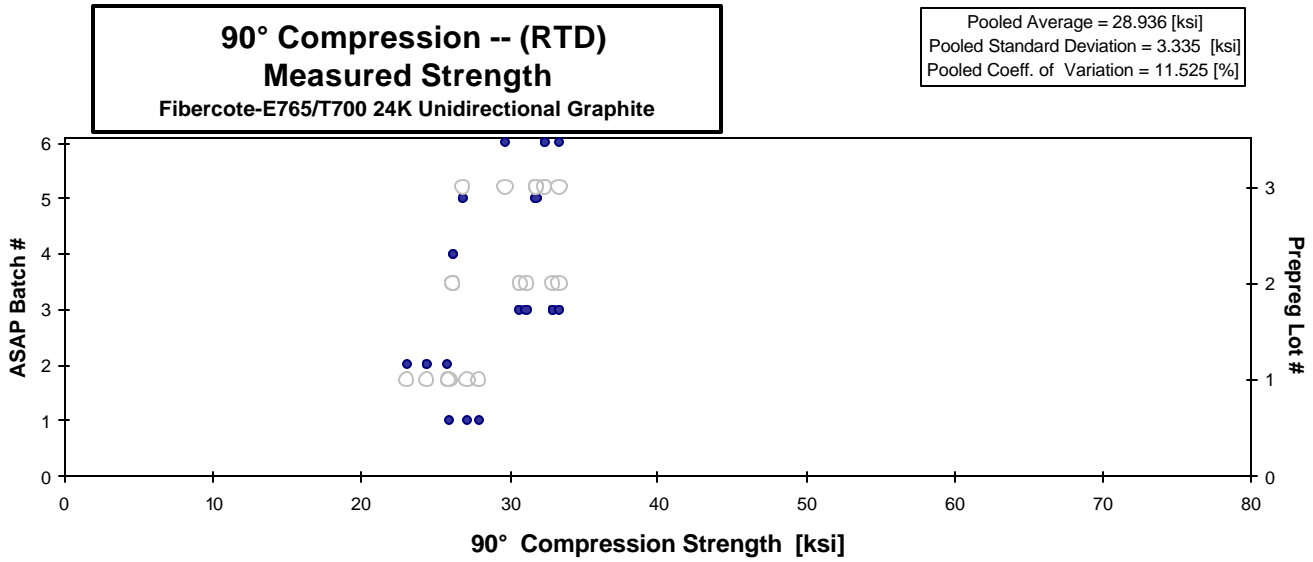


90° Compression -- (RTD)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{div} [in]
TAW1211A	3	1	1	27.194		0.039	7	0.00557
TAW1212A	3	1	1	25.949		0.040	7	0.00565
TAW1213A	3	1	1	27.925		0.038	7	0.00547
TAZ1215A*	3	1	1		2.509	0.039	7	0.00557
TAW1122A	4	1	2	24.372		0.042	7	0.00593
TAW1123A	4	1	2	25.904		0.042	7	0.00605
TAW1124A	4	1	2	23.076		0.042	7	0.00601
TAZ1115A	4	1	2		1.567	0.043	7	0.00608
TAW2117A	3	2	3	32.885		0.040	7	0.00574
TAW2118A	3	2	3	30.740		0.039	7	0.00564
TAW2121A	3	2	3	31.136		0.039	7	0.00558
TAW2122A	3	2	3	33.399		0.039	7	0.00561
TAZ2115A	3	2	3		1.793	0.040	7	0.00565
TAW21L3A	4	2	4	26.168		0.039	7	0.00556
TAW21L4A	4	2	4	26.145		0.041	7	0.00583
TAZ2219A	4	2	4		1.543	0.042	7	0.00603
TAW3116A	3	3	5	31.836		0.038	7	0.00542
TAW3117A	3	3	5	31.812		0.038	7	0.00544
TAW3118A	3	3	5	26.865		0.037	7	0.00531
TAZ3216A	3	3	5		1.735	0.038	7	0.00541
TAW3121A	4	3	6	33.336		0.039	7	0.00558
TAW3122A	4	3	6	32.352		0.039	7	0.00552
TAW3123A	4	3	6	29.758		0.040	7	0.00573
TAZ3116A	4	3	6		1.760	0.039	7	0.00553

*High outlier, omitted from calculations

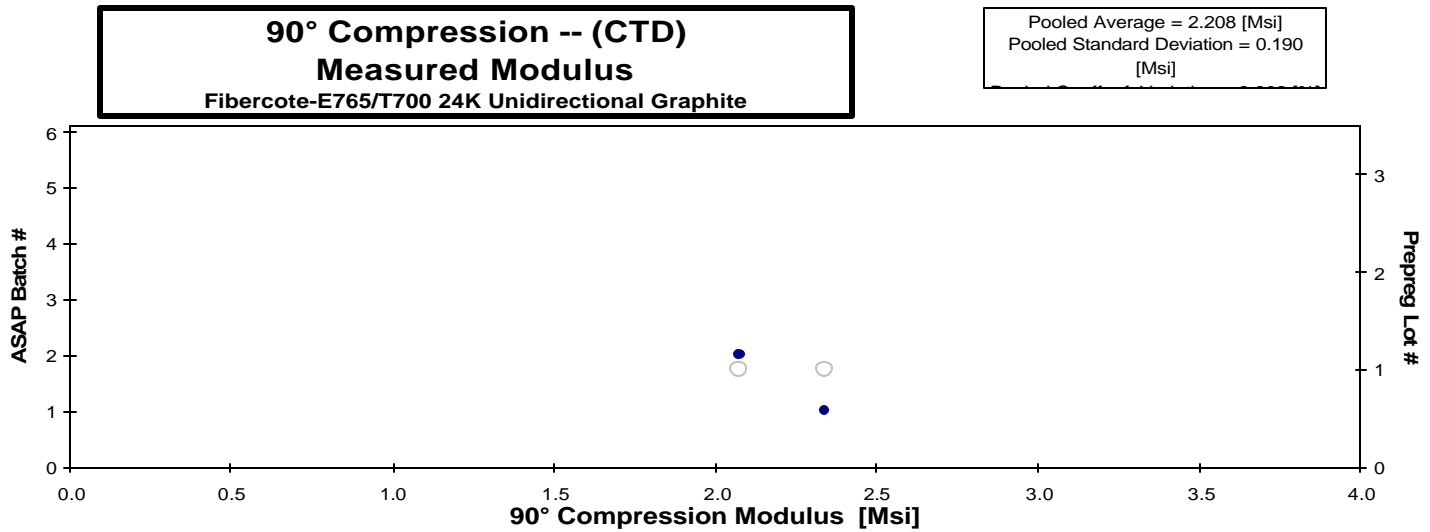
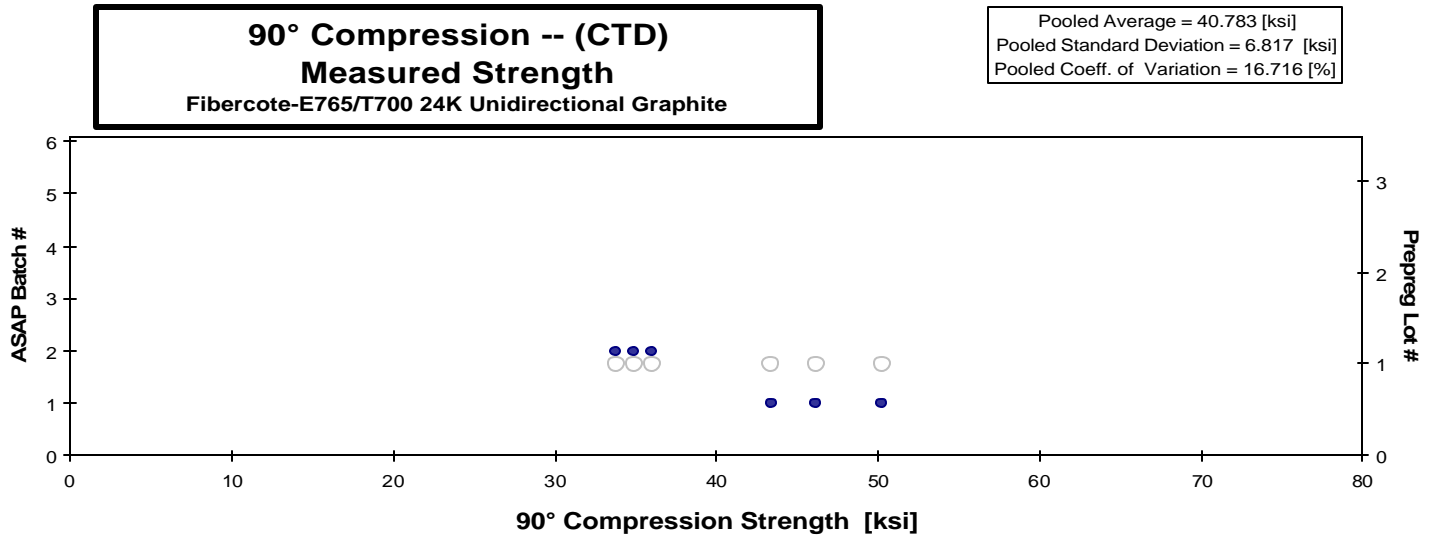
Average	28.936	1.679	0.0057
Standard Dev.	3.335	0.116	
Coeff. of Var. [%]	11.525	6.900	
Min.	23.076	1.543	Min. 0.0053
Max.	33.399	1.793	Max. 0.0061
Number of Spec.	18	5	



**90° Compression-- (CTD)
 Strength & Modulus**
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{ply} [in]
TAW1311B	A	1	1	46.198		0.041	7	0.00583
TAW1312B	A	1	1	43.458		0.041	7	0.00579
TAW1313B	A	1	1	50.288		0.041	7	0.00580
TAZ1217B	3	1	1		2.343	0.040	7	0.00577
TAW1126B	4	1	2	33.852		0.042	7	0.00602
TAW1127B	4	1	2	36.037		0.042	7	0.00601
TAW1128B	4	1	2	34.867		0.042	7	0.00599
TAZ1118B	4	1	2		2.074	0.042	7	0.00603

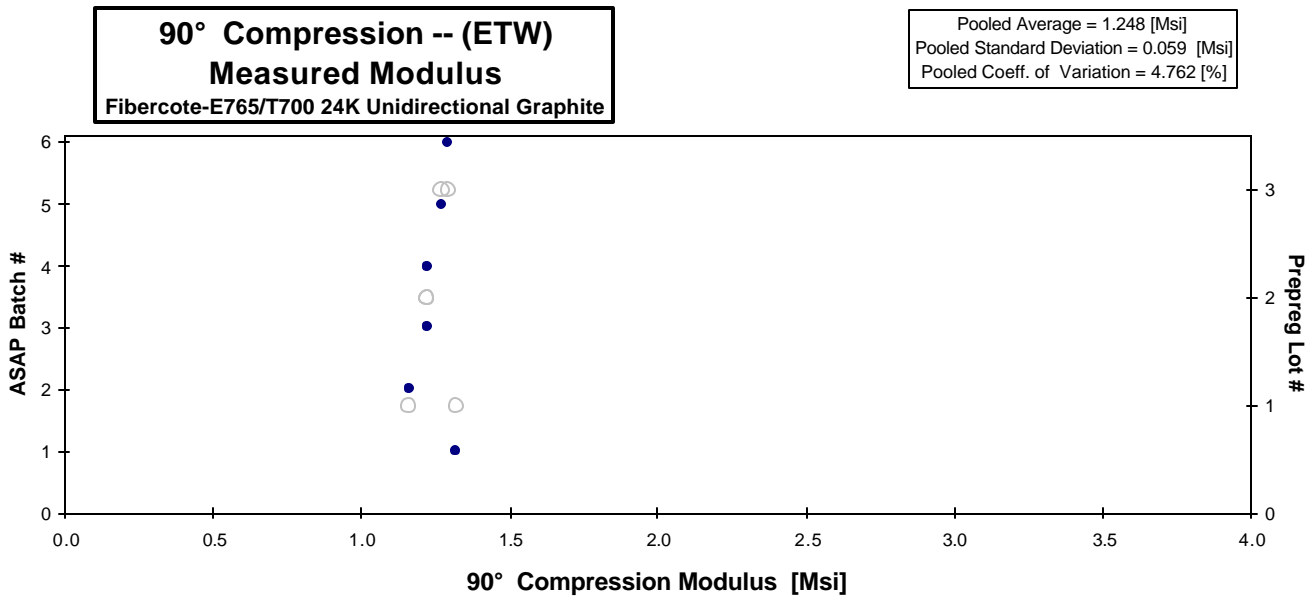
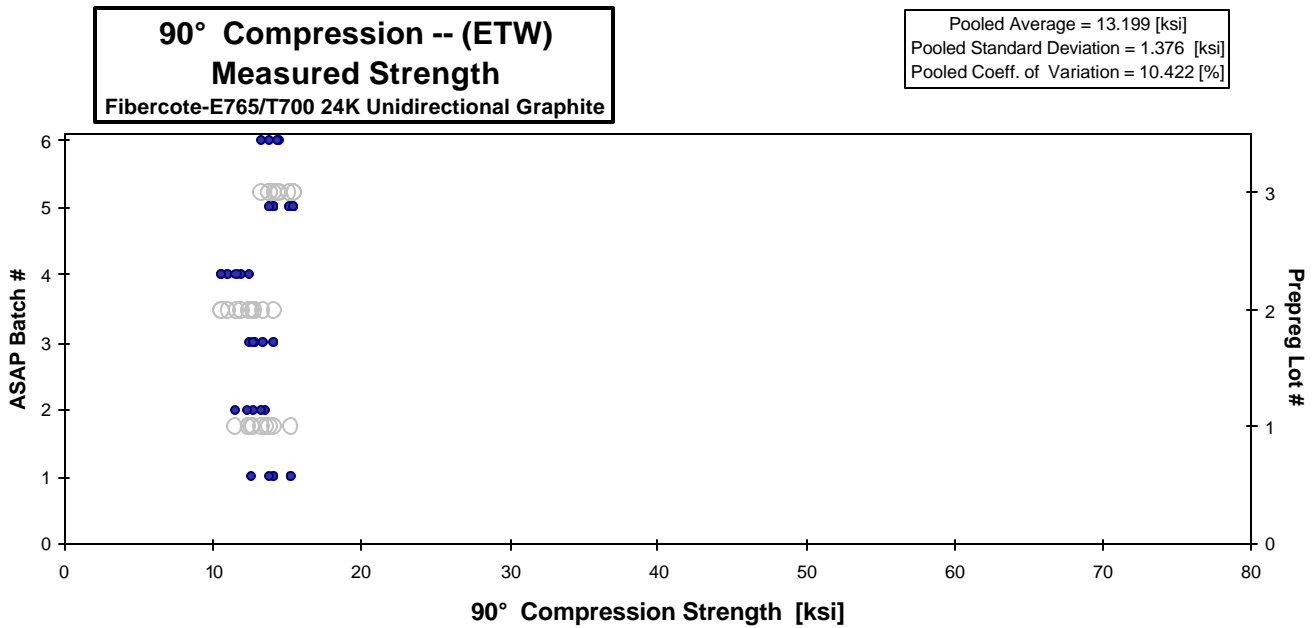
Average	40.783	2.208	0.0059
Standard Dev.	6.817	0.190	
Coeff. of Var. [%]	16.716	8.602	
Min.	33.852	2.074	Min. 0.0058
Max.	50.288	2.343	Max. 0.0060
Number of Spec.	6	2	



90° Compression -- (ETW)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thicken. [in]	# Plies in Laminate	Avg. tply [in]
TAW1221F	3	1	1	12.574		0.040	7	0.00570
TAW1223F	3	1	1	15.196		0.038	7	0.00536
TAW1224F	3	1	1	14.128		0.038	7	0.00546
TAW1225F	3	1	1	13.794		0.040	7	0.00565
TAZ1211F	3	1	1		1.323	0.039	7	0.00554
TAW1111F	4	1	2	11.515		0.041	7	0.00593
TAW1112F	4	1	2	13.547		0.040	7	0.00576
TAW1113F	4	1	2	12.661		0.040	7	0.00568
TAW1114F	4	1	2	12.320		0.039	7	0.00561
TAW1115F	4	1	2	13.244		0.040	7	0.00574
TAZ1111F	4	1	2		1.160	0.042	7	0.00601
TAW2111F	3	2	3	12.488		0.041	7	0.00581
TAW2112F	3	2	3	13.370		0.040	7	0.00575
TAW2114F	3	2	3	14.130		0.039	7	0.00564
TAW2115F	3	2	3	12.819		0.039	7	0.00553
TAW2116F	3	2	3	12.742		0.040	7	0.00574
TAZ2111F	3	2	3		1.219	0.039	7	0.00551
TAW2131F	4	2	4	10.620		0.043	7	0.00611
TAW2132F	4	2	4	11.889		0.042	7	0.00596
TAW2133F	4	2	4	11.093		0.042	7	0.00600
TAW2134F	4	2	4	11.610		0.041	7	0.00591
TAW2135F	4	2	4	10.575		0.042	7	0.00600
TAW2136F	4	2	4	12.533		0.041	7	0.00580
TAZ2211F	4	2	4		1.220	0.042	7	0.00598
TAW31L1F	3	3	5	15.513		0.037	7	0.00534
TAW31L2F	3	3	5	15.110		0.038	7	0.00542
TAW31L3F	3	3	5	14.120		0.037	7	0.00533
TAW31L4F	3	3	5	15.483		0.038	7	0.00540
TAW31L5F	3	3	5	13.814		0.038	7	0.00546
TAZ3211F	3	3	5		1.272	0.038	7	0.00545
TAW3111F	4	3	6	14.520		0.038	7	0.00538
TAW3112F	4	3	6	13.208		0.039	7	0.00553
TAW3113F	4	3	6	14.403		0.038	7	0.00544
TAW3114F	4	3	6	13.760		0.038	7	0.00541
TAZ3111F	4	3	6		1.294	0.039	7	0.00556

Average	13.199	1.248	0.0057
Standard Dev.	1.376	0.059	
Coeff. of Var. [%]	10.422	4.762	
Min.	10.575	1.160	Min. 0.0053
Max.	15.513	1.323	Max. 0.0061
Number of Spec.	29	6	



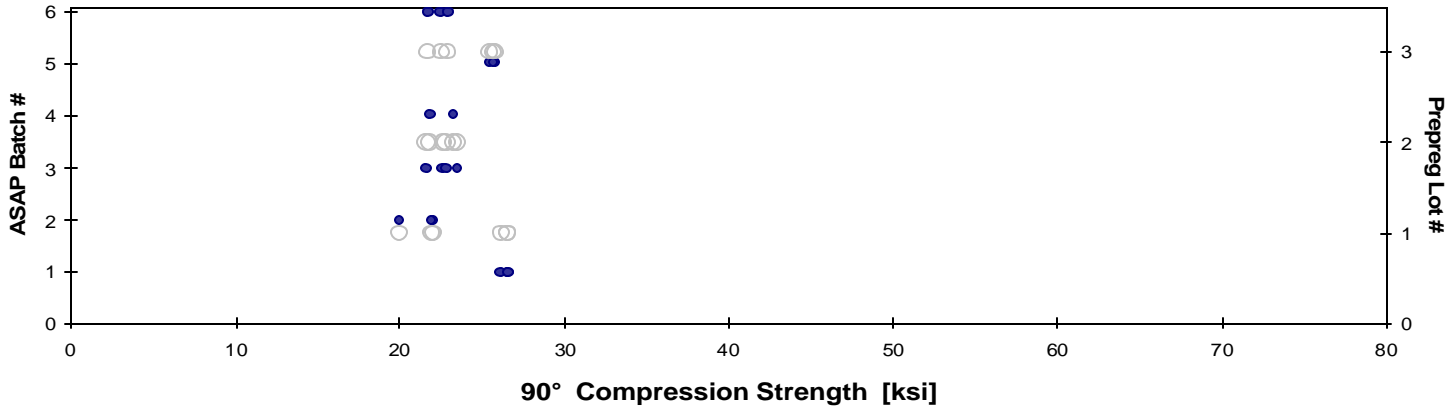
90° Compression -- (ETD)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{ply} [in]
TAW1315G	A	1	1	26.577		0.040	7	0.00574
TAW1316G	A	1	1	26.150		0.040	7	0.00576
TAW1317G	A	1	1	26.620		0.040	7	0.00568
TAZ1219G	3	1	1		1.389	0.040	7	0.00569
TAW1116G	4	1	2	22.067		0.040	7	0.00574
TAW1117G	4	1	2	21.983		0.040	7	0.00564
TAW1118G	4	1	2	19.947		0.041	7	0.00583
TAZ111BG	4	1	2		1.278	0.042	7	0.00600
TAW21Z1G	3	2	3	22.684		0.041	7	0.00579
TAW21Z2G	3	2	3	21.708		0.041	7	0.00585
TAW21Z3G	3	2	3	22.883		0.041	7	0.00582
TAW21Z4G	3	2	3	23.567		0.041	7	0.00588
TAZ2114G	3	2	3		1.437	0.040	7	0.00571
TAW21L1G	4	2	4	21.848		0.040	7	0.00566
TAW21L2G	4	2	4	23.305		0.039	7	0.00564
TAZ2216G	4	2	4		1.210	0.041	7	0.00586
TAW3311G	B	3	5	25.475		0.040	7	0.00571
TAW3312G	B	3	5	25.834		0.039	7	0.00563
TAW3313G	B	3	5	25.784		0.040	7	0.00573
TAZ3219G	3	3	5		1.482	0.037	7	0.00531
TAW3125G	4	3	6	22.539		0.040	7	0.00565
TAW3126G	4	3	6	22.948		0.039	7	0.00564
TAW31X1G	4	3	6	21.771		0.040	7	0.00569
TAZ311AG	4	3	6		1.567	0.039	7	0.00551

Average	23.538	1.394		0.0057
Standard Dev.	2.014	0.132		
Coeff. of Var. [%]	8.558	9.464		
Min.	19.947	1.210	Min.	0.0053
Max.	26.620	1.567	Max.	0.0060
Number of Spec.	18	6		

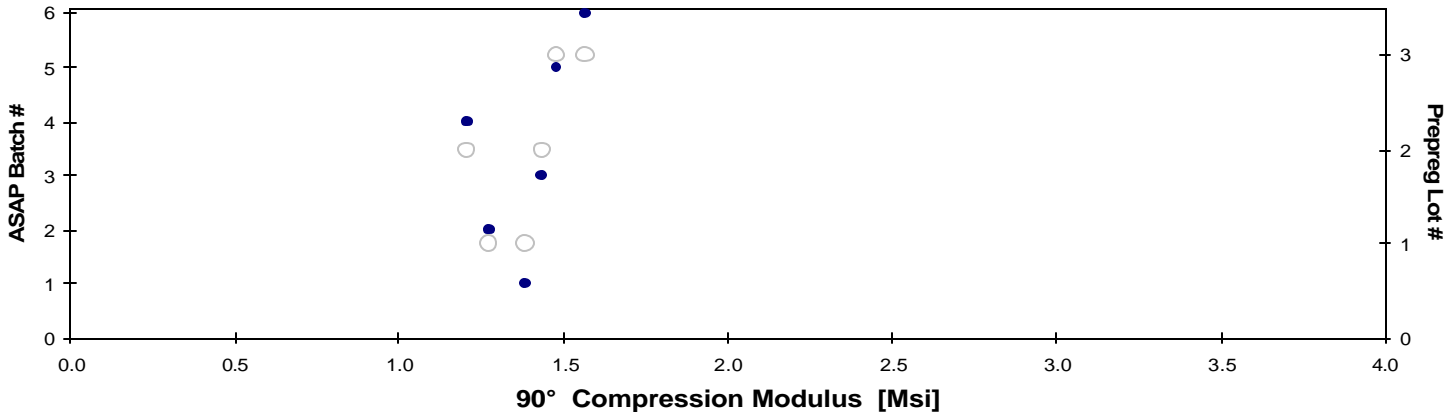
**90° Compression -- (ETD)
 Measured Strength
 Fibercote-E765/T700 24K Unidirectional Graphite**

Pooled Average = 23.538 [ksi]
 Pooled Standard Deviation = 2.014 [ksi]
 Pooled Coeff. of Variation = 8.558 [%]



**90° Compression -- (ETD)
 Measured Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite**

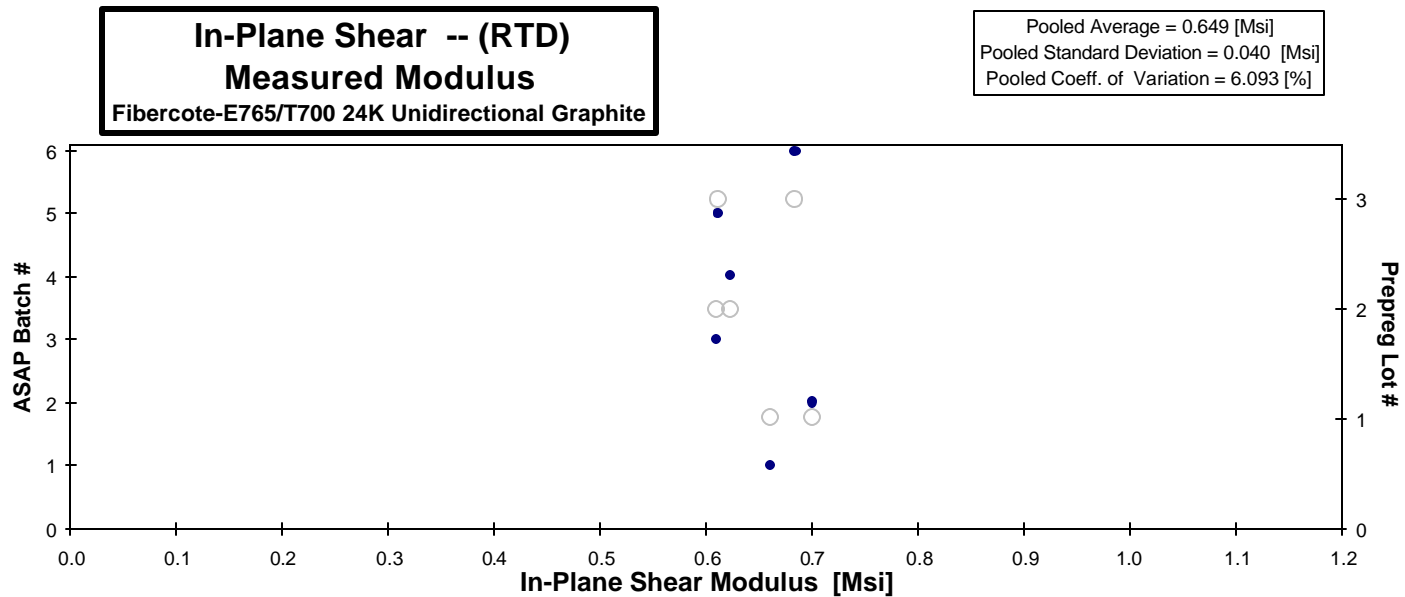
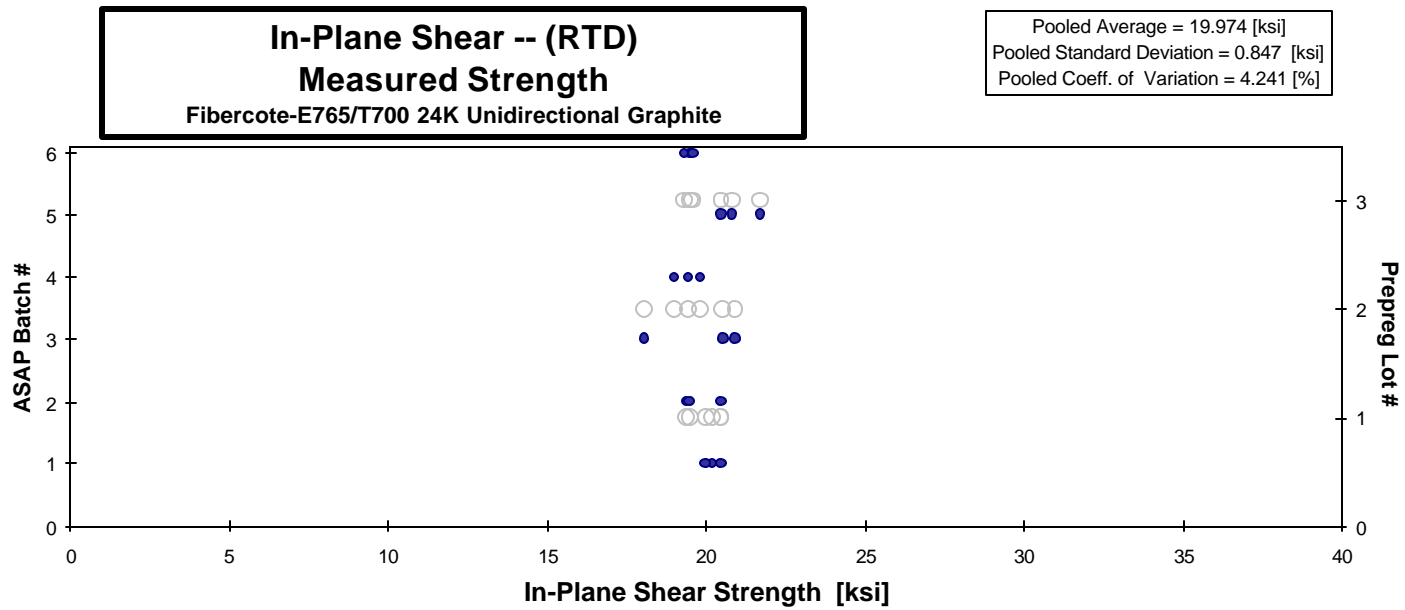
Pooled Average = 1.394 [Msi]
 Pooled Standard Deviation = 0.132 [Msi]
 Pooled Coeff. of Variation = 9.464 [%]



**In-Plane Shear -- (RTD)
 Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite**

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thckn. [in]	# Plies in Laminate	Avg. t _{div} [in]
TAN1116A	5	1	1	20.214	0.662	0.138	24	0.00573
TAN1117A	5	1	1	20.512		0.138	24	0.00575
TAN112AA	5	1	1	19.997		0.138	24	0.00575
TAN1226A	6	1	2	19.381	0.701	0.137	24	0.00569
TAN1227A	6	1	2	20.524		0.136	24	0.00568
TAN1228A	6	1	2	19.527		0.136	24	0.00569
TAN2131A	5	2	3	18.046	0.610	0.142	24	0.00593
TAN2132A	5	2	3	20.928		0.142	24	0.00594
TAN2133A	5	2	3	20.578		0.142	24	0.00593
TAN2216A	6	2	4	19.434	0.623	0.141	24	0.00588
TAN2217A	6	2	4	19.853		0.140	24	0.00582
TAN2218A	6	2	4	19.007		0.141	24	0.00586
TAN3121A	5	3	5	20.823		0.137	24	0.00569
TAN3122A	5	3	5	21.726	0.611	0.137	24	0.00569
TAN3123A	5	3	5	20.486		0.134	24	0.00560
TAN3226A	6	3	6	19.509	0.685	0.137	24	0.00570
TAN3227A	6	3	6	19.358		0.137	24	0.00571
TAN3228A	6	3	6	19.632		0.136	24	0.00568

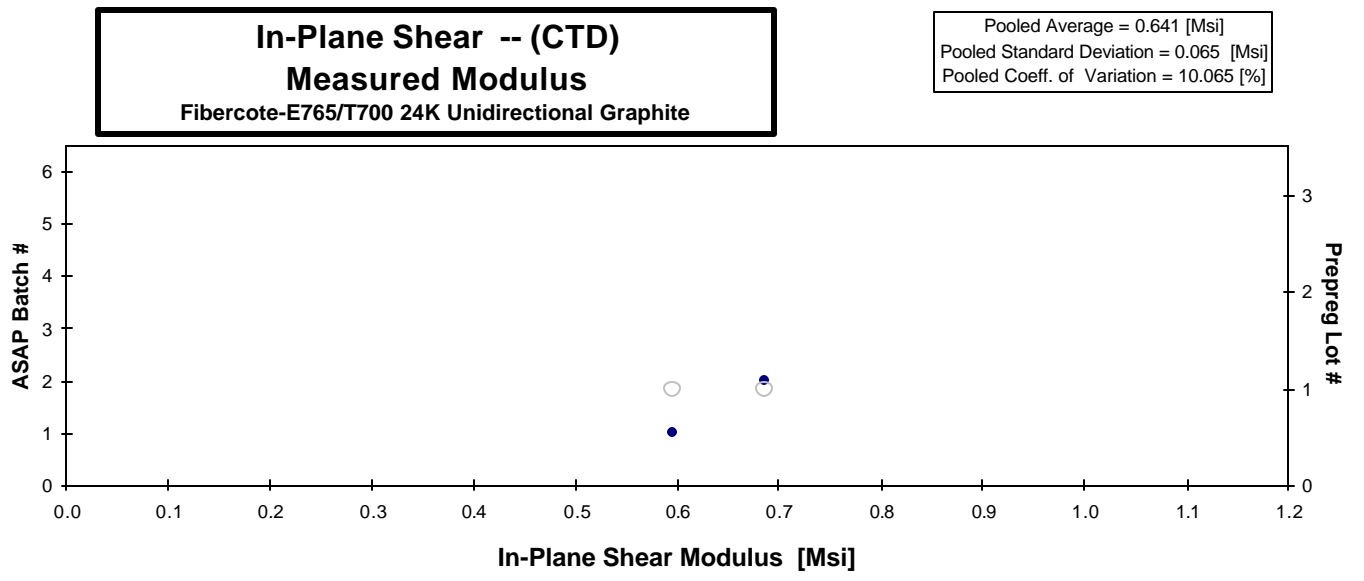
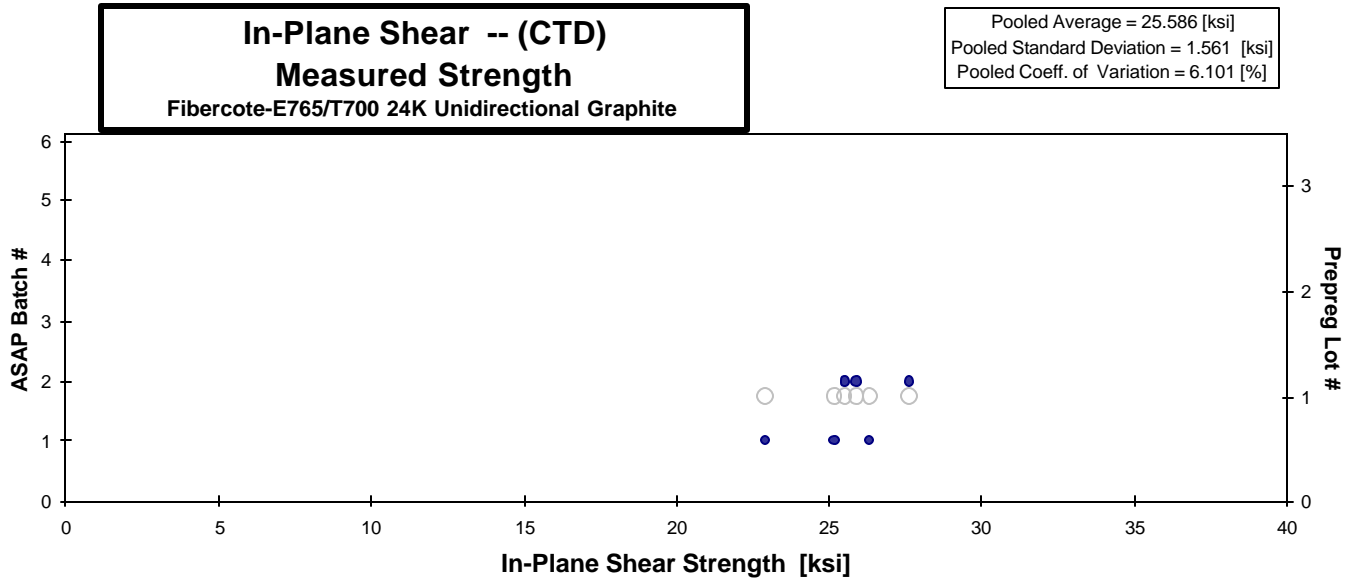
Average	19.974	0.649	0.0058
Standard Dev.	0.847	0.040	
Coeff. of Var. [%]	4.241	6.093	
Min.	18.046	0.610	Min. 0.0056
Max.	21.726	0.701	Max. 0.0059
Number of Spec.	18	6	



In-Plane Shear -- (CTD) Strength & Modulus Fibercote-E765/T700 24K Unidirectional Graphite
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Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{ply} [in]
TAN1126B	5	1	1	26.362		0.138	24	0.00573
TAN1128B	5	1	1	25.198		0.138	24	0.00573
TAN1129B	5	1	1	22.903	0.595	0.138	24	0.00574
TAN1218B	6	1	2	27.618		0.139	24	0.00578
TAN1219B	6	1	2	25.901		0.140	24	0.00585
TAN121AB	6	1	2	25.532	0.686	0.138	24	0.00574

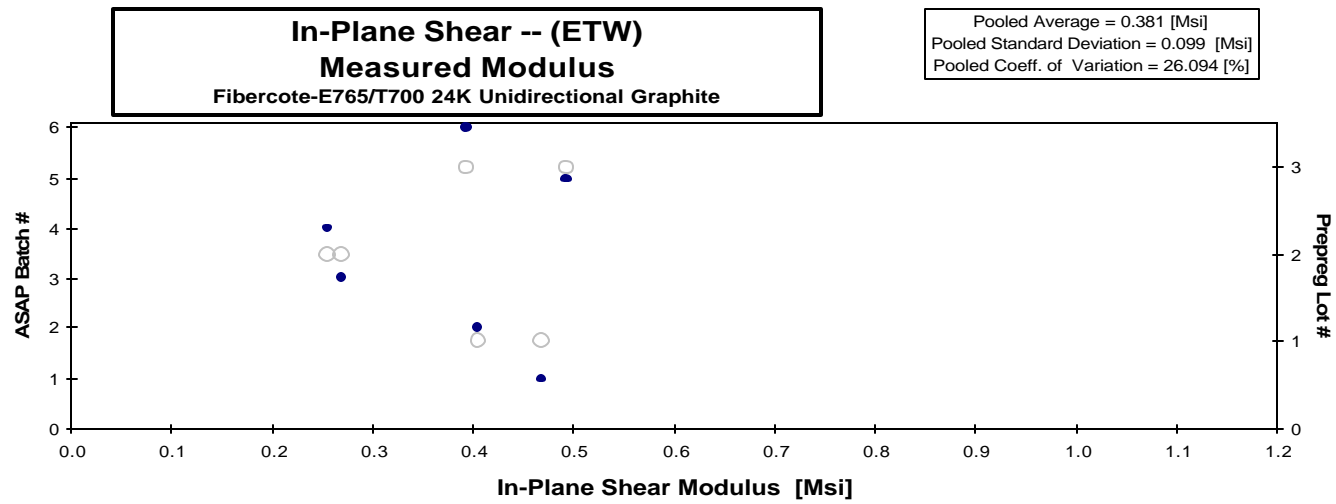
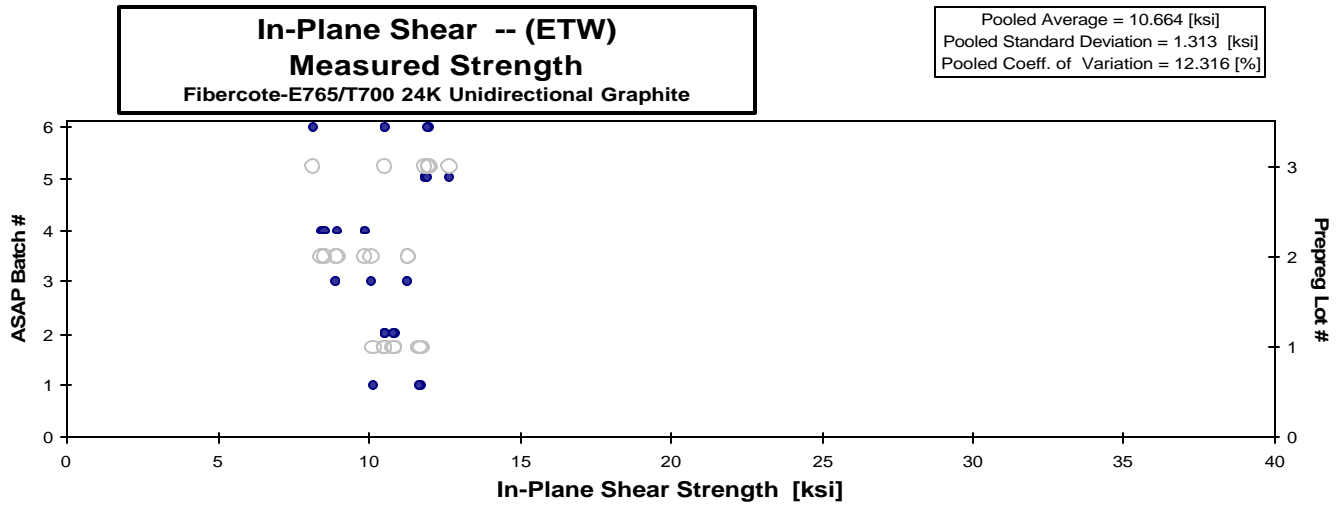
Average	25.586	0.641	0.0058
Standard Dev.	1.561	0.065	
Coeff. of Var. [%]	6.101	10.065	
Min.	22.903	0.595	Min. 0.0057
Max.	27.618	0.686	Max. 0.0058
Number of Spec.	6	2	



In-Plane Shear -- (ETW)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{div} [in]
TAN1111F	5	1	1	10.154	0.468	0.139	24	0.00578
TAN1112F	5	1	1	11.779		0.137	24	0.00572
TAN1113F	5	1	1	11.709		0.138	24	0.00575
TAN1114F	5	1	1	11.718		0.138	24	0.00575
TAN1221F	6	1	2	10.574	0.405	0.138	24	0.00574
TAN1222F	6	1	2	10.883		0.136	24	0.00567
TAN1223F	6	1	2	10.838		0.137	24	0.00571
TAN1224F	6	1	2	10.569		0.139	24	0.00579
TAN2112F	5	2	3	8.947	0.269	0.138	24	0.00577
TAN2113F	5	2	3	11.342		0.138	24	0.00576
TAN2114F	5	2	3	11.350		0.139	24	0.00579
TAN2115F	5	2	3	10.121		0.138	24	0.00576
TAN2211F	6	2	4	8.433	0.255	0.142	24	0.00590
TAN2212F	6	2	4	9.901		0.142	24	0.00590
TAN2213F	6	2	4	8.583		0.142	24	0.00593
TAN2214F	6	2	4	9.000		0.140	24	0.00585
TAN3113F	5	3	5	11.882		0.135	24	0.00560
TAN3115F	5	3	5	11.989		0.135	24	0.00562
TAN3117F	5	3	5	12.707	0.493	0.133	24	0.00552
TAN3222F	6	3	6	10.543		0.137	24	0.00572
TAN3223F	6	3	6	12.046		0.136	24	0.00565
TAN3224F	6	3	6	12.012		0.137	24	0.00573
TAN3225F	6	3	6	8.183	0.394	0.137	24	0.00572

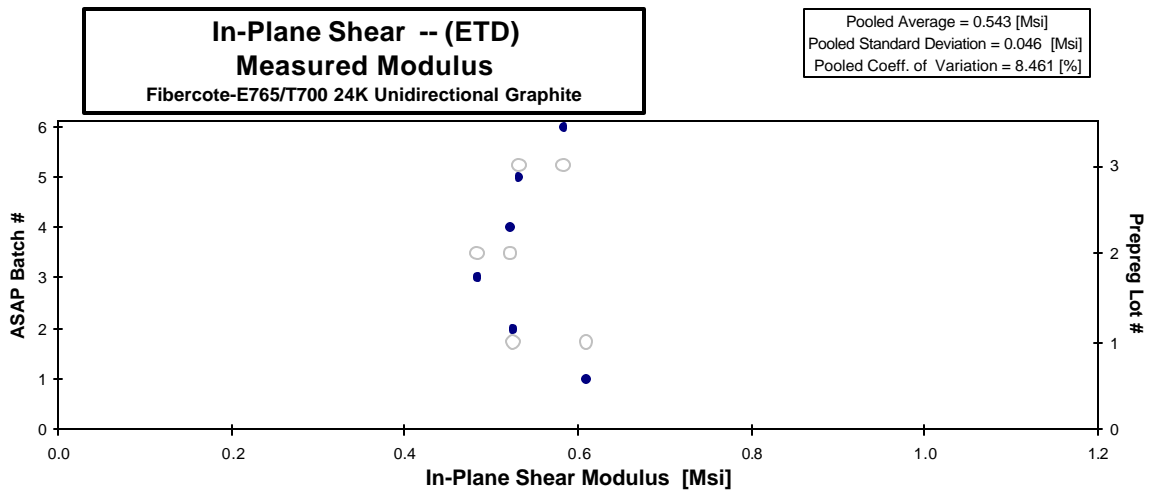
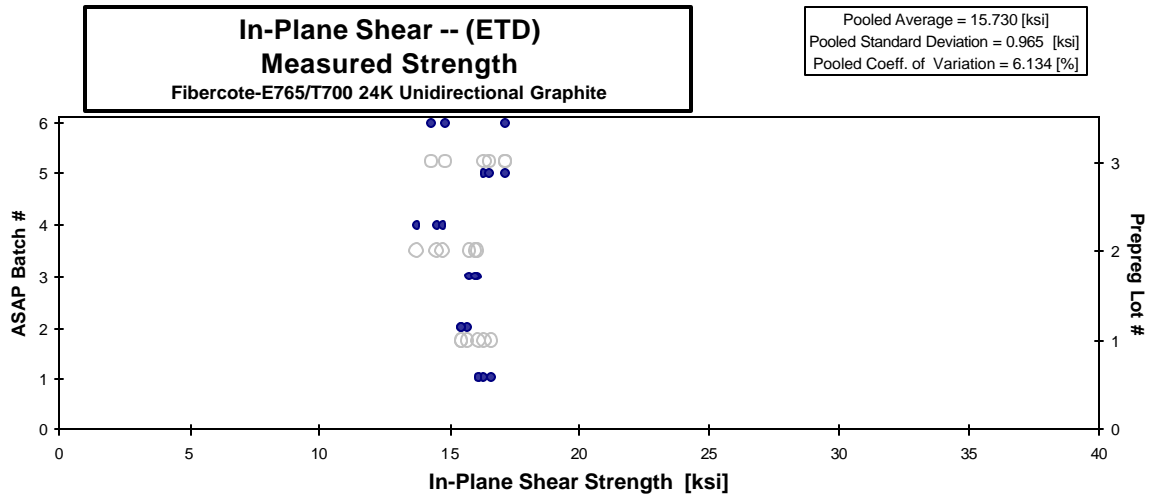
Average	10.664	0.381	0.0057
Standard Dev.	1.313	0.099	
Coeff. of Var. [%]	12.316	26.094	
Min.	8.183	0.255	Min. 0.0055
Max.	12.707	0.493	Max. 0.0059
Number of Spec.	23	6	



**In-Plane Shear -- (ETD)
 Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite**

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Modulus [Msi]	Avg. Specimen Thckn. [in]	# Plies in Laminate	Avg. t _{div} [in]
TAN1121G	5	1	1	16.609	0.610	0.137	24	0.00570
TAN1122G	5	1	1	16.146		0.138	24	0.00576
TAN1123G	5	1	1	16.335		0.138	24	0.00575
TAN1212G	6	1	2	15.670	0.526	0.139	24	0.00580
TAN1213G	6	1	2	15.492		0.140	24	0.00582
TAN1215G	6	1	2	15.448		0.142	24	0.00592
TAN2121G	5	2	3	15.795	0.483	0.141	24	0.00587
TAN2122G	5	2	3	16.072		0.141	24	0.00587
TAN2123G	5	2	3	16.008		0.141	24	0.00586
TAN2222G	6	2	4	14.538	0.522	0.138	24	0.00577
TAN2223G	6	2	4	14.754		0.139	24	0.00578
TAN2225G	6	2	4	13.768		0.142	24	0.00590
TAN3131G	5	3	5	16.349	0.532	0.136	24	0.00568
TAN3132G	5	3	5	17.160		0.137	24	0.00570
TAN3133G	5	3	5	16.568		0.137	24	0.00570
TAN3211G	6	3	6	17.202	0.584	0.136	24	0.00569
TAN3212G	6	3	6	14.336		0.138	24	0.00574
TAN3213G	6	3	6	14.886		0.138	24	0.00575

Average	15.730	0.543		0.0058
Standard Dev.	0.965	0.046		
Coeff. of Var. [%]	6.134	8.461		
Min.	13.768	0.483	Min.	0.0057
Max.	17.202	0.610	Max.	0.0059
Number of Spec.	18	6		



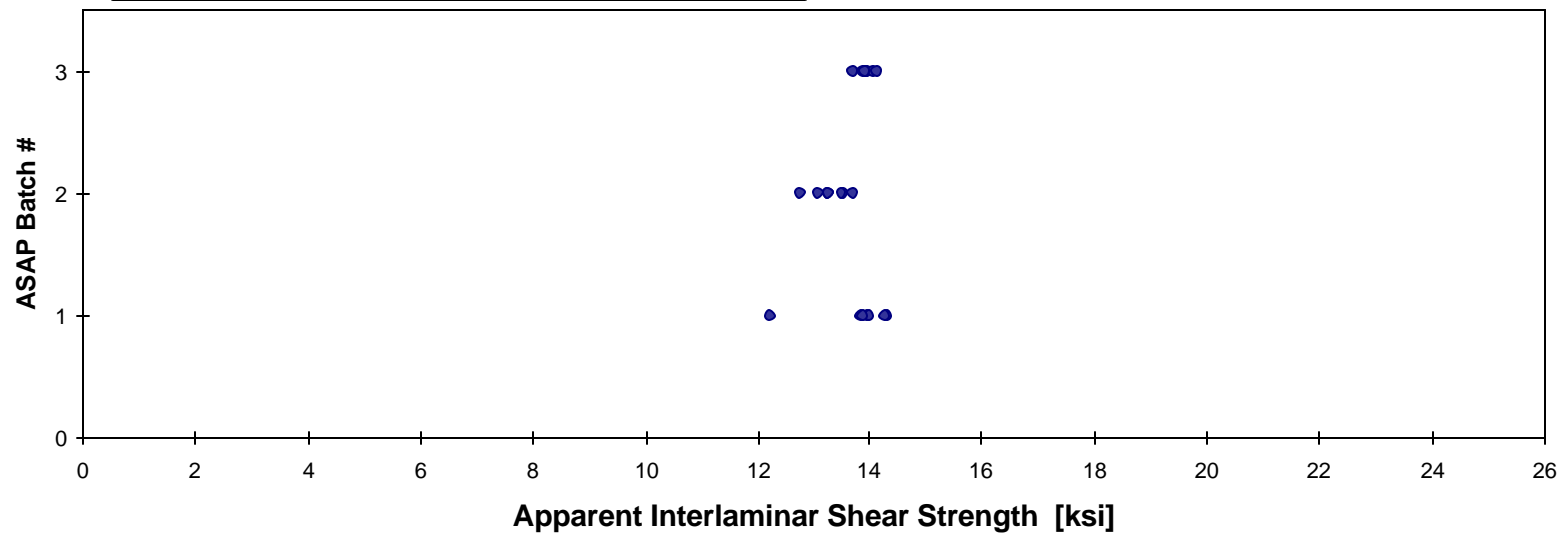
Apparent Interlaminar Shear -- (RTD) Strength Fibercote-E765/T700 24K Unidirectional Graphite
--

Specimen Number	Cure Cycle	Prepreg Lot #	ASAP Batch #	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t _{div} [in]
TAQ1119A	5	1	1	13.968	0.098	18	0.00547
TAQ111AA	5	1	1	14.001	0.100	18	0.00553
TAQ111BA	5	1	1	13.843	0.099	18	0.00551
TAQ111CA	5	1	1	12.219	0.097	18	0.00541
TAQ111DA	5	1	1	14.313	0.099	18	0.00552
TAQ111EA	5	1	1	14.289	0.098	18	0.00547
TAQ111FA	5	1	1	13.890	0.098	18	0.00546
TAQ2111A	6	2	2	13.061	0.104	18	0.00575
TAQ2112A	6	2	2	13.231	0.103	18	0.00572
TAQ2113A	6	2	2	13.254	0.103	18	0.00573
TAQ2114A	6	2	2	13.548	0.103	18	0.00573
TAQ2115A	6	2	2	13.487	0.103	18	0.00574
TAQ2116A	6	2	2	12.737	0.103	18	0.00575
TAQ2117A	6	2	2	13.709	0.104	18	0.00578
TAQ3121A	5	3	3	13.957	0.102	18	0.00567
TAQ3122A	5	3	3	13.893	0.101	18	0.00562
TAQ3123A	5	3	3	14.068	0.101	18	0.00563
TAQ3124A	5	3	3	13.917	0.099	18	0.00549
TAQ3125A	5	3	3	14.145	0.102	18	0.00567
TAQ3126A	5	3	3	13.696	0.103	18	0.00570
TAQ3127A	5	3	3	13.922	0.099	18	0.00549

Average	13.674	0.0056
Standard Dev.	0.523	
Coeff. of Var. [%]	3.827	
Min.	12.219	Min. 0.0054
Max.	14.313	Max. 0.0058
Number of Spec.	21	

**Apparent Interlaminar Shear -- (RTD)
Measured Strength**
Fibercote-E765/T700 24K Unidirectional Graphite

Pooled Average = 13.674 [ksi]
Pooled Standard Deviation = 0.523 [ksi]
Pooled Coeff. of Variation = 3.827 [%]



3.2.2 Fluid Sensitivity Raw Data Spreadsheets and Scatter Charts

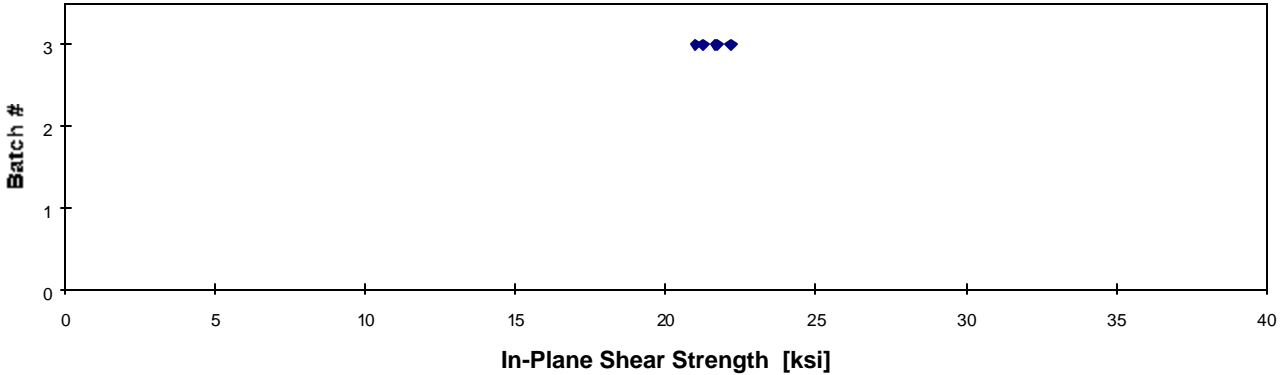
In-Plane Shear -- (MEK - RTD)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Batch Number	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{div} [in]
TAN3136A	3	21.242	0.135	24	0.00562
TAN3137A	3	21.728	0.139	24	0.00577
TAN3138A	3	21.659	0.135	24	0.00564
TAN3139A	3	20.990	0.138	24	0.00576
TAN313AA	3	22.182	0.138	24	0.00574

Average	21.560	0.0057
Standard Dev.	0.461	
Coeff. of Var. [%]	2.139	
Min.	20.990	Min. 0.0056
Max.	22.182	Max. 0.0058
Number of Spec.	5	

In-Plane Shear -- (MEK - RTD)
Measured Strength
 Fibercote-E765/T700 24K Unidirectional Graphite

Pooled Average = 21.560 [ksi]
 Pooled Standard Deviation = 0.461 [ksi]
 Pooled Coeff. of Variation = 2.139 [%]



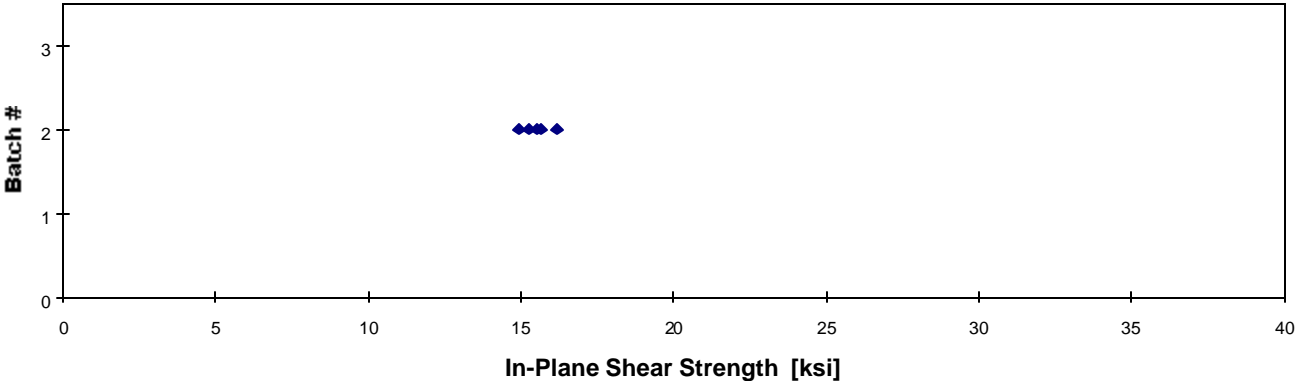
In-Plane Shear -- (JP-4 JET FUEL - ETD)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Batch Number	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{div} [in]
TAN2136G	2	14.922	0.143	24	0.00594
TAN2137G	2	15.662	0.141	24	0.00589
TAN2138G	2	16.167	0.143	24	0.00596
TAN2139G	2	15.539	0.143	24	0.00594
TAN213AG	2	15.258	0.142	24	0.00593

Average	15.510	0.0059
Standard Dev.	0.465	
Coeff. of Var. [%]	2.996	
Min.	14.922	Min. 0.0059
Max.	16.167	Max. 0.0060
Number of Spec.	5	

In-Plane Shear -- (JP-4 JET FUEL - ETD)
Measured Strength
 Fibercote-E765/T700 24K Unidirectional Graphite

Pooled Average = 15.510 [ksi]
 Pooled Standard Deviation = 0.465 [ksi]
 Pooled Coeff. of Variation = 2.996 [%]



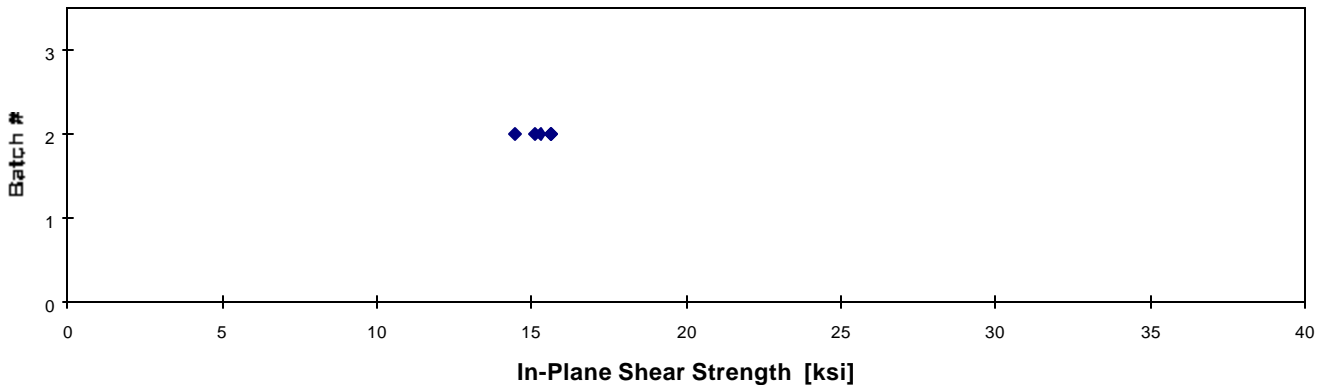
In-Plane Shear -- (Hydraulic Fluid - ETD)
Strength & Modulus
 Fibercote-E765/T700 24K Unidirectional Graphite

Specimen Number	Batch Number	Strength [ksi]	Avg. Specimen Thickn. [in]	# Plies in Laminate	Avg. t_{div} [in]
TAN2126G	2	14.449	0.142	24	0.00590
TAN2127G	2	15.290	0.140	24	0.00585
TAN2128G	2	15.627	0.141	24	0.00587
TAN2129G	2	15.631	0.143	24	0.00594
TAN212AG	2	15.111	0.141	24	0.00588

Average	15.221	0.0059
Standard Dev.	0.486	
Coeff. of Var. [%]	3.195	
Min.	14.449	Min. 0.0059
Max.	15.631	Max. 0.0059
Number of Spec.	5	

In-Plane Shear -- (Hydraulic Fluid - ETD)
Measured Strength
 Fibercote-E765/T700 24K Unidirectional Graphite

Pooled Average = 15.221 [ksi]
 Pooled Standard Deviation = 0.486 [ksi]
 Pooled Coeff. of Variation = 3.195 [%]



Fluid Sensitivity Comparison:

Average In-Plane Shear Strength with Fluid (ksi)	SAME ENVIRONMENT IN-PLANE SHEAR STRENGTH WITHOUT FLUID (KSI)	WORST CASE ENVIRONMENT IN-PLANE SHEAR STRENGTH (KSI)
MEK (RTD) 21.56	(RTD) 19.97	(ETW) 10.66

The RTD average in-plane shear strength was not reduced after exposure to MEK.

Average In-Plane Shear Strength with Fluid (ksi)	SAME ENVIRONMENT IN-PLANE SHEAR STRENGTH WITHOUT FLUID (KSI)	WORST CASE ENVIRONMENT IN-PLANE SHEAR STRENGTH (KSI)
JP-4 JET FUEL (ETD) 15.51	(ETD) 15.73	(ETW) 10.66

The ETD average in-plane shear strength was reduced by 1% after exposure to JP-4 Jet Fuel. However it remained 45% higher than water exposure in ETW conditions.

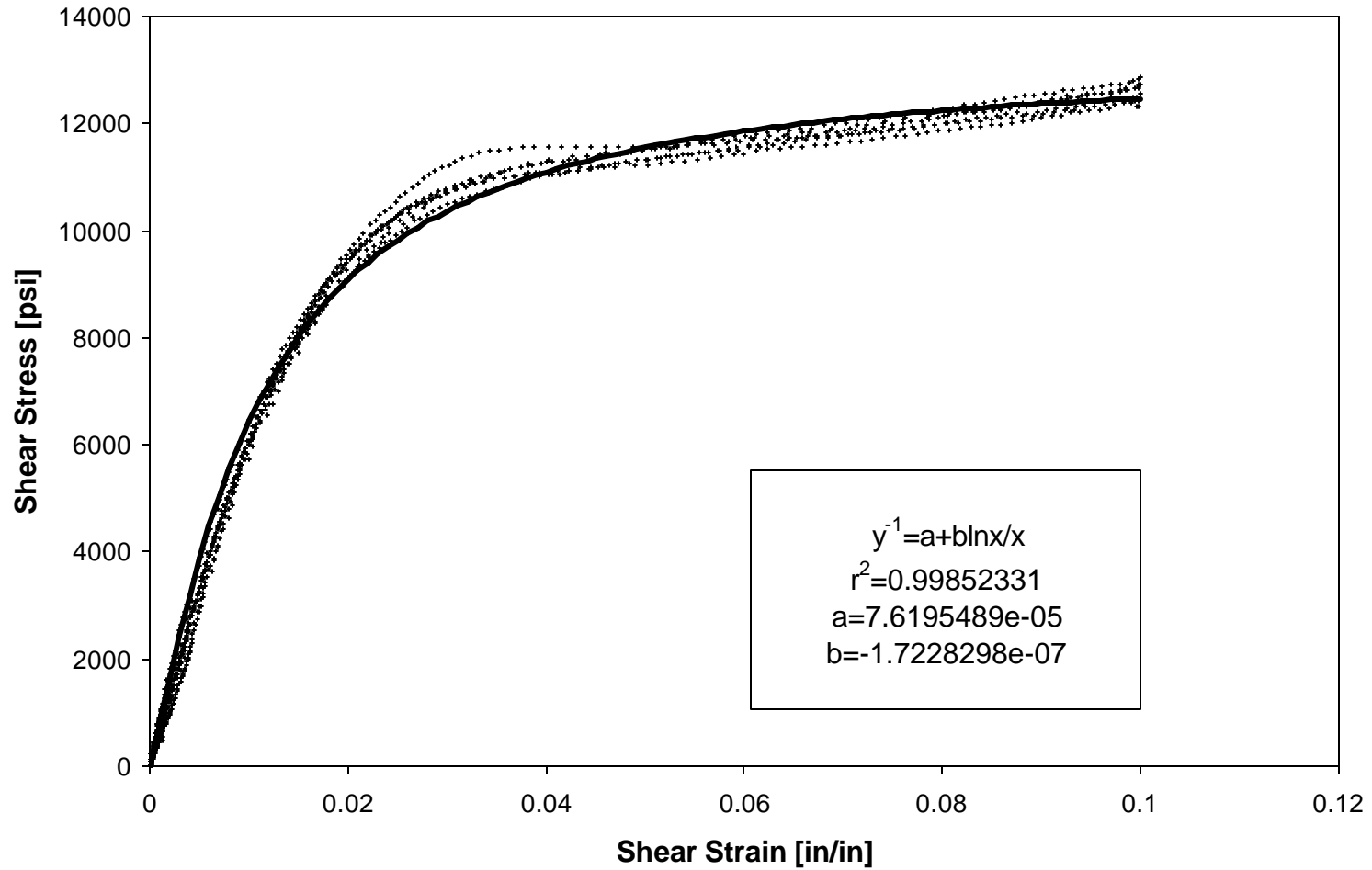
Average In-Plane Shear Strength with Fluid (ksi)	SAME ENVIRONMENT IN-PLANE SHEAR STRENGTH WITHOUT FLUID (KSI)	WORST CASE ENVIRONMENT IN-PLANE SHEAR STRENGTH (KSI)
HYDRAULIC FLUID (ETD) 15.22	(ETD) 15.73	(ETW) 10.66

The ETD average in-plane shear strength was reduced by 3% after exposure to Hydraulic Fluid. However, it remained 43% higher than water exposure in ETW conditions.

3.2.3 Representative Shear Stress-Strain Curve

The following stress-strain curve is representative of the FiberCote T700 24K/E765 prepreg system. The tension and compression stress-strain curves are not presented in graphical form. If strain design allowables from these tests are required, simple one-dimensional linear stress-strain relationships may be used to obtain corresponding strain design values. This process should approximate tensile and compressive strain behavior relatively well but may produce extremely conservative strain values in shear due to the nonlinear behavior. A more realistic approach for shear strain design allowables is to use a maximum strain value of 5% (reference MIL-HDBK-17-1E, section 5.7.6). If a nonlinear analysis of the material's shear behavior is required, the curve-fit of the shear stress-strain curve may be used. The representative shear stress-strain curve was obtained by taking the average of all the sample shear curves and determining the best-fit line through the data. The actual data points also presented on the chart to demonstrate material variability.

Shear Stress vs. Shear Strain, RTD

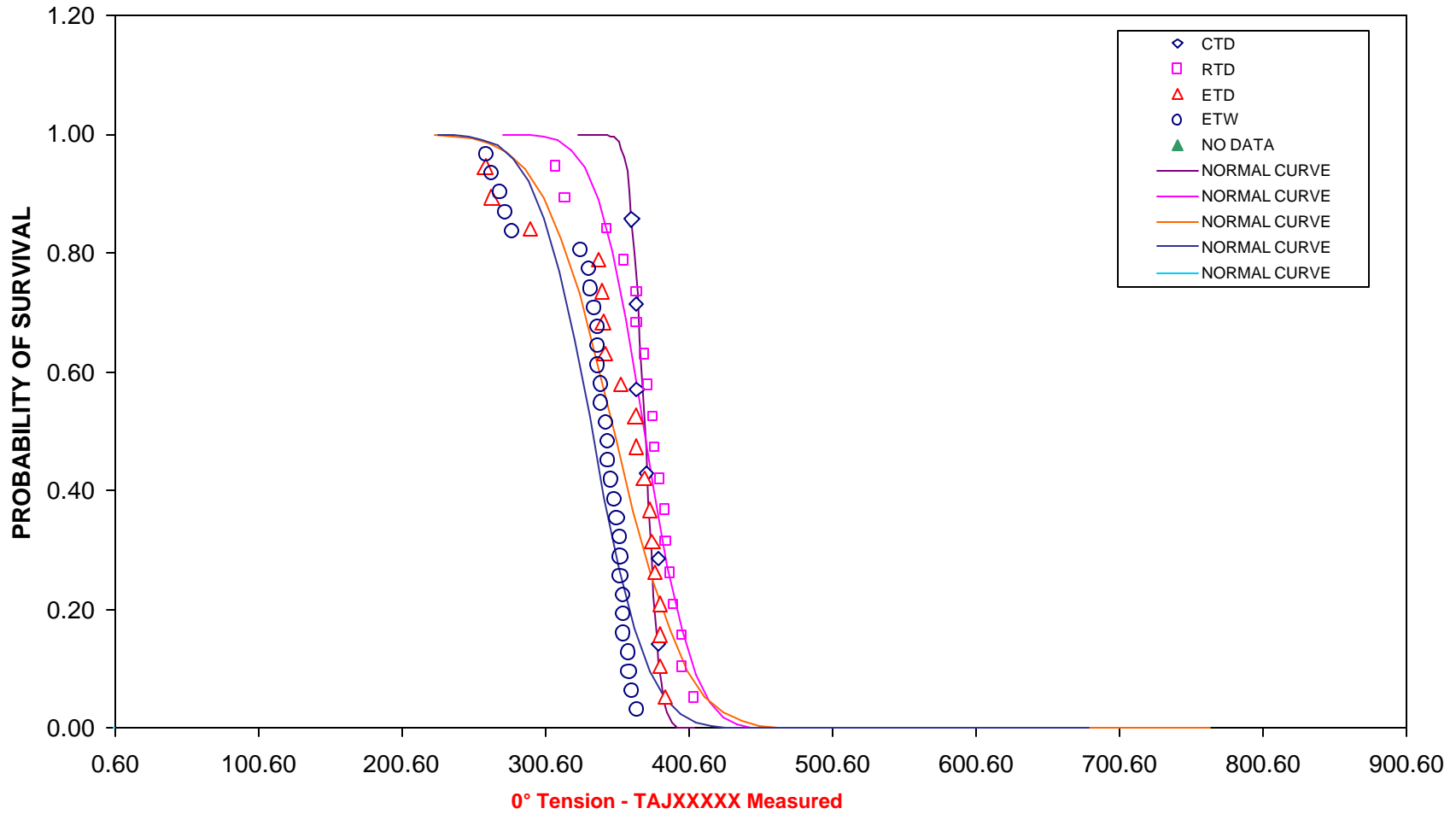


3.3 Statistical Results

3.3.1 Plot by Condition

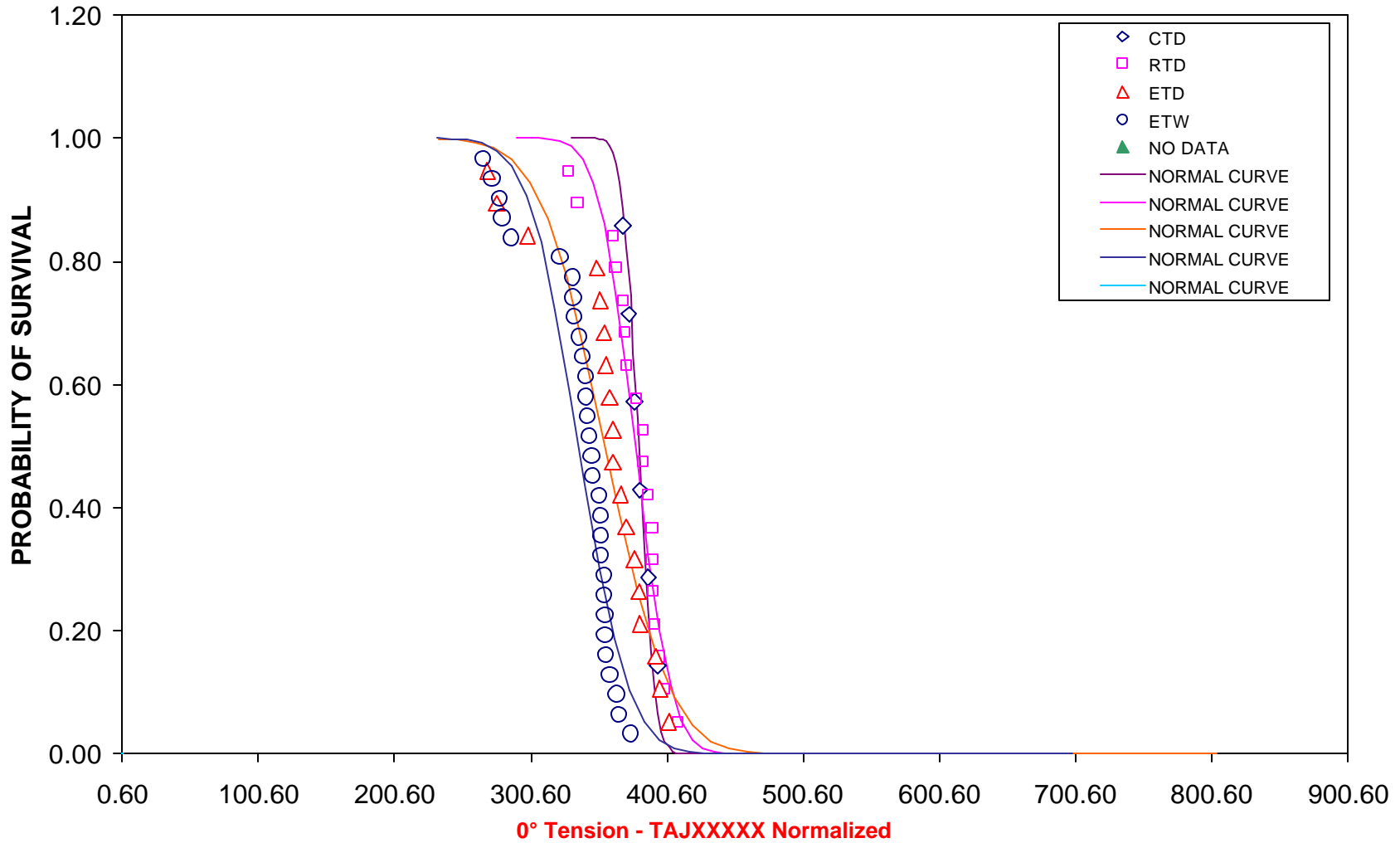
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

Fibercote-E765/T700 24K Unidirectional Graphite
 Fibercote



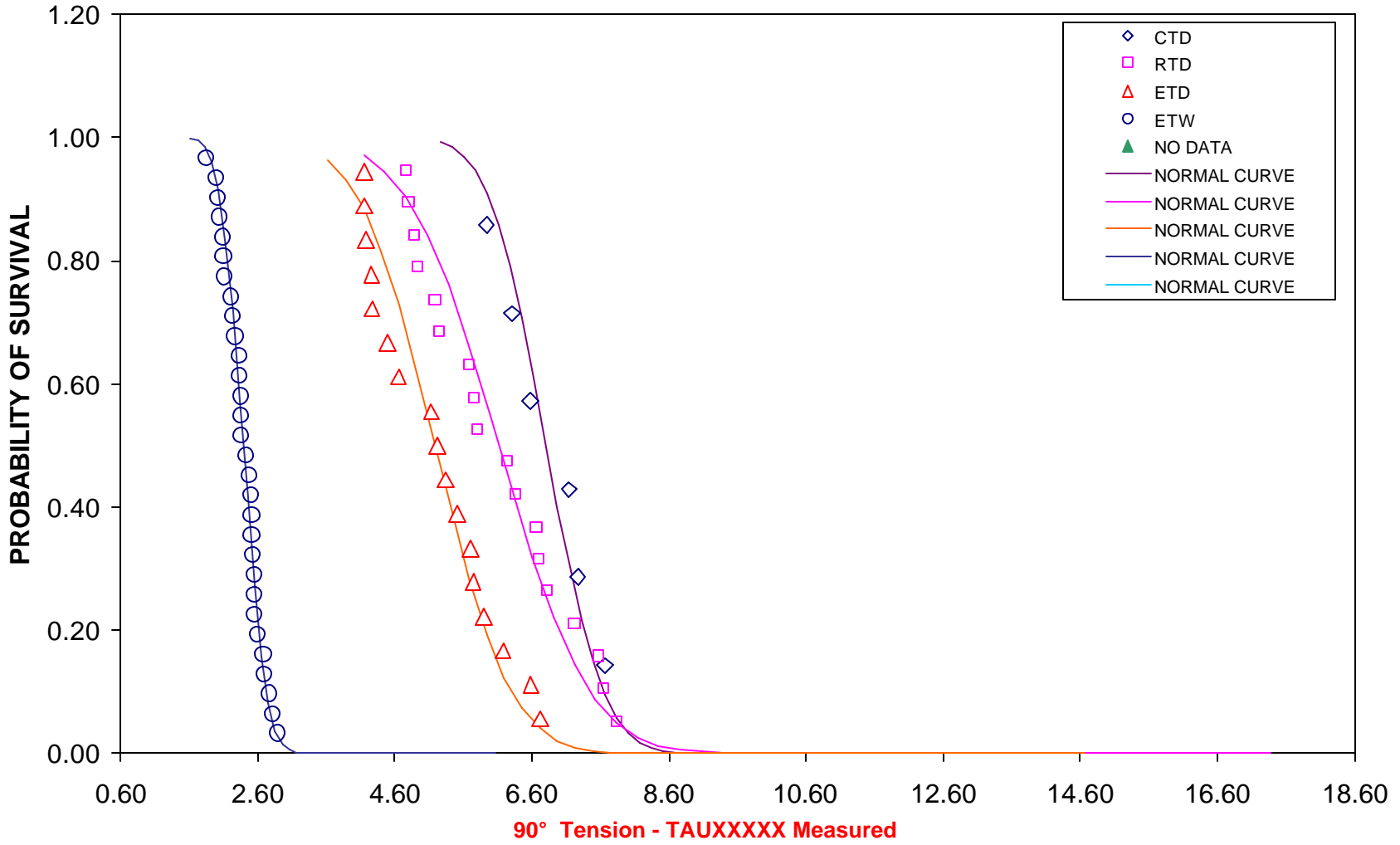
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote



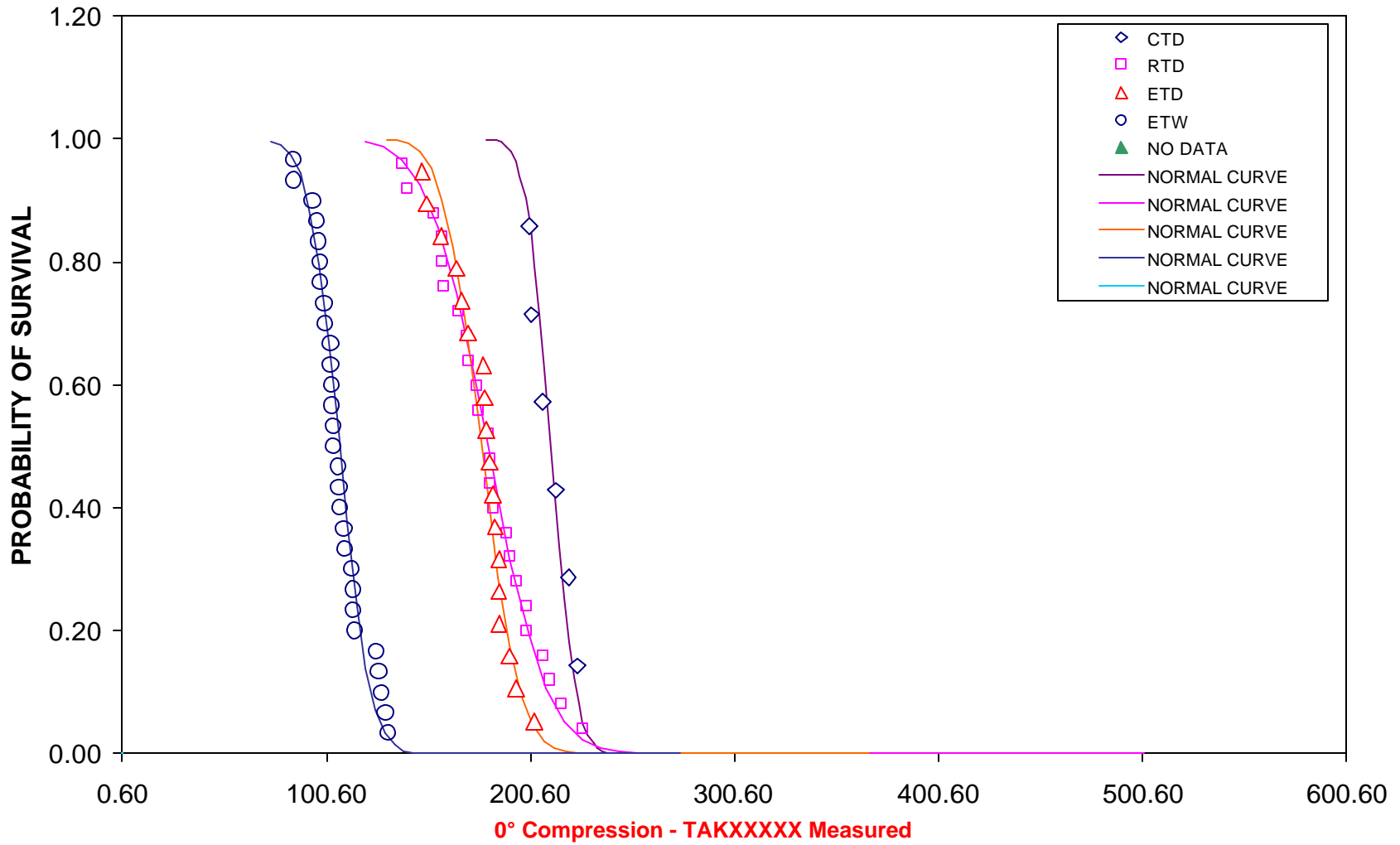
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

**Fibercote-E765/T700 24K Unidirectional Graphite
 Fibercote**



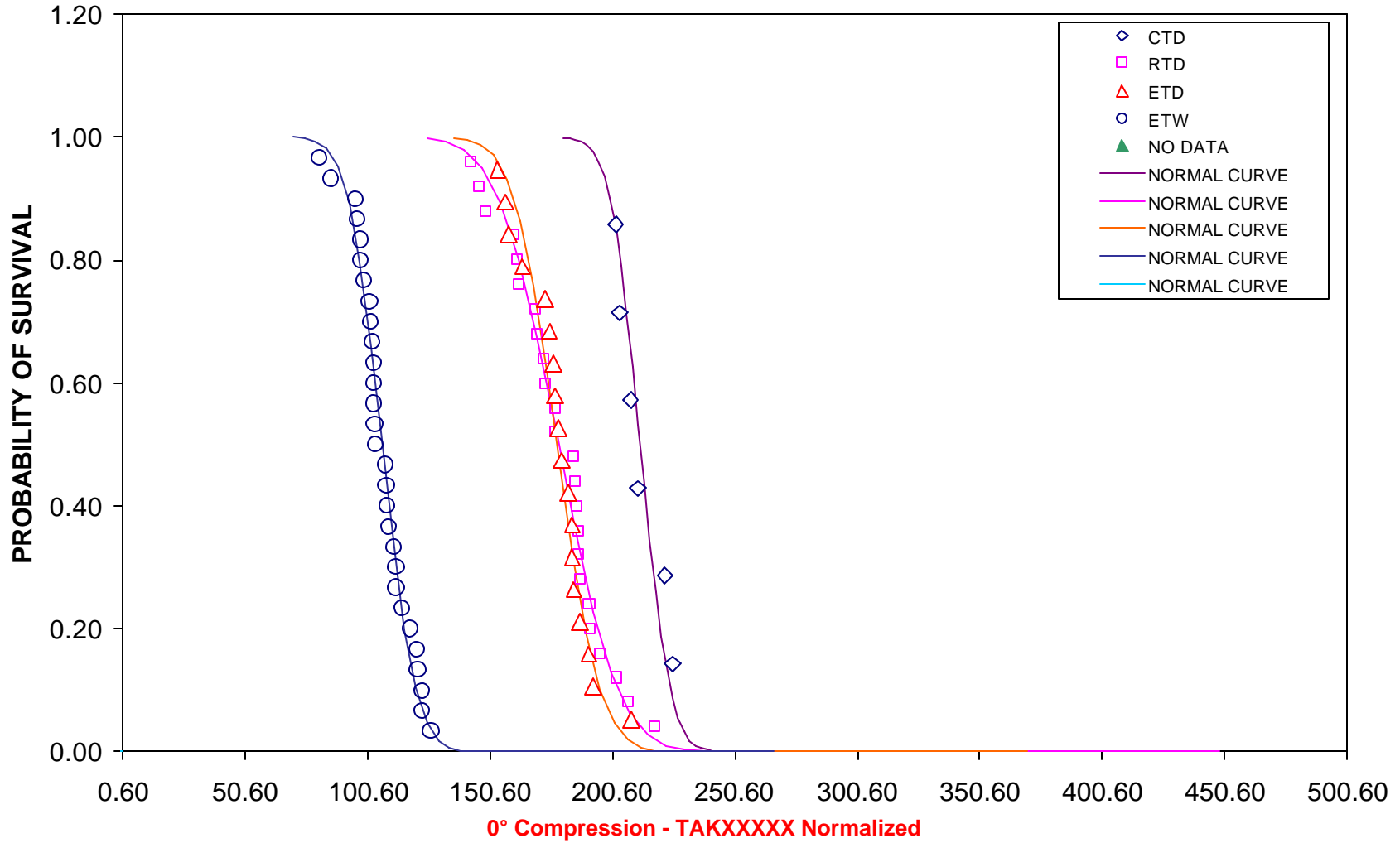
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

**Fibercote-E765/T700 24K Unidirectional Graphite
 Fibercote**



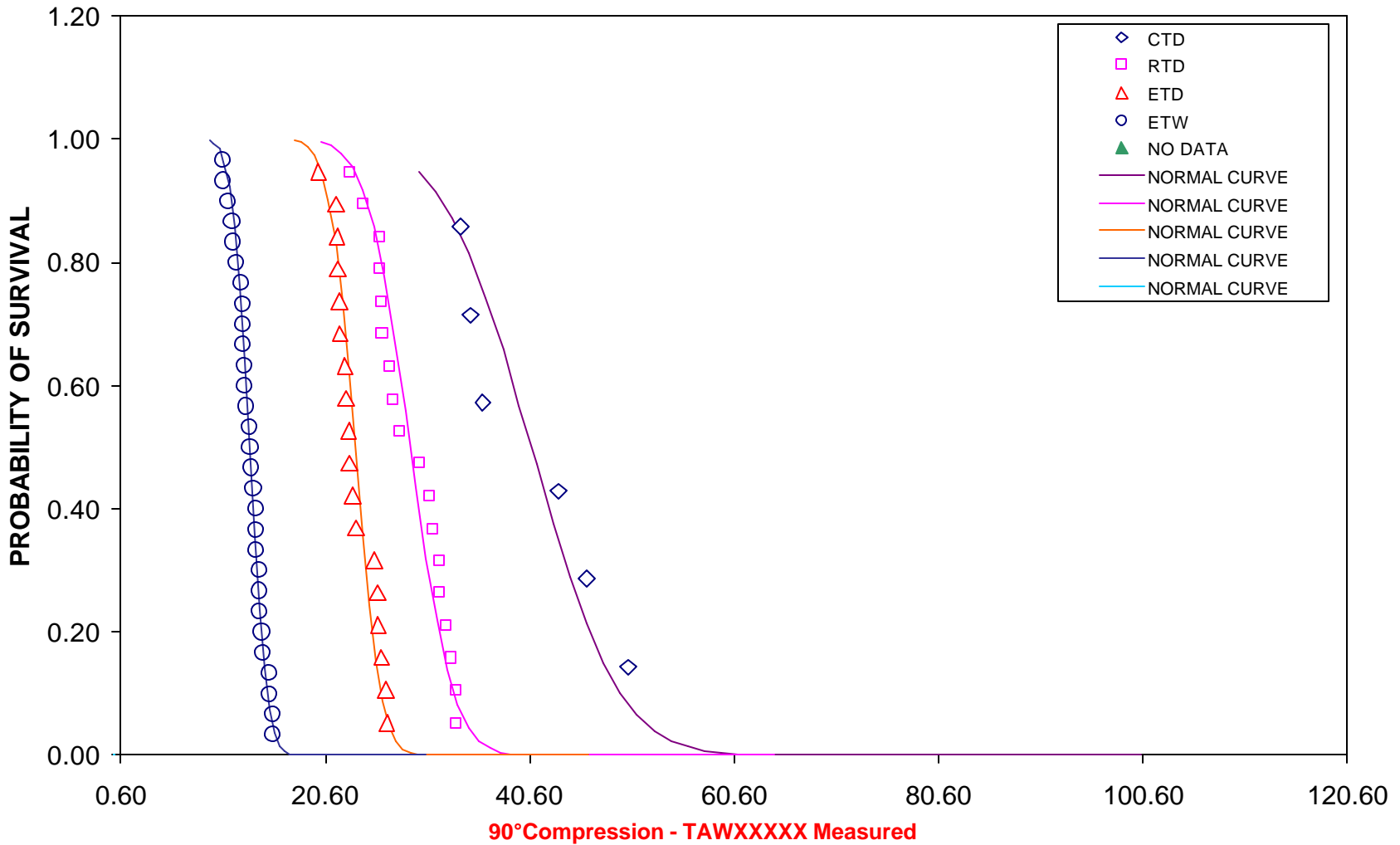
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

**Fibercote-E765/T700 24K Unidirectional Graphite
 Fibercote**



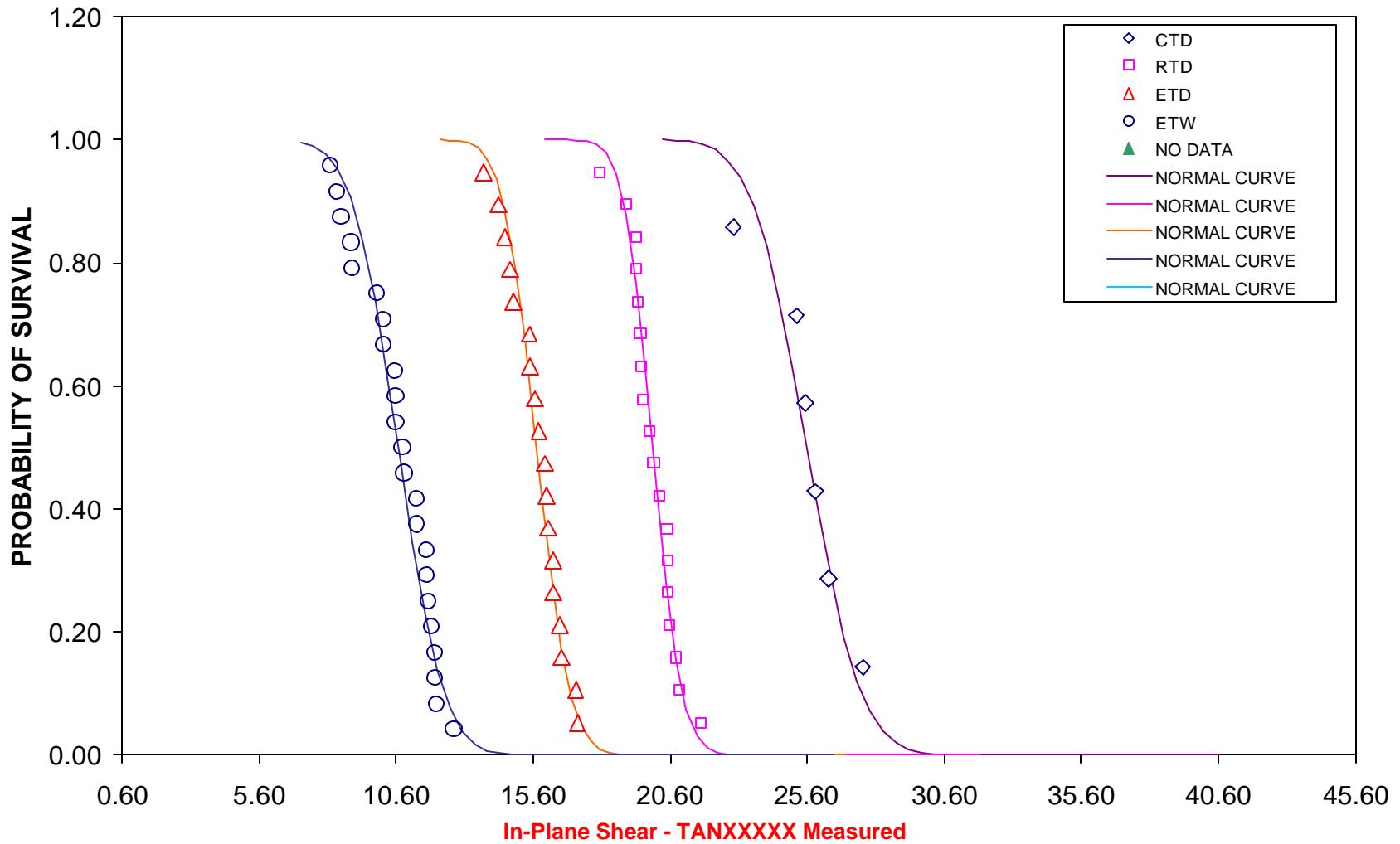
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

**Fibercote-E765/T700 24K Unidirectional Graphite
 Fibercote**



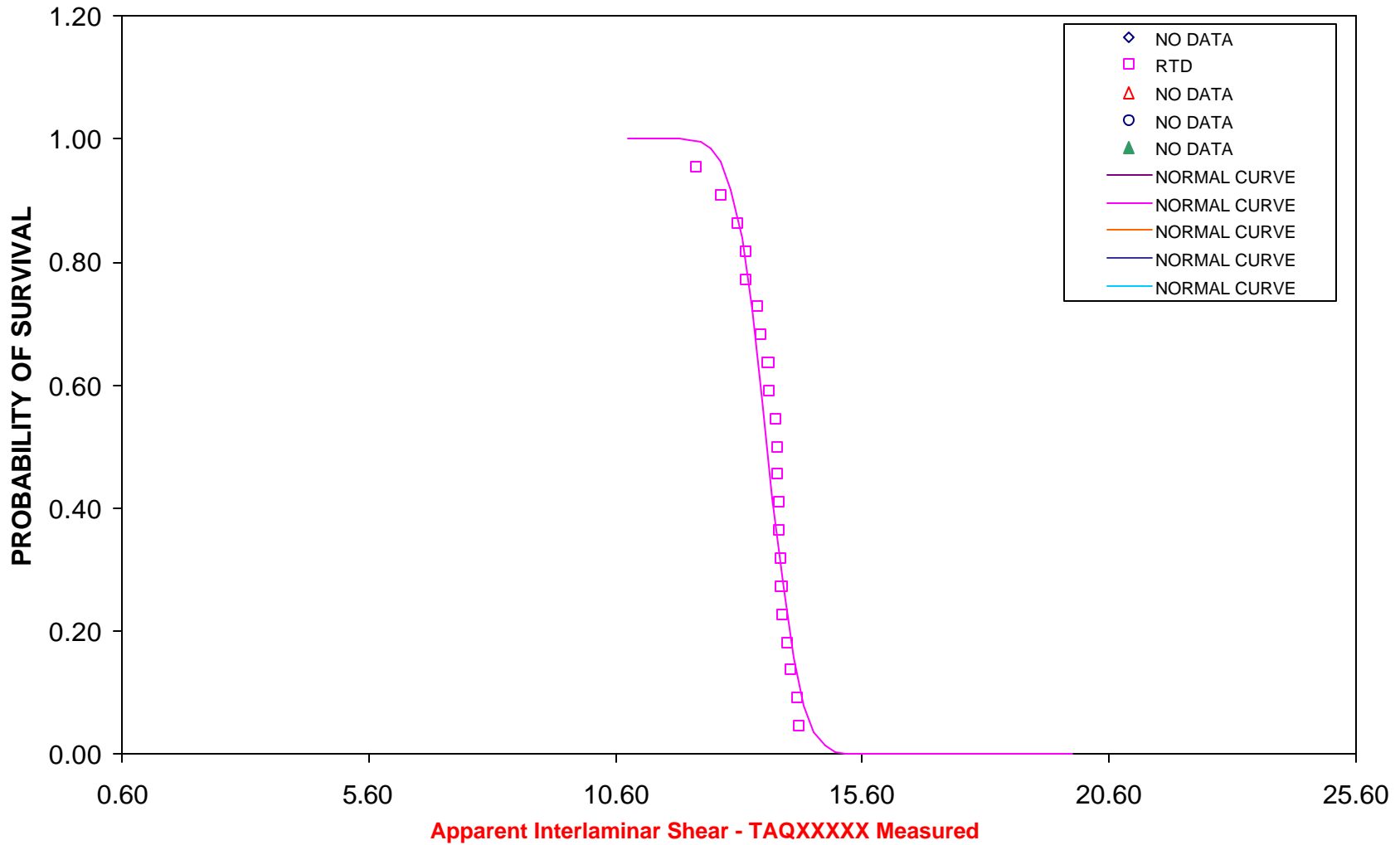
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

**Fibercote-E765/T700 24K Unidirectional Graphite
 Fibercote**



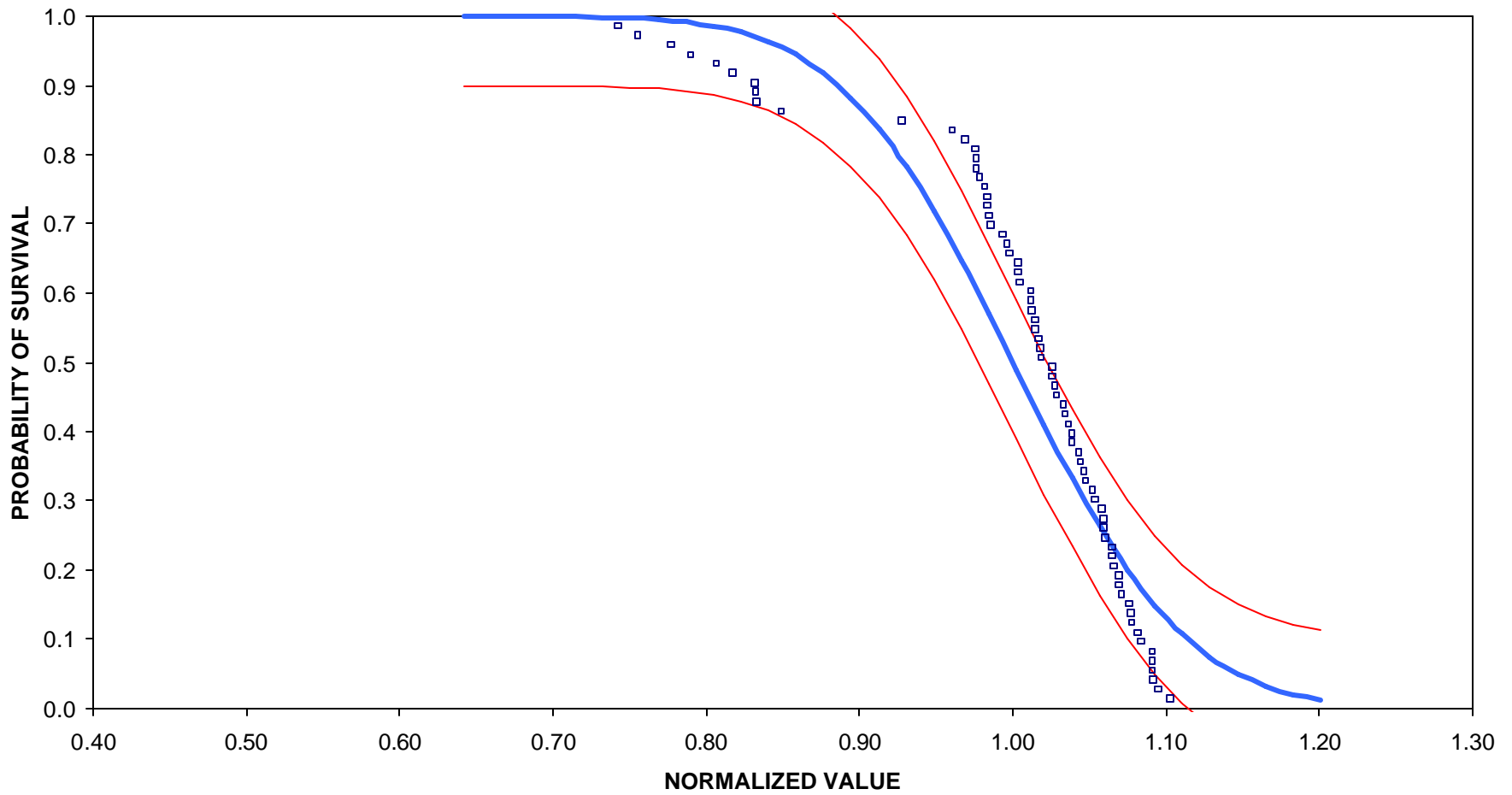
DISTRIBUTION OF GROUPED DATA FOR DIFFERENT TEST CONDITIONS

**Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote**

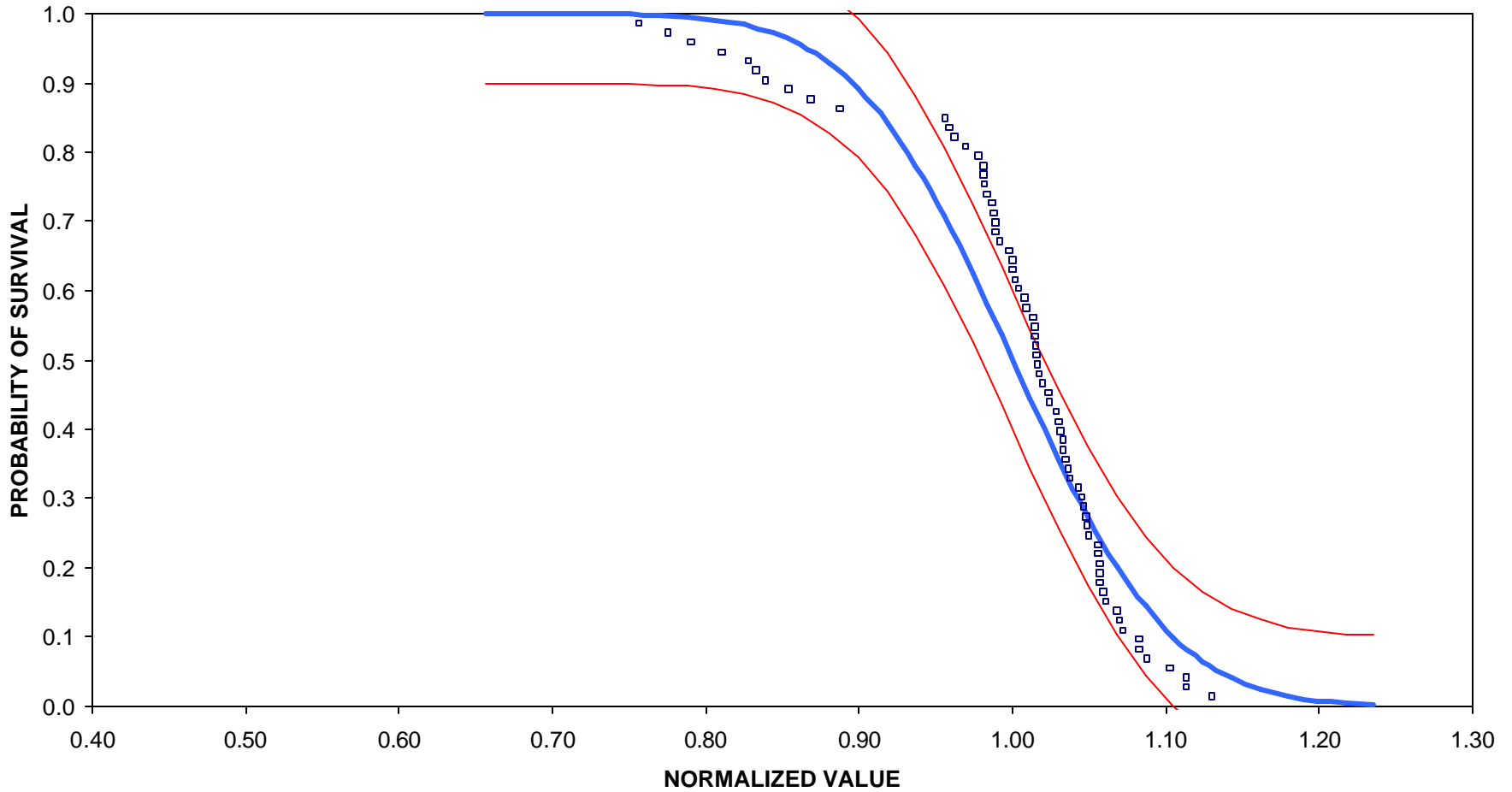


3.3.2 Plot of Pooled Data

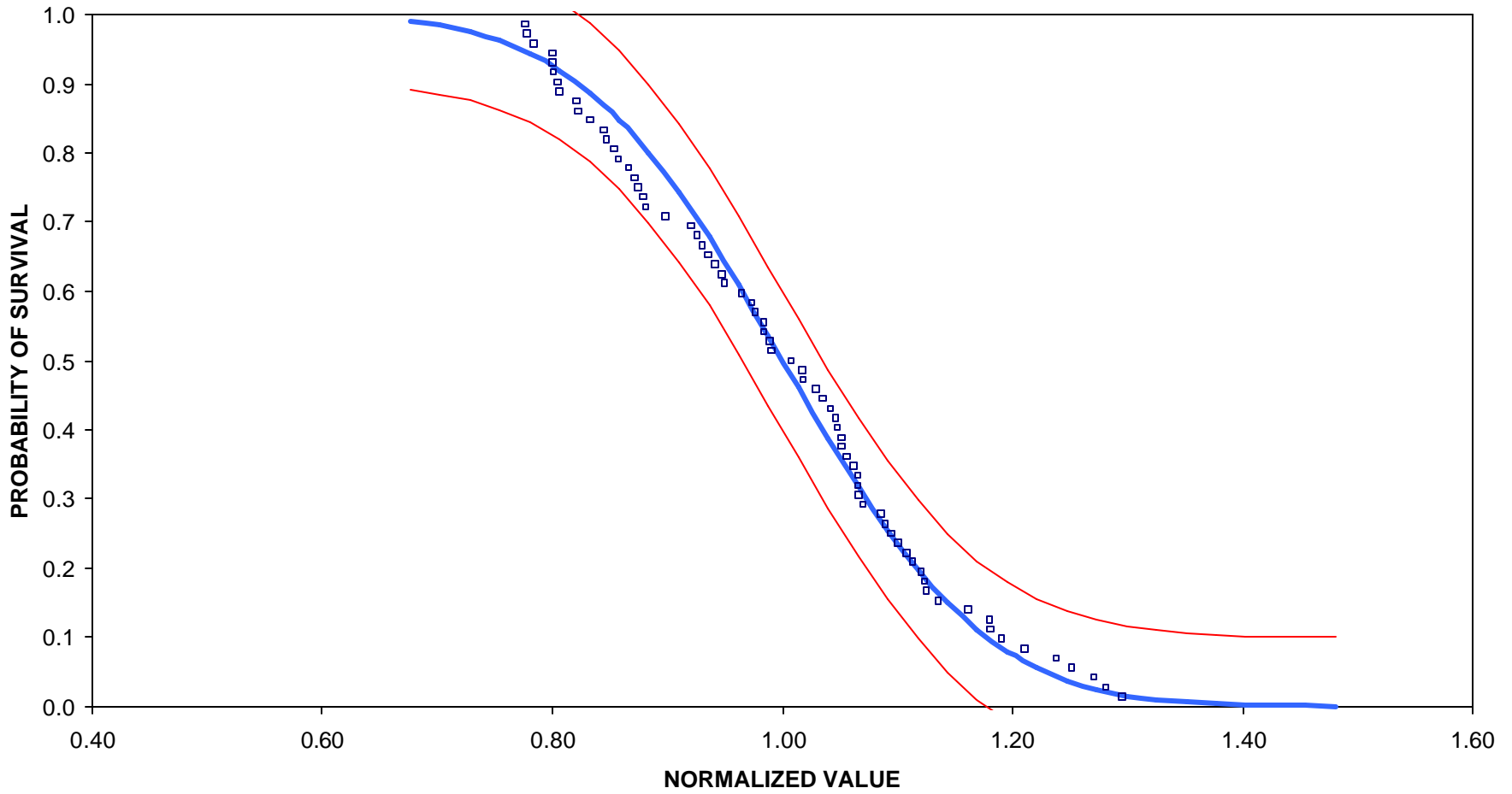
DISTRIBUTION OF POOLED DATA
Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote
0° Tension - TAJXXXXX Measured



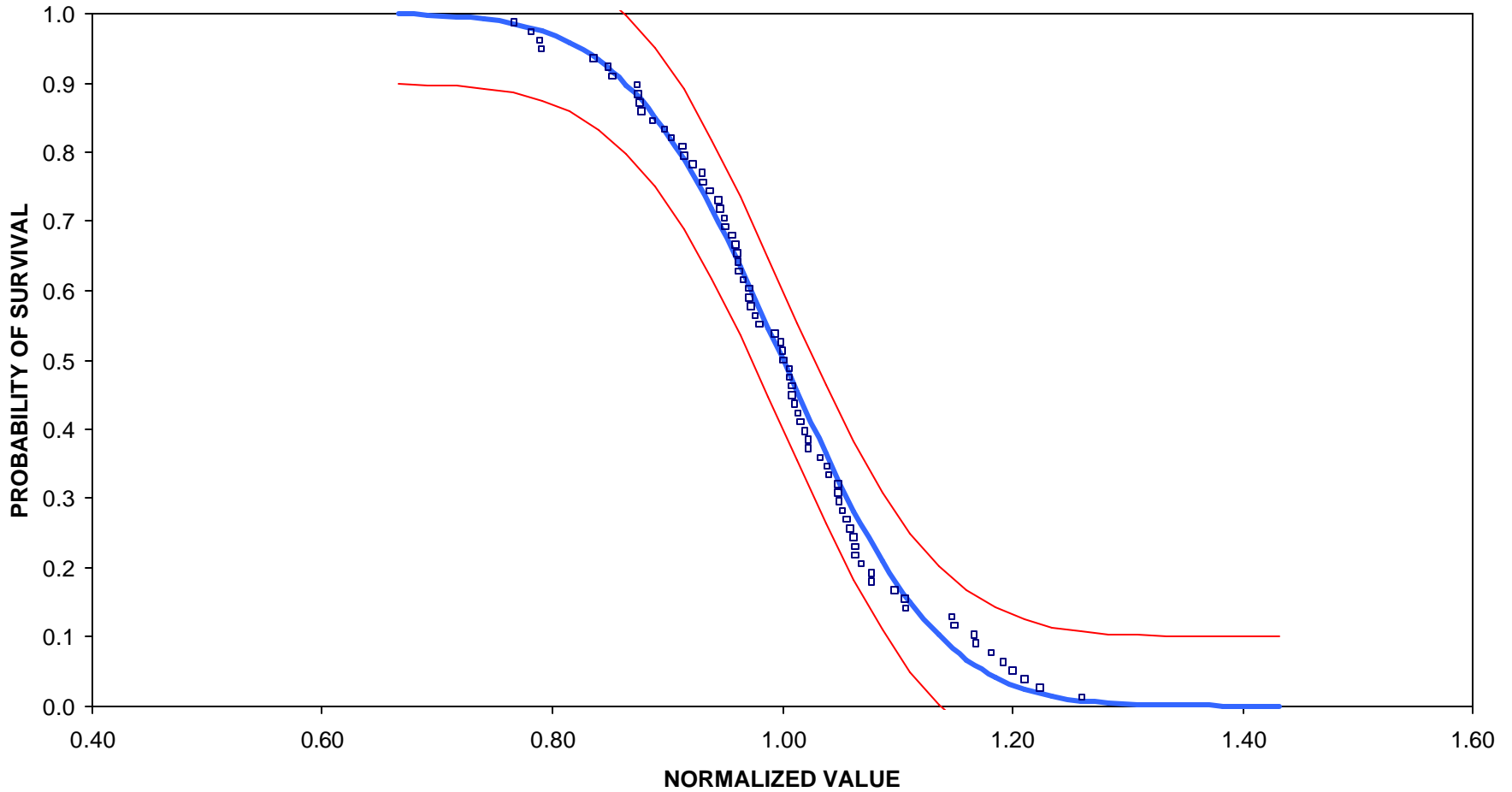
DISTRIBUTION OF POOLED DATA
Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote
0° Tension - TAJXXXXX Normalized



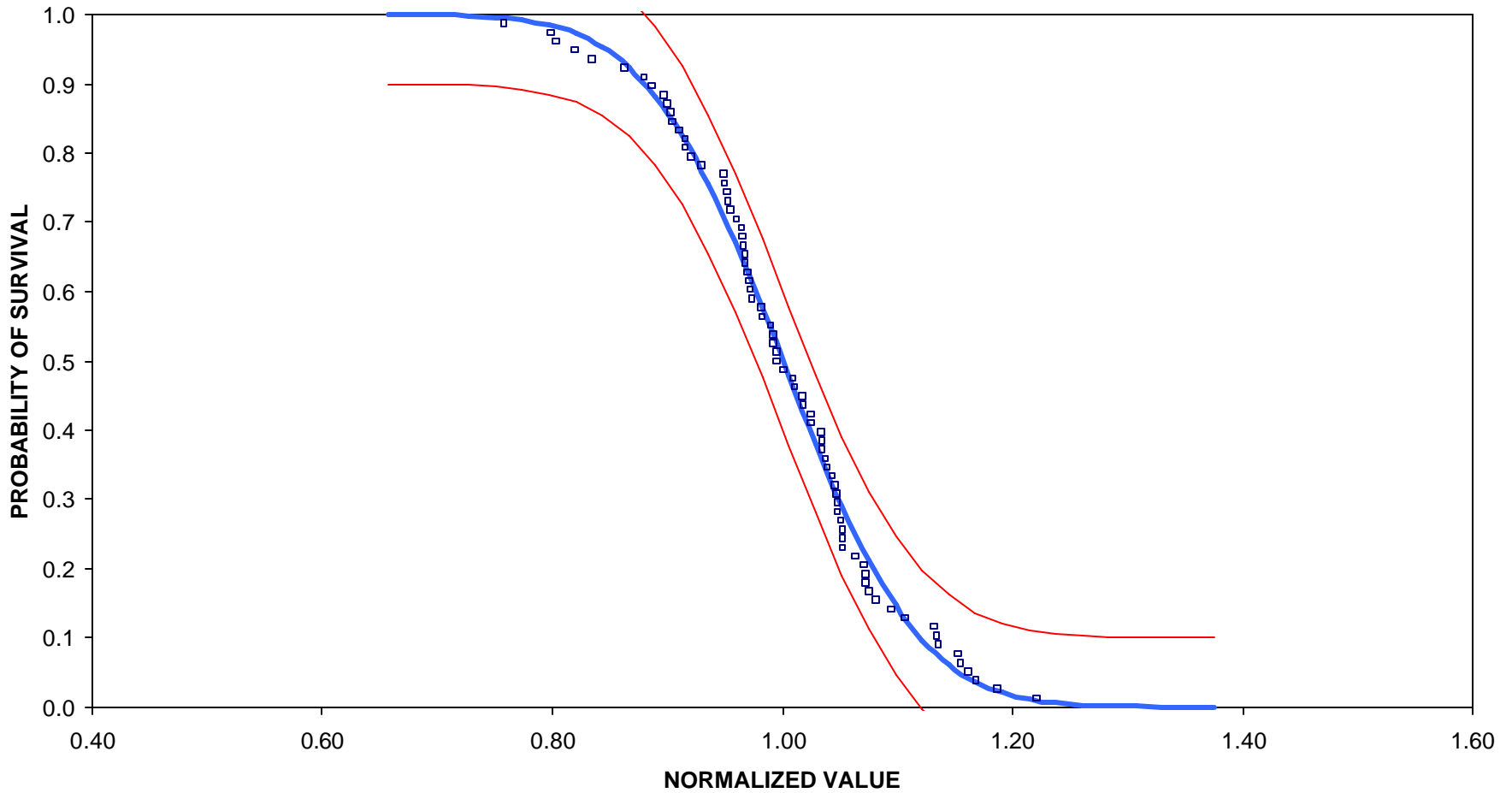
DISTRIBUTION OF POOLED DATA
Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote
90° Tension - TAUXXXX Measured



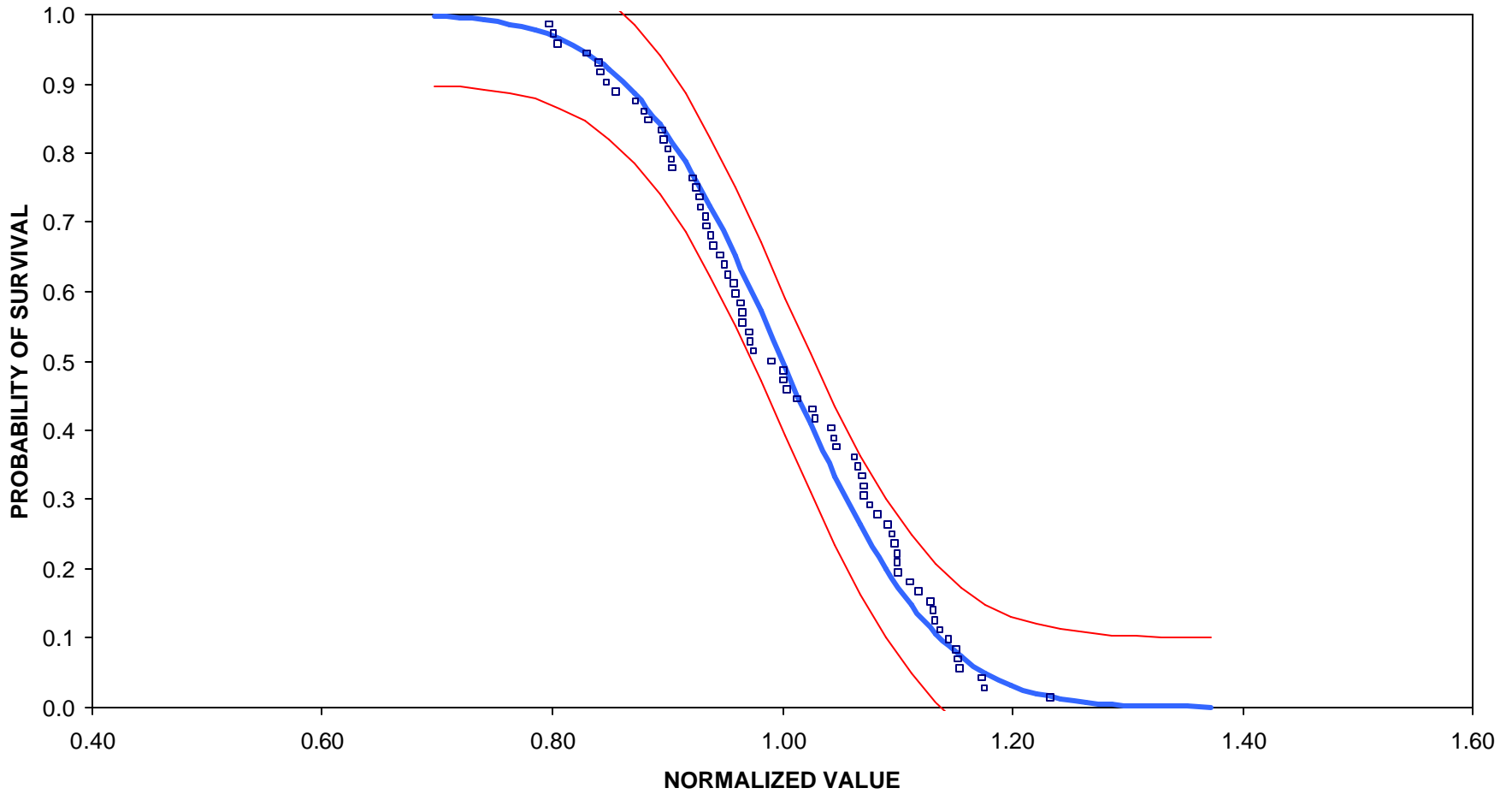
DISTRIBUTION OF POOLED DATA
Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote
0° Compression - TAKXXXXX Measured



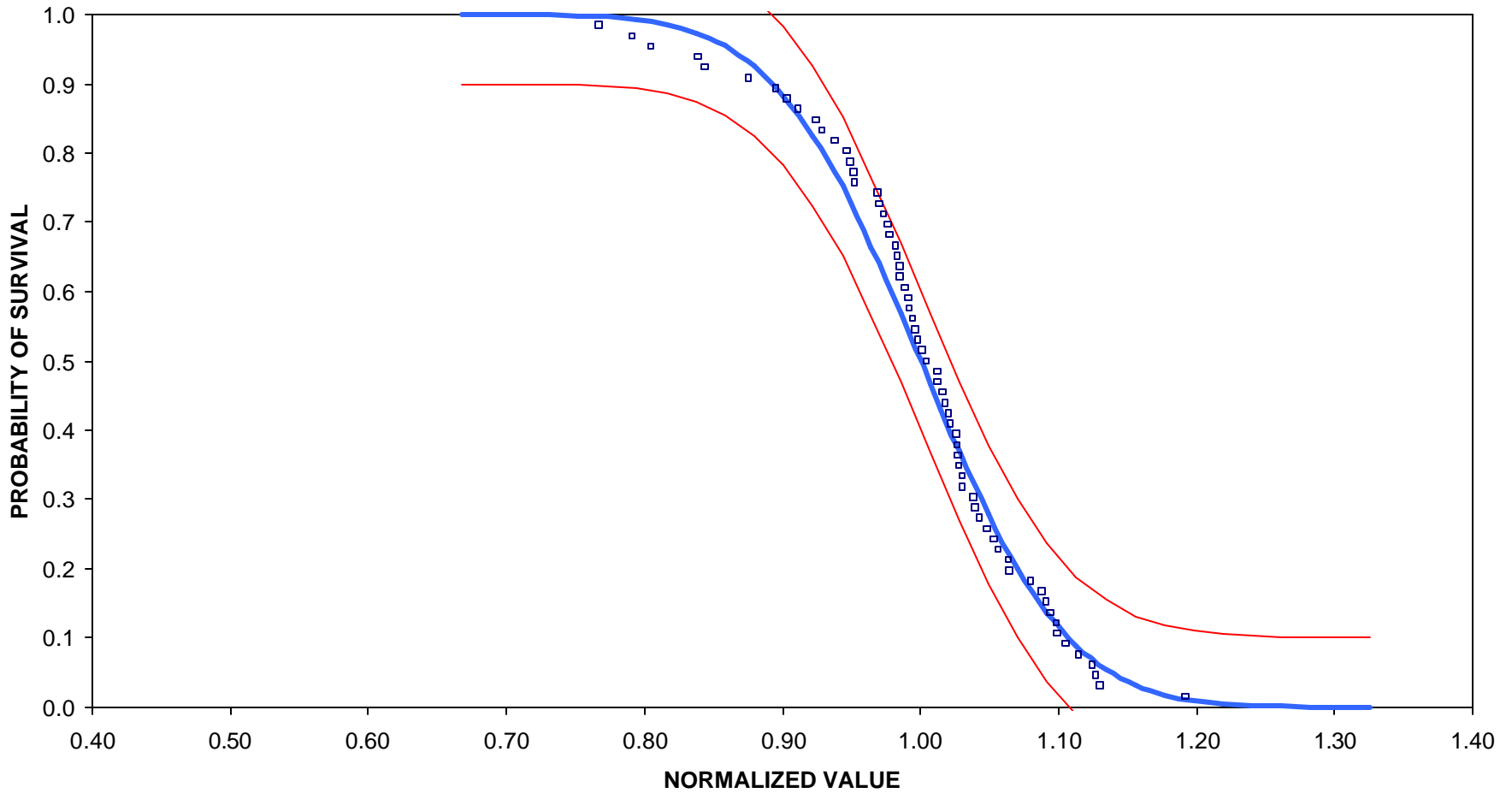
DISTRIBUTION OF POOLED DATA
Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote
0° Compression - TAKXXXXX Normalized



DISTRIBUTION OF POOLED DATA
Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote
90° Compression - TAWXXXXX Measured



DISTRIBUTION OF POOLED DATA
Fibercote-E765/T700 24K Unidirectional Graphite
Fibercote
In-Plane Shear - TANXXXXX Measured

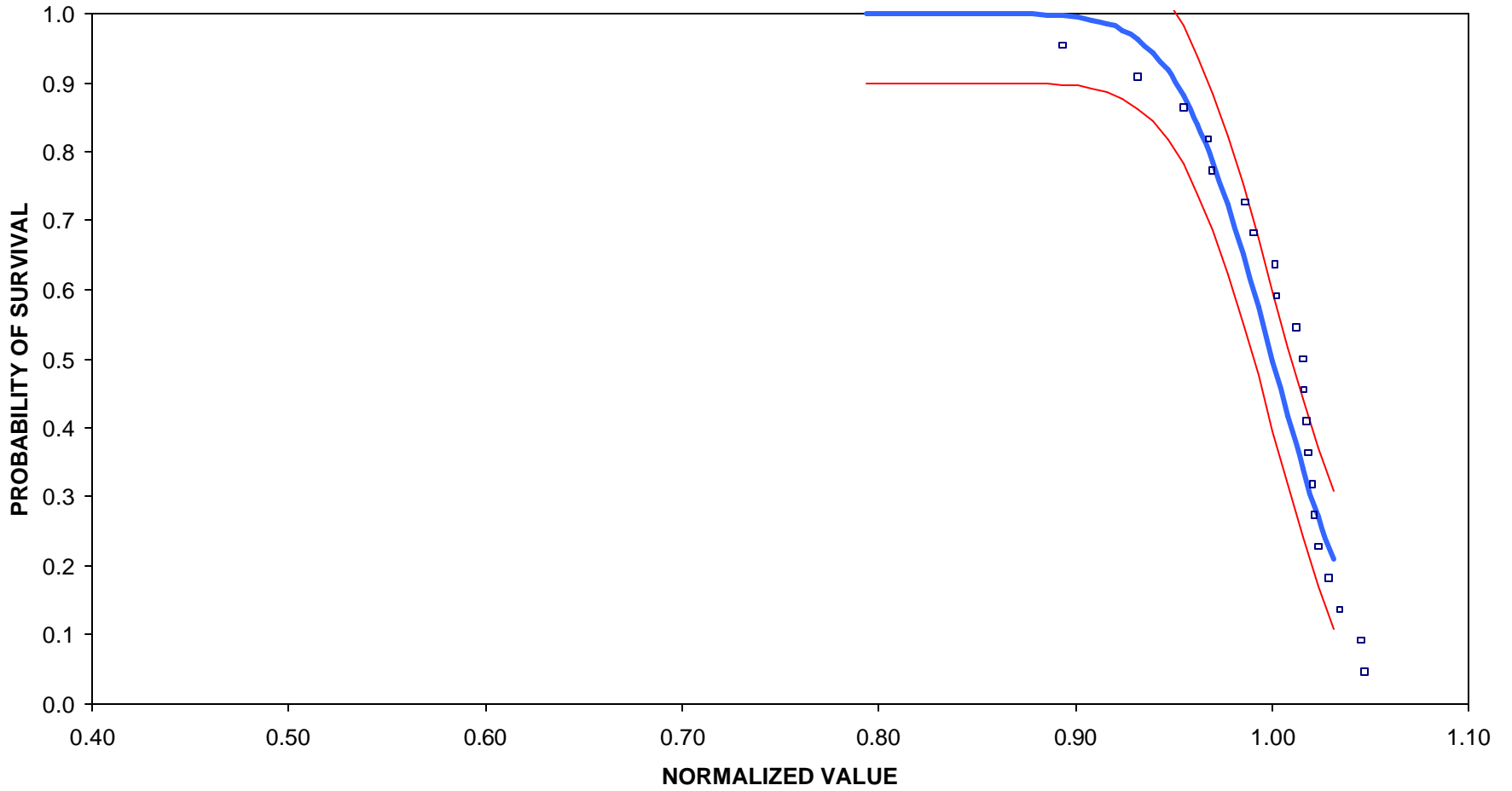


DISTRIBUTION OF POOLED DATA

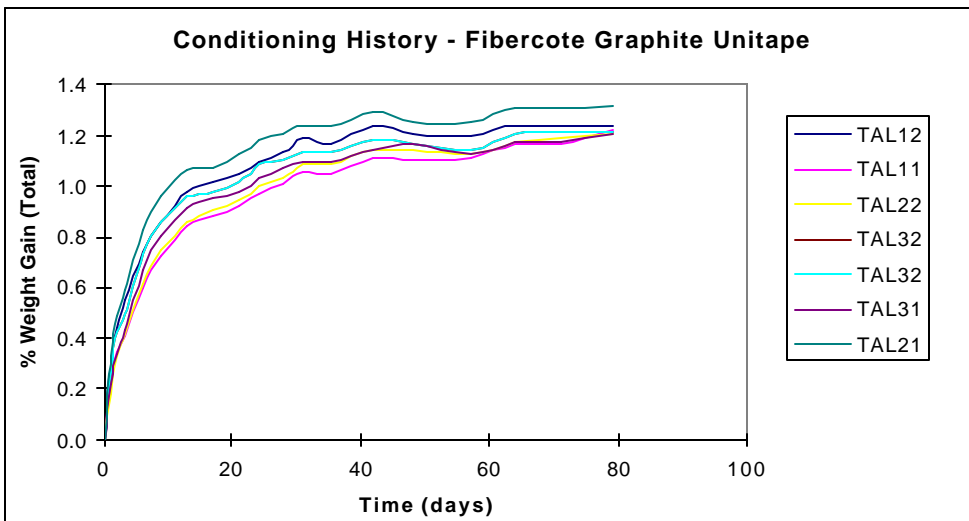
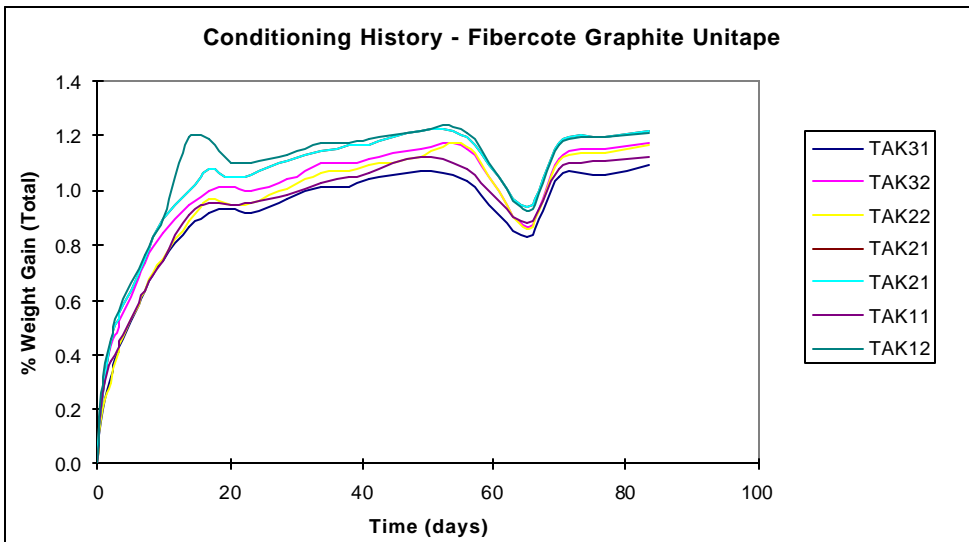
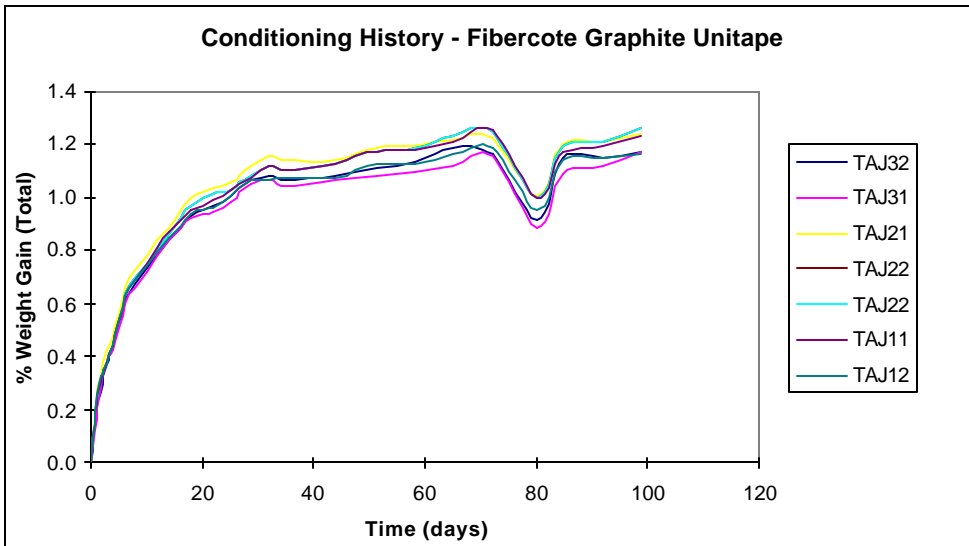
Fibercote-E765/T700 24K Unidirectional Graphite

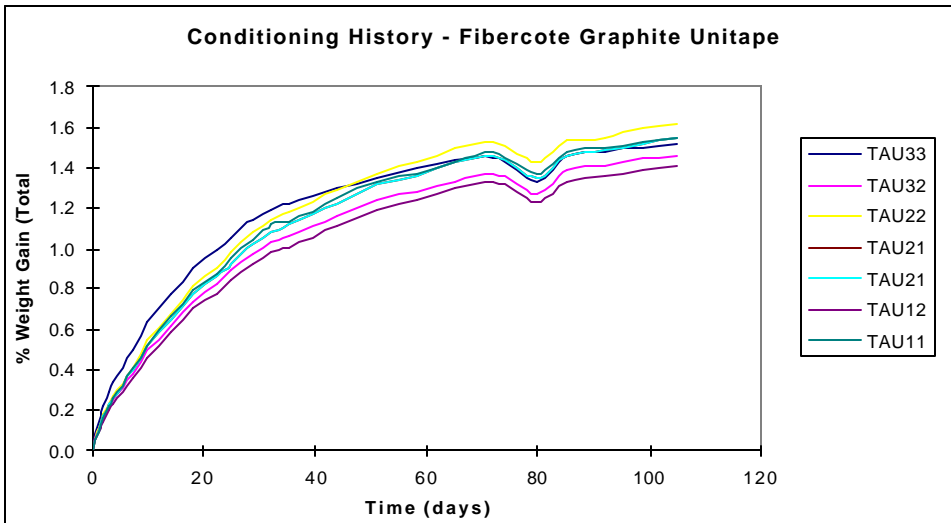
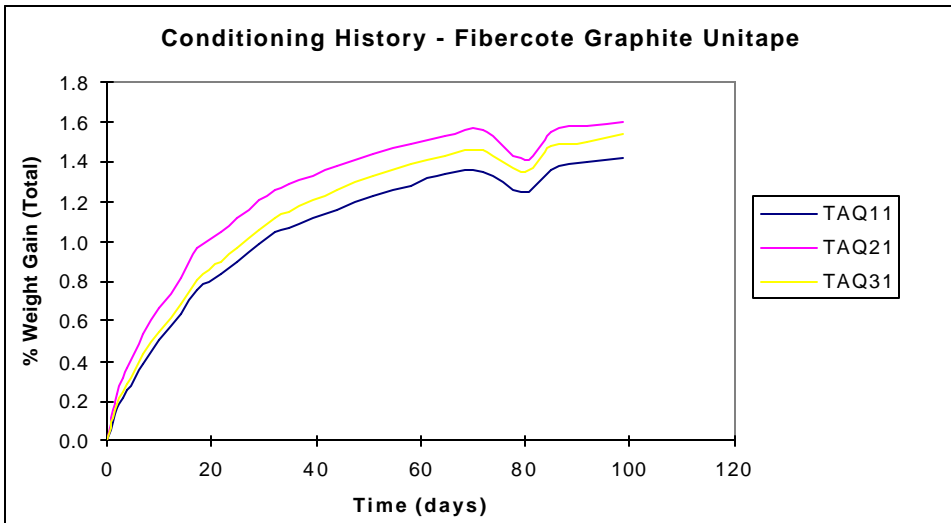
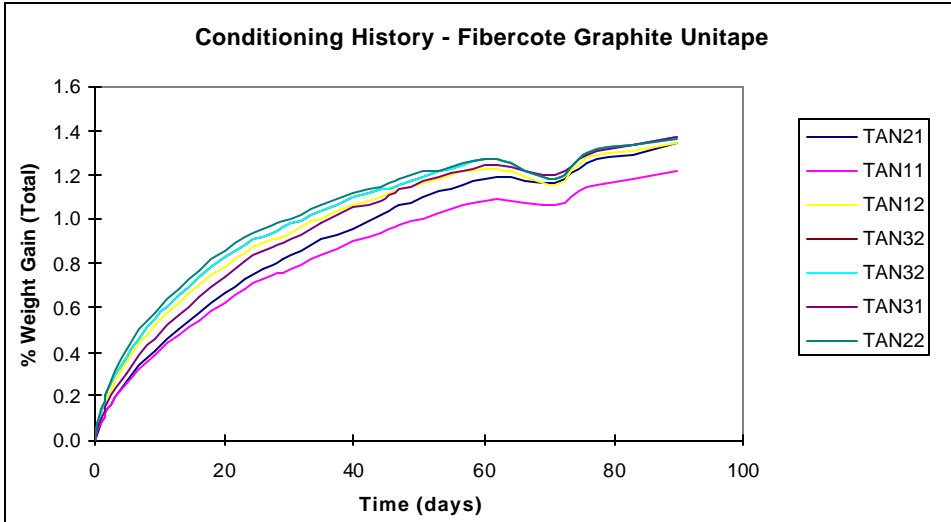
Fibercote

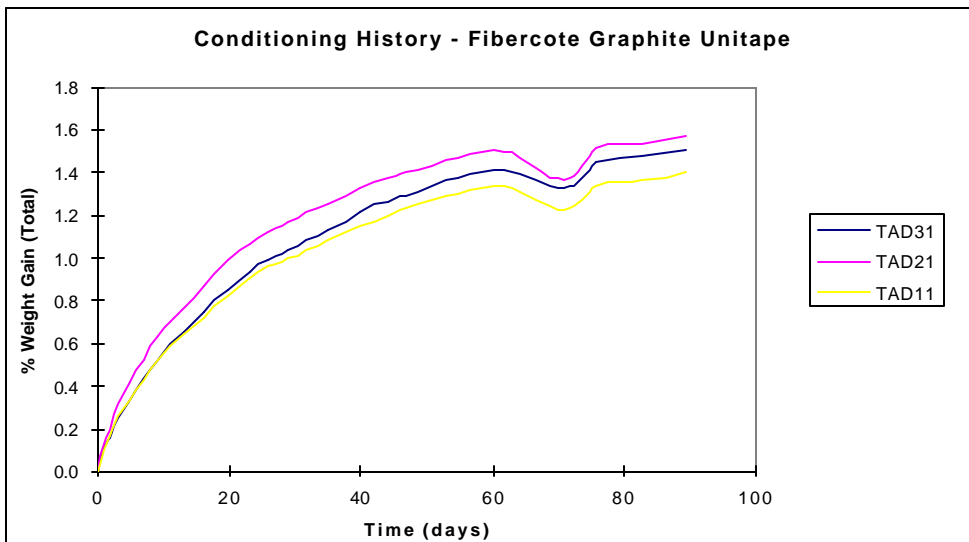
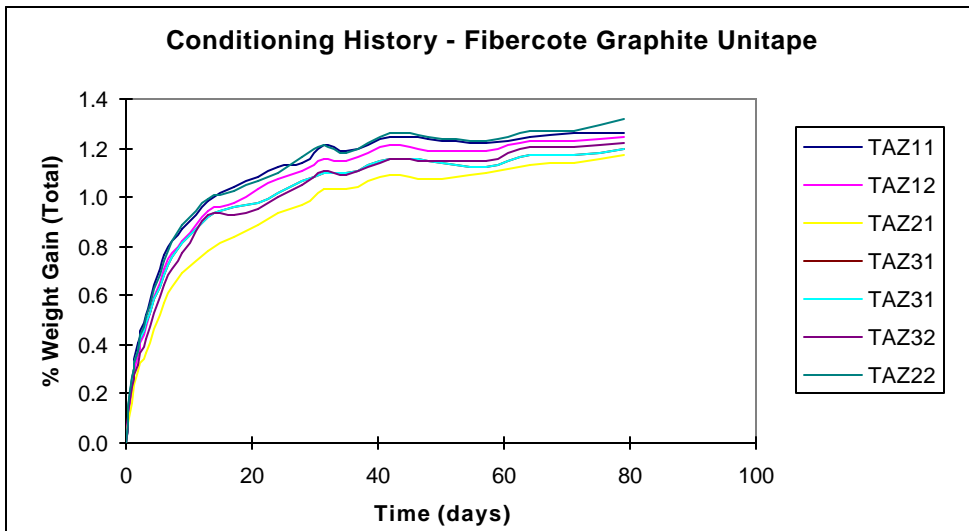
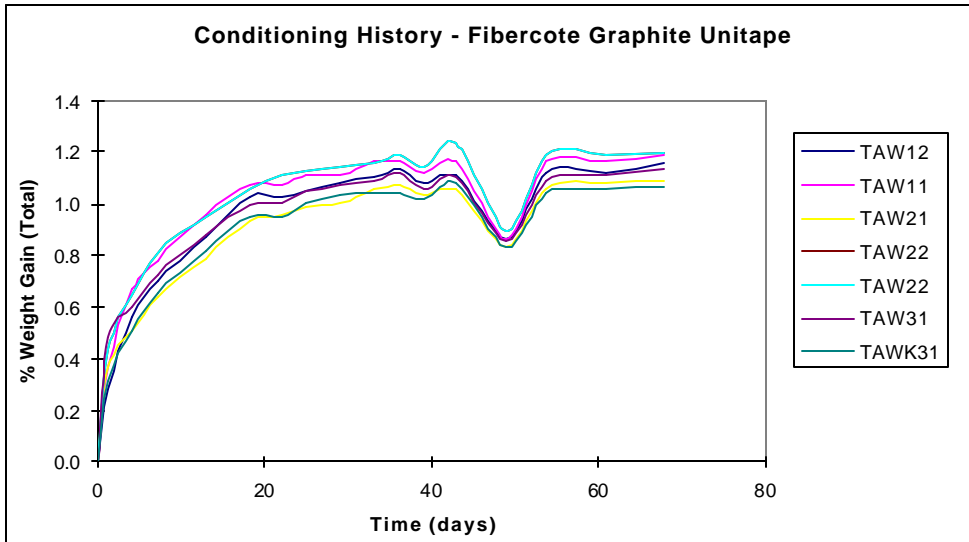
Apparent Interlaminar Shear - TAQXXXXX Measured



3.4 Moisture Conditioning History Charts







3.5 Physical Test Results

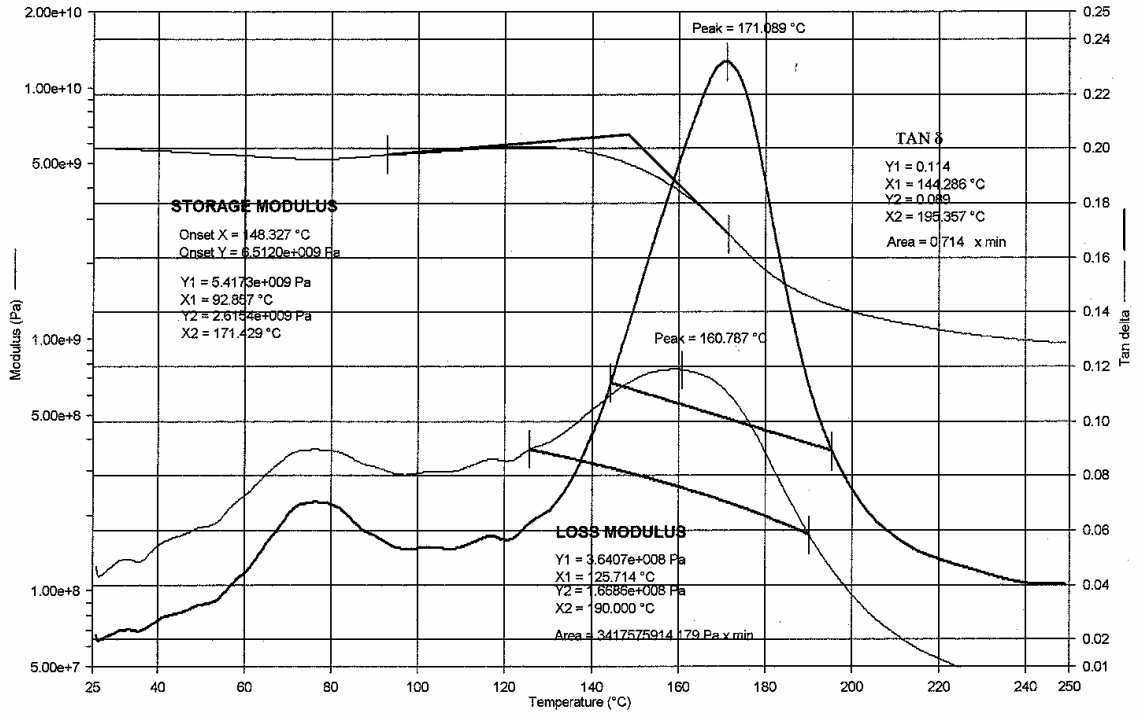
Physical Test Summary
FiberCote-E765/T700 24K Unidirectional Graphite

	Composite Density [g/cc]	Resin Content [wt%]	Fiber Volume [vol%]	Void Content [vol%]
0° Tension (TAJXXXXX)				
No. of Specimens	11	11	11	11
Mean	1.546	34.413	56.329	0.632
Standard Deviation	0.016	1.394	1.508	0.686
90° Tension (TAUXXXXX)				
No. of Specimens	13	13	13	13
Mean	1.550	32.875	57.800	0.997
Standard Deviation	0.016	2.483	2.163	1.271
0° Compression (TAKXXXXX)				
No. of Specimens	6	6	6	6
Mean	1.550	34.963	56.024	0.609
Standard Deviation	0.029	1.703	2.096	0.952
90° Compression (TAWXXXXX)				
No. of Specimens	6	6	6	6
Mean	1.534	35.894	54.638	0.651
Standard Deviation	0.015	1.550	1.793	0.430
In-Plane Shear (TANXXXXX)				
No. of Specimens	6	6	6	6
Mean	1.551	35.036	55.964	0.230
Standard Deviation	0.011	0.841	0.912	0.436
Interlaminar Shear (TAQXXXXX)				
No. of Specimens	3	3	3	3
Mean	1.559	33.785	57.341	0.140
Standard Deviation	0.016	1.139	1.559	0.231
Overall No. of Specimens				
Overall Mean	45	45	45	45
Overall Std. Deviation	1.548	34.281	56.507	0.651
Overall Std. Deviation	0.018	1.992	1.990	0.879

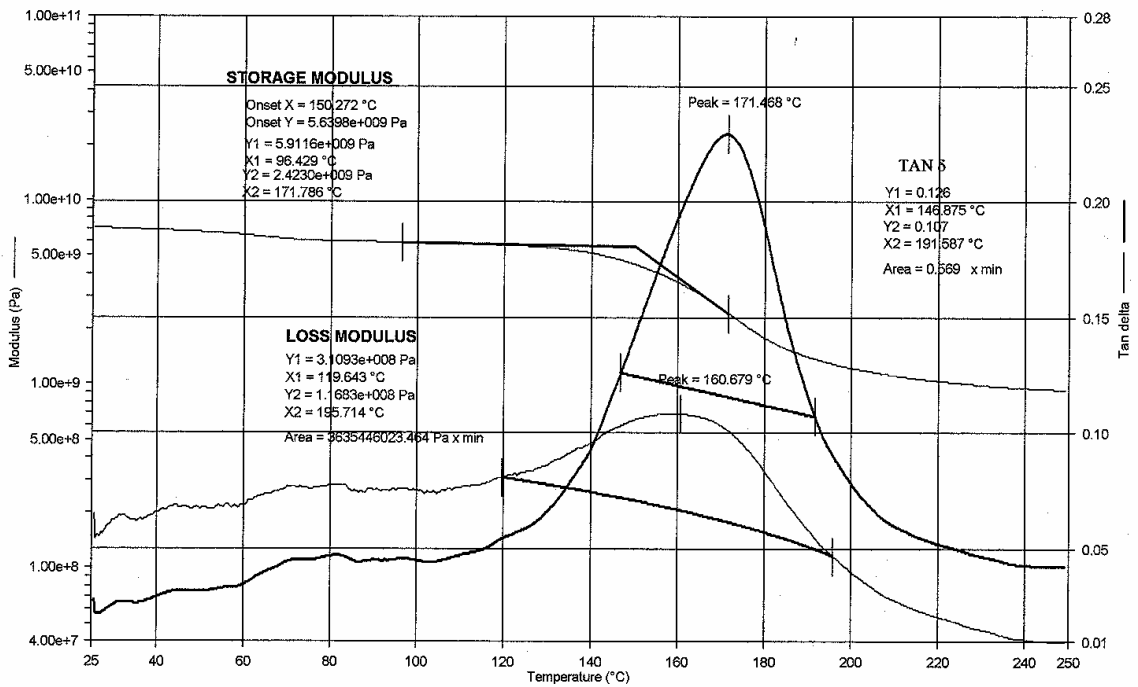
DMA Results -- Onset Storage Modulus					
DRY			HOT WET		
As Fabricated			Saturated		
Sample #	Tg [°C]	Tg [°F]	Sample #	Tg [°C]	Tg [°F]
TAD111-1A	148.33	298.99	TAD111-1C	97.16	206.89
TAD111-2A	150.27	302.49	TAD111-2C	100.11	212.19
TAD111-3A	148.74	299.74	TAD111-3C	98.03	208.46
TAD211-1A	148.53	299.35	TAD211-1C	99.36	210.84
TAD211-2A	153.94	309.09	TAD211-2C	99.77	211.59
TAD211-3A	150.85	303.52	TAD211-3C	97.21	206.97
TAD311-1A	153.15	307.67	TAD311-1C	97.97	208.35
TAD311-2A	152.58	306.64	TAD311-2C	91.50	196.70
TAD311-3A	152.82	307.07	TAD311-3C	97.39	207.30
TAD311-4A	153.92	309.05	TAD111-4C	98.86	209.95
			TAD111-5C	100.39	212.70
			TAD211-4C	101.50	214.71
			TAD211-5C	95.82	204.47
			TAD311-4C	93.07	199.53
			TAD311-5C	98.79	209.83
Average [°F]		304.36	Average [°F]		208.03
Standard Dev. [°F]		4.05	Standard Dev. [°F]		4.84
Coeff. Of Var. [%]		1.33	Coeff. Of Var. [%]		2.33

DMA Results - Peak Tan Delta					
DRY			HOT WET		
As Fabricated			Saturated		
Sample #	Tg [°C]	Tg [°F]	Sample #	Tg [°C]	Tg [°F]
TAD111-1A	171.09	339.96	TAD111-1C	119.97	247.95
TAD111-2A	171.47	340.64	TAD111-2C	119.24	246.63
TAD111-3A	172.51	342.52	TAD111-3C	119.80	247.63
TAD211-1A	174.83	346.70	TAD211-1C	121.12	250.01
TAD211-2A	175.68	348.22	TAD211-2C	122.38	252.29
TAD211-3A	175.51	347.91	TAD211-3C	122.34	252.22
TAD311-1A	173.00	343.39	TAD311-1C	118.73	245.71
TAD311-2A	175.61	348.09	TAD311-2C	116.72	242.09
TAD311-3A	175.00	347.01	TAD311-3C	116.66	241.98
TAD311-4A	174.35	345.83	TAD111-4C	120.58	249.05
			TAD111-5C	118.03	244.45
			TAD211-4C	119.64	247.36
			TAD211-5C	119.24	246.63
			TAD311-4C	117.43	243.38
			TAD311-5C	117.14	242.85
Average [°F]		345.03	Average [°F]		246.68
Standard Dev. [°F]		3.15	Standard Dev. [°F]		3.34
Coeff. Of Var. [%]		0.91	Coeff. Of Var. [%]		1.36

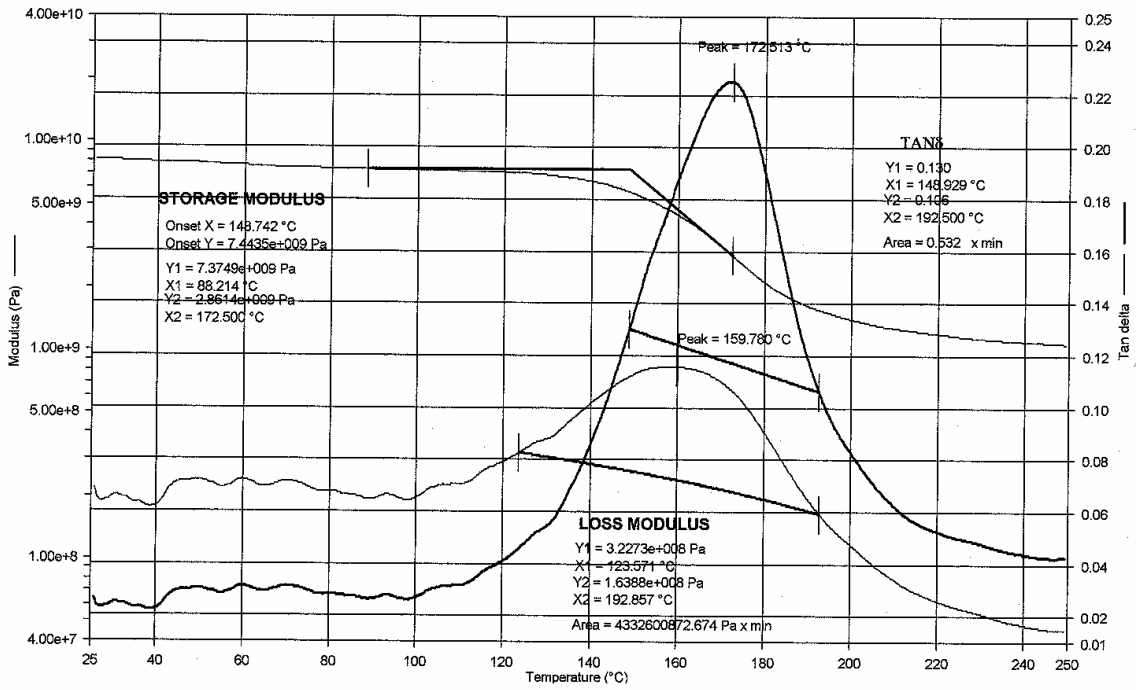
DMA Results - Peak Loss Modulus					
DRY			HOT WET		
As Fabricated			Saturated		
Sample #	Tg [°C]	Tg [°F]	Sample #	Tg [°C]	Tg [°F]
TAD111-1A	160.79	321.42	TAD111-1C	111.76	233.17
TAD111-2A	160.68	321.22	TAD111-2C	111.45	232.62
TAD111-3A	159.78	319.60	TAD111-3C	111.17	232.11
TAD211-1A	164.95	328.92	TAD211-1C	110.90	231.61
TAD211-2A	165.97	330.74	TAD211-2C	114.44	237.98
TAD211-3A	165.64	330.15	TAD211-3C	112.54	234.56
TAD311-1A	163.20	325.76	TAD311-1C	111.45	232.61
TAD311-2A	162.72	324.90	TAD311-2C	107.55	225.60
TAD311-3A	165.88	330.58	TAD311-3C	107.97	226.34
TAD311-4A	164.67	328.40	TAD111-4C	111.96	233.53
			TAD111-5C	108.91	228.04
			TAD211-4C	110.86	231.54
			TAD211-5C	111.20	232.16
			TAD311-4C	107.82	226.07
			TAD311-5C	110.85	231.53
Average [°F]		326.17	Average [°F]		231.30
Standard Dev. [°F]		4.23	Standard Dev. [°F]		3.42
Coeff. Of Var. [%]		1.30	Coeff. Of Var. [%]		1.48



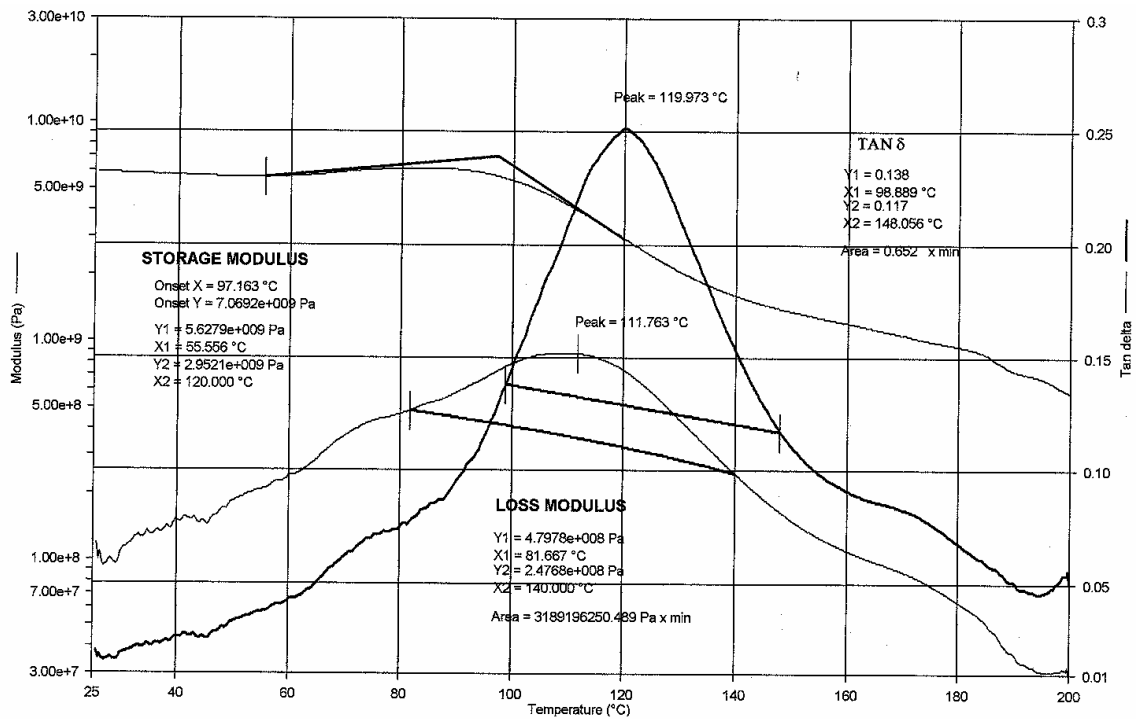
TAD111-1A



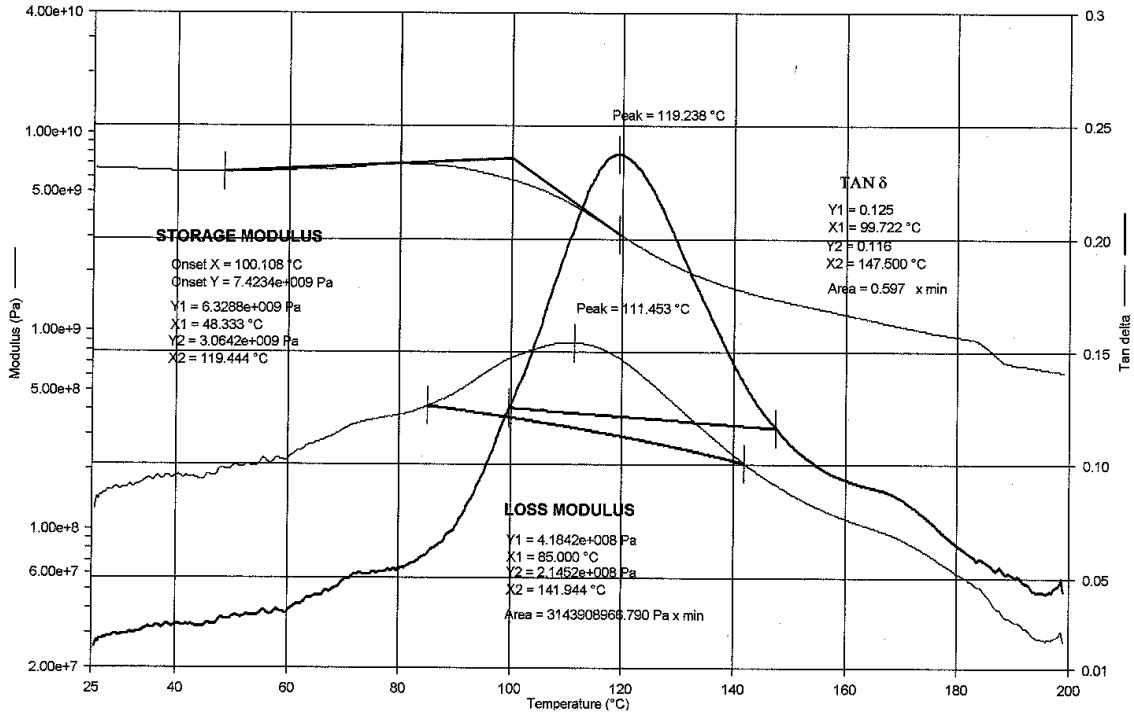
TAD111-2A



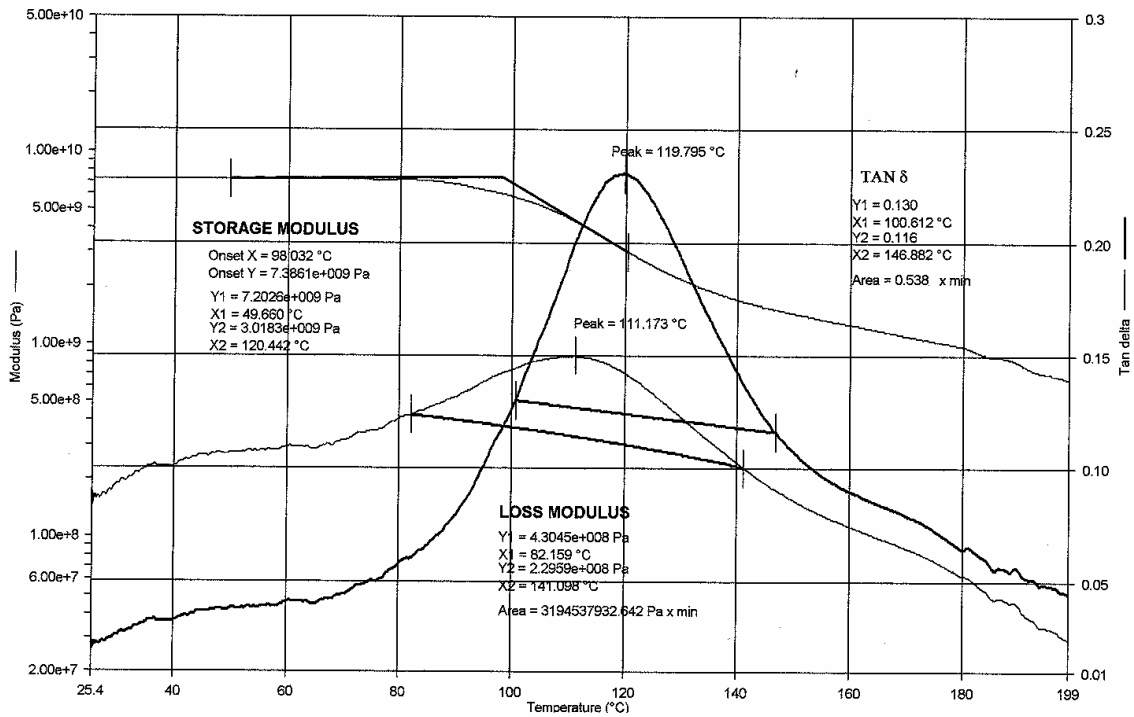
TAD111-3A



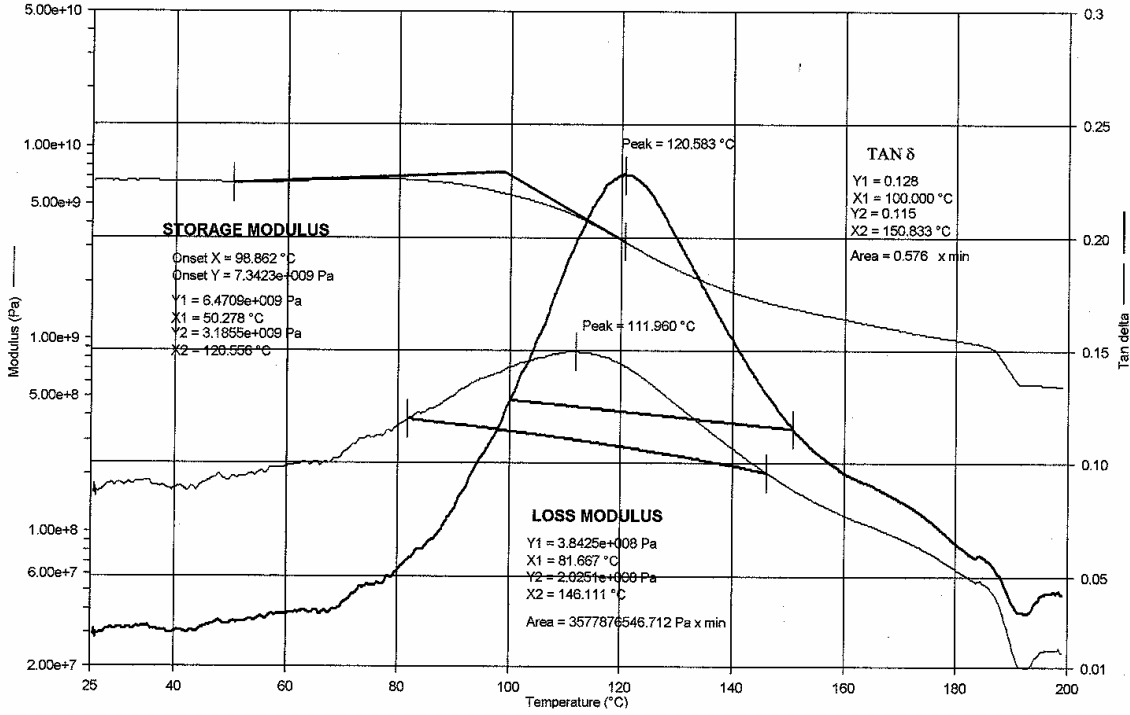
TAD111-1C



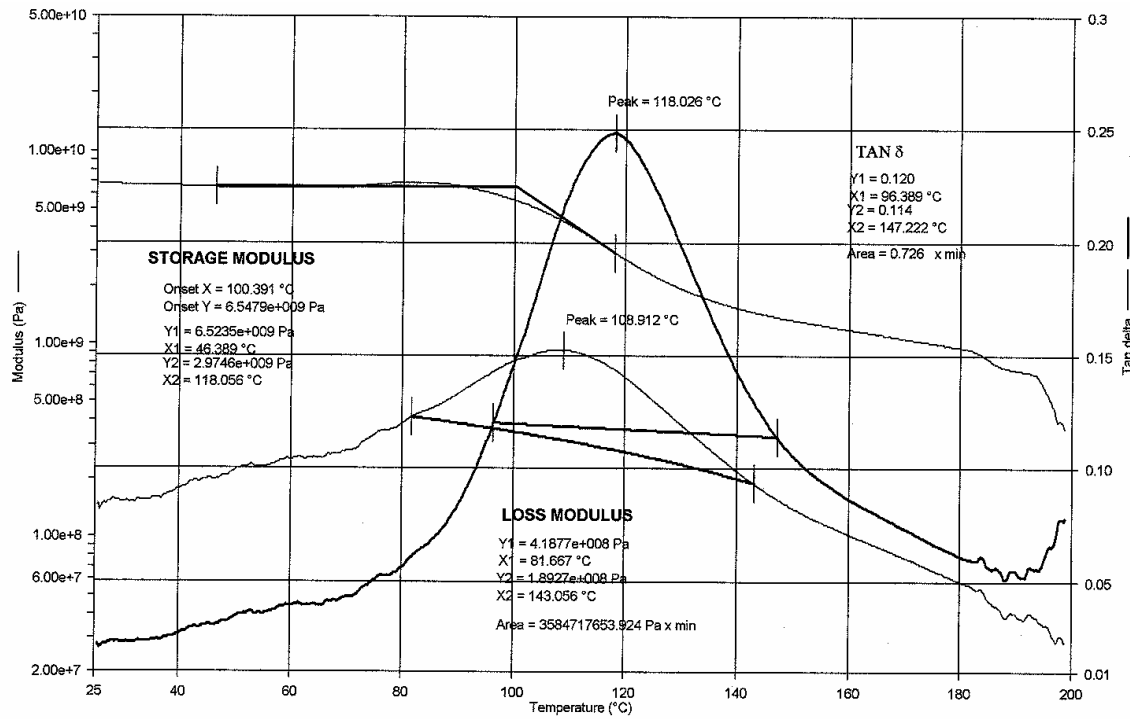
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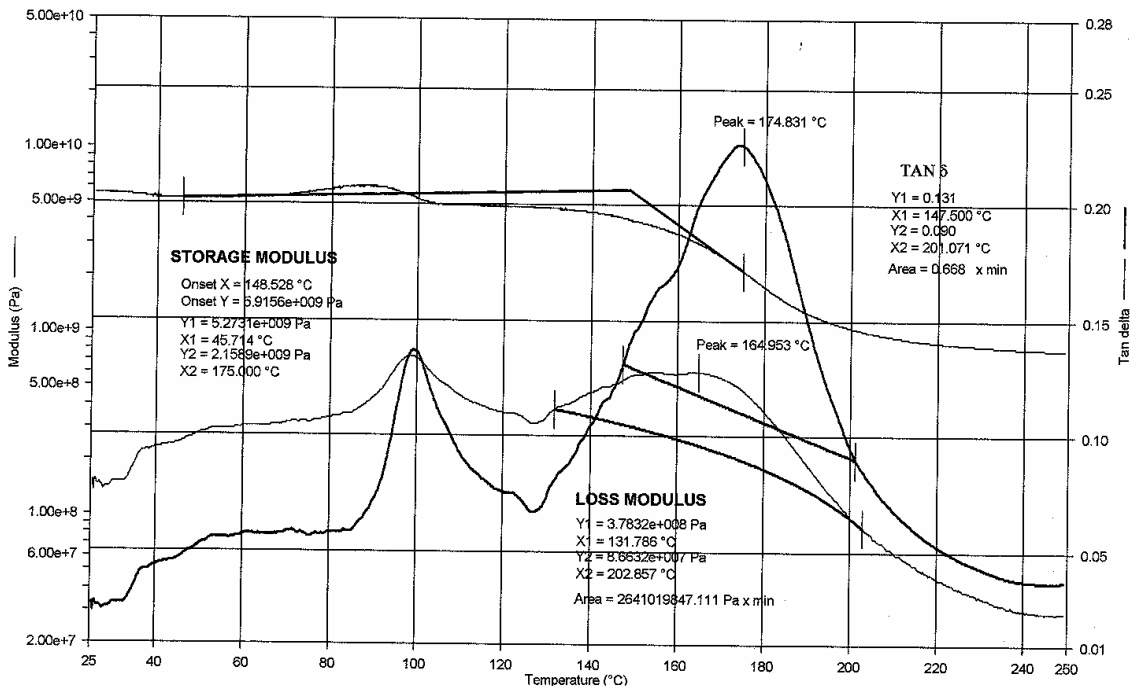
TAD111-3C



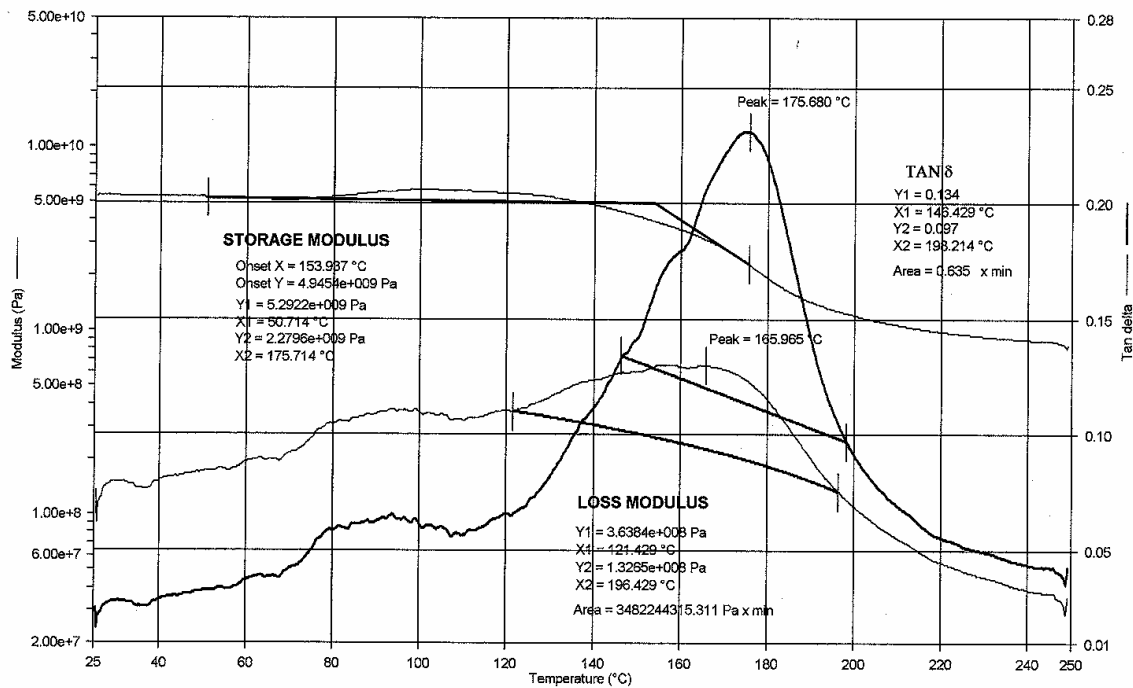
TAD111-4C



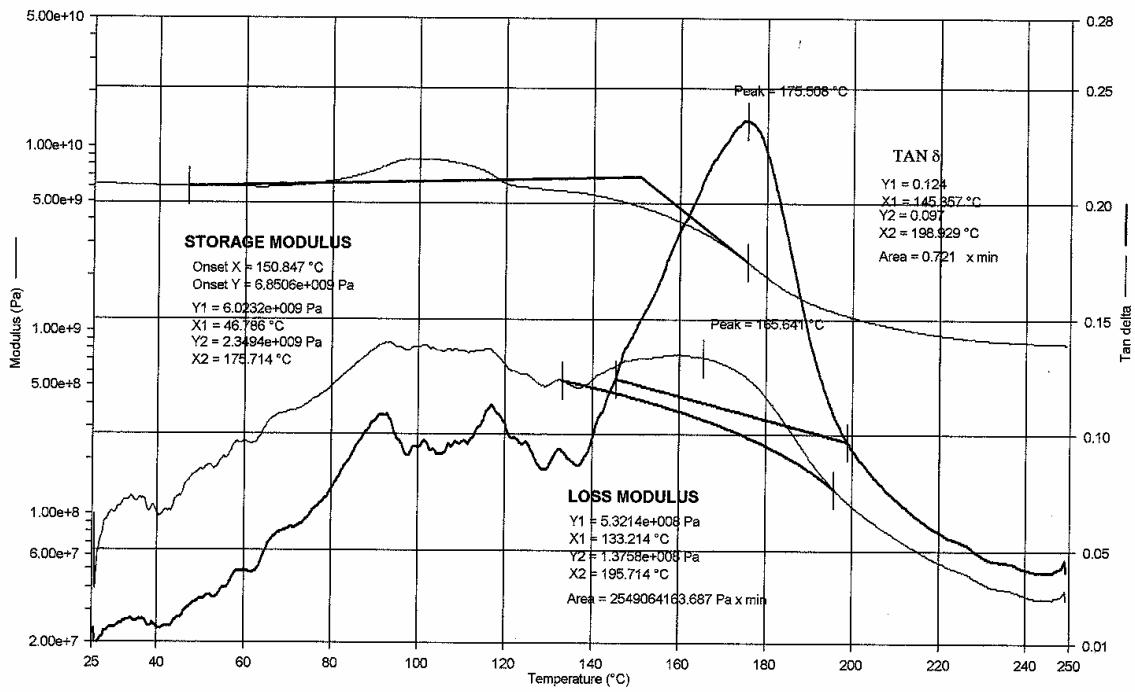
TAD111-5C



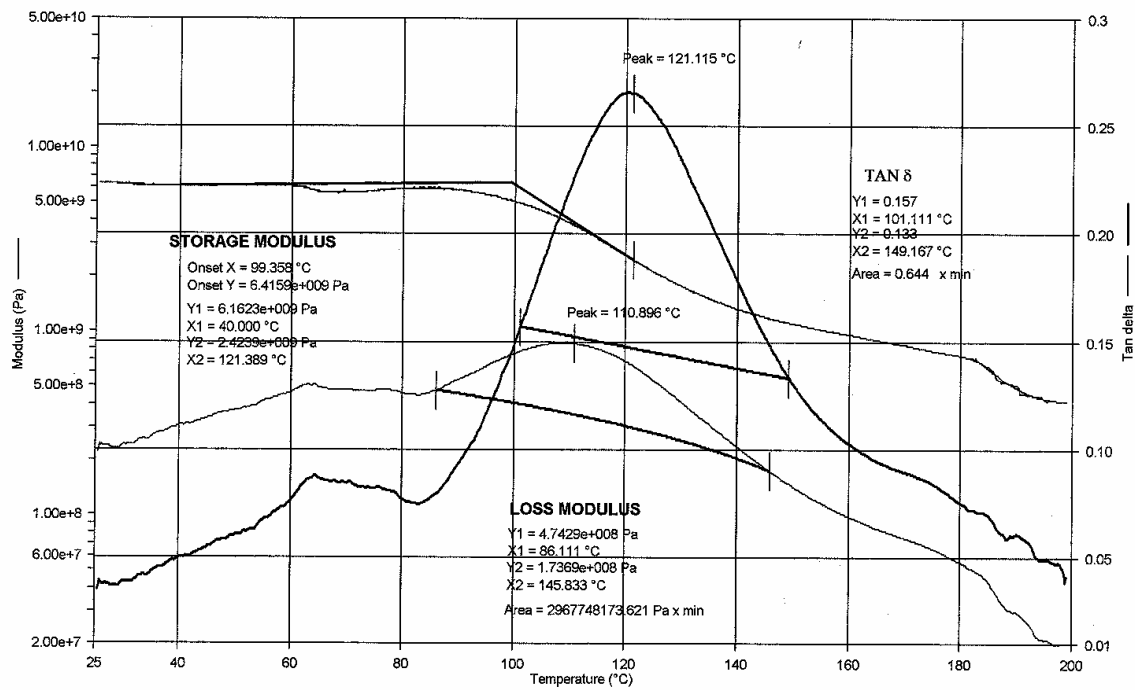
TAD211-1A



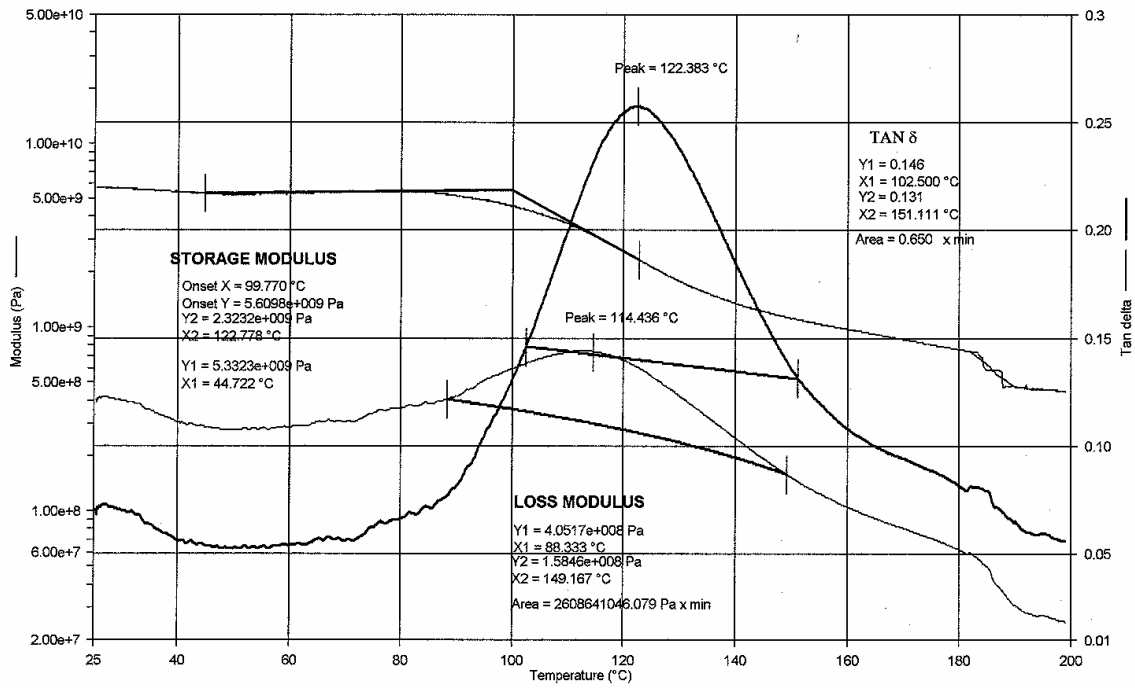
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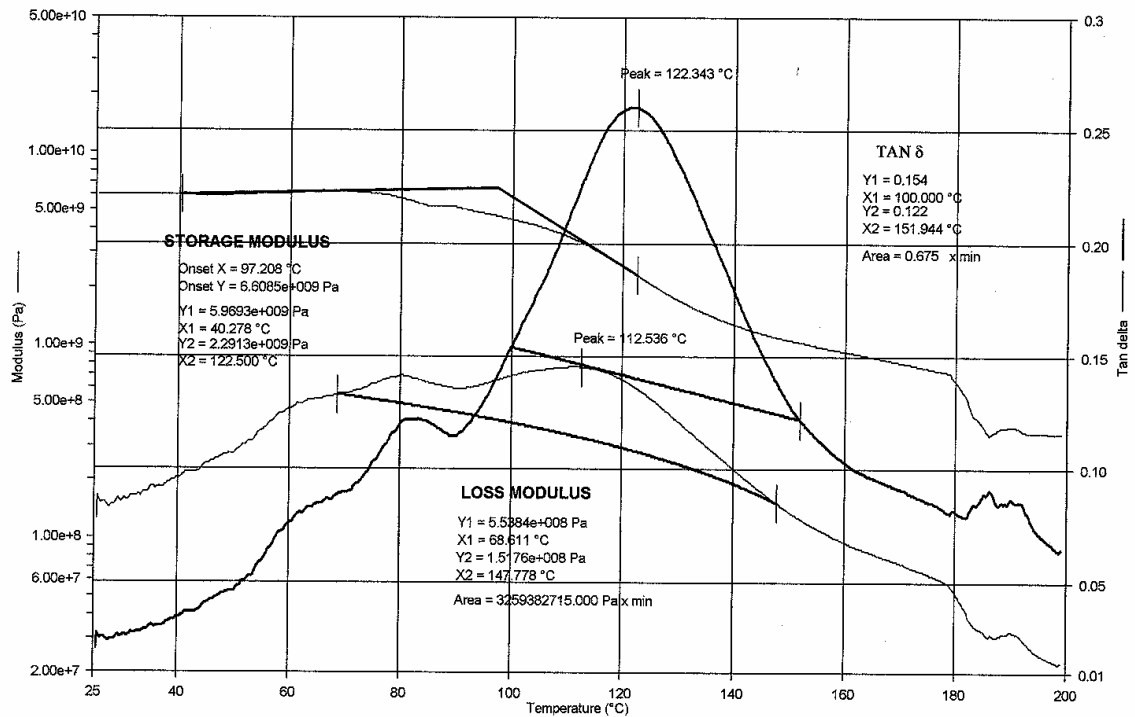
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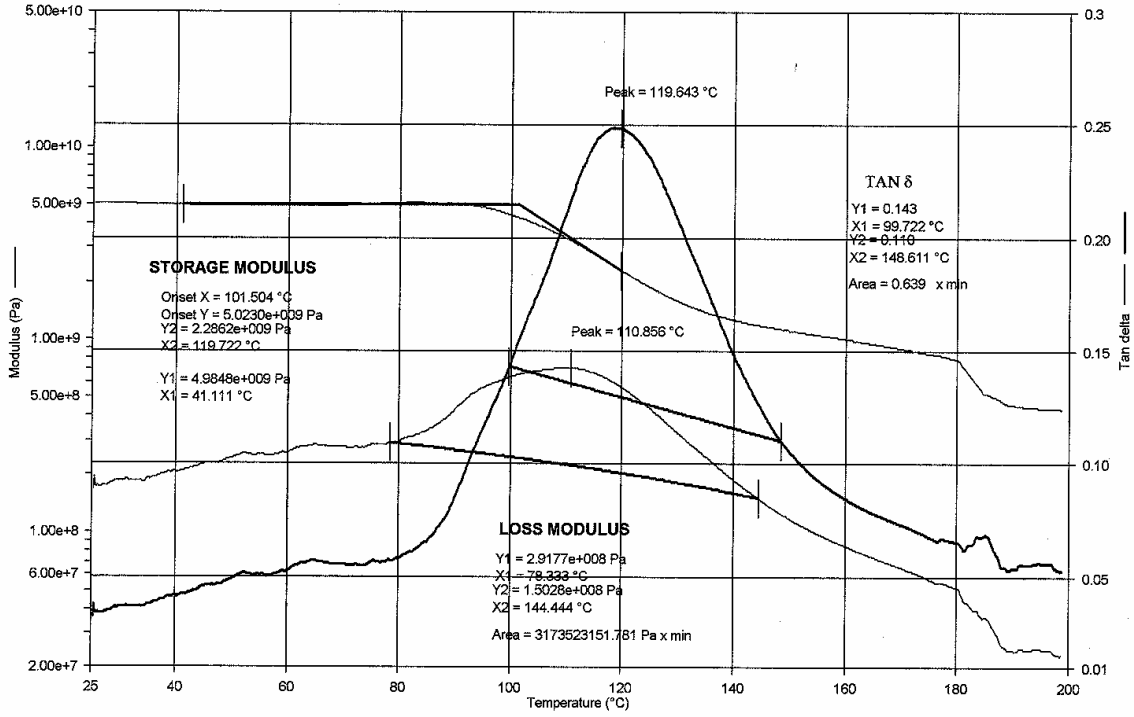
TAD211-1C



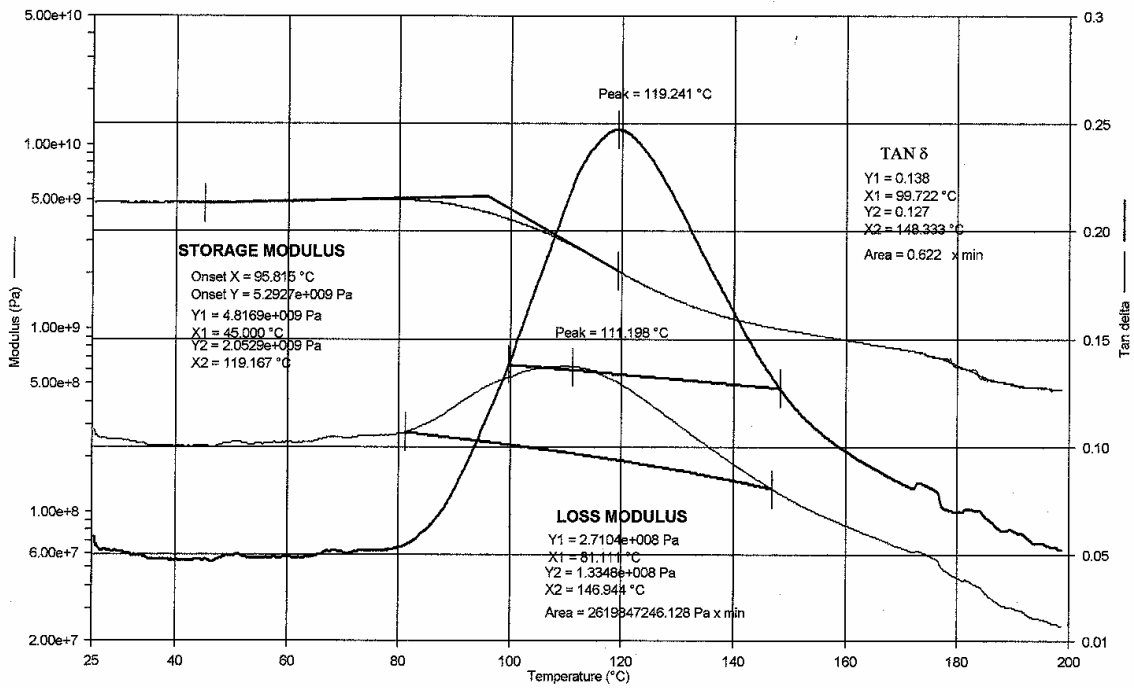
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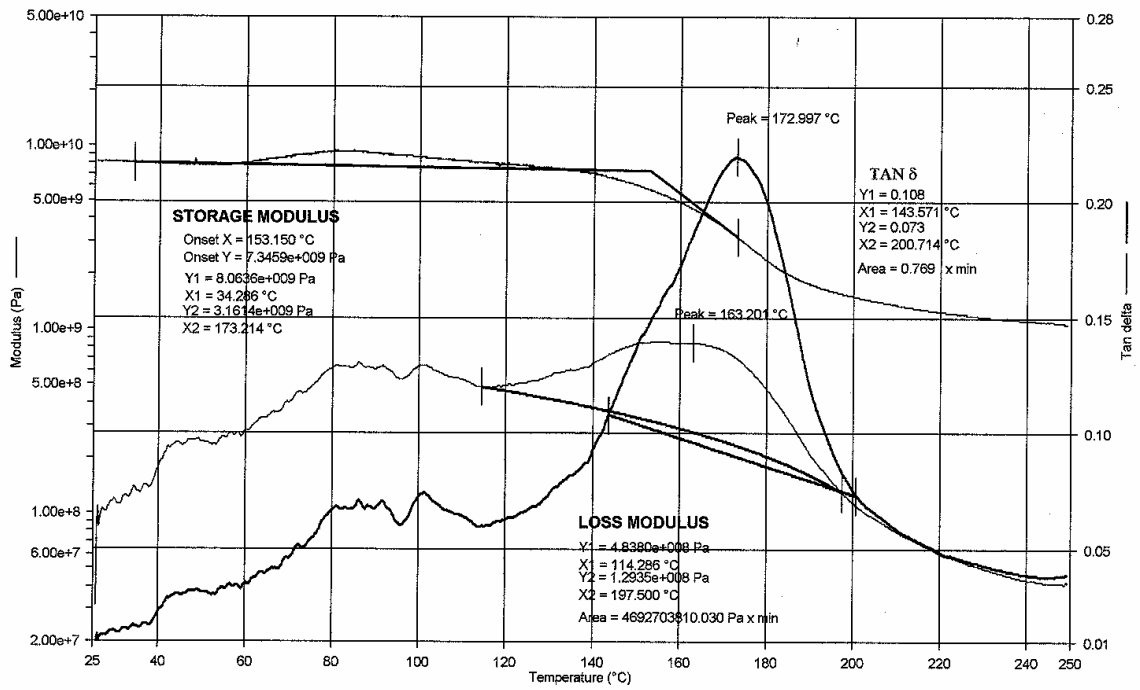
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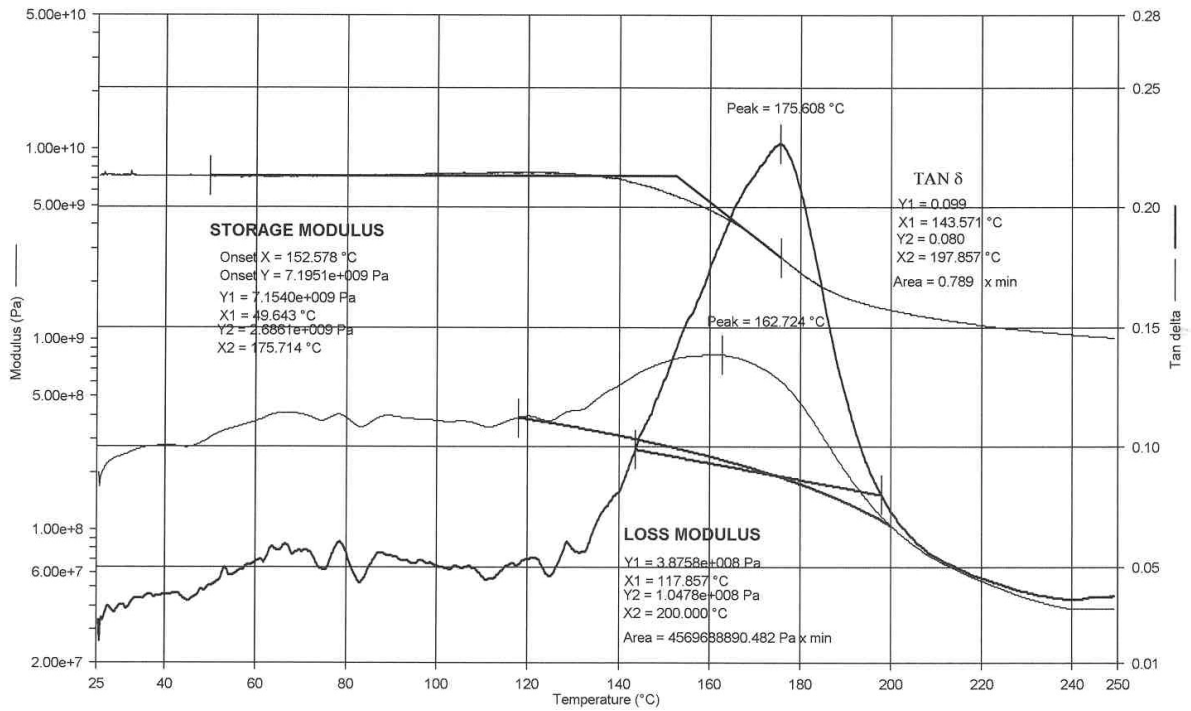
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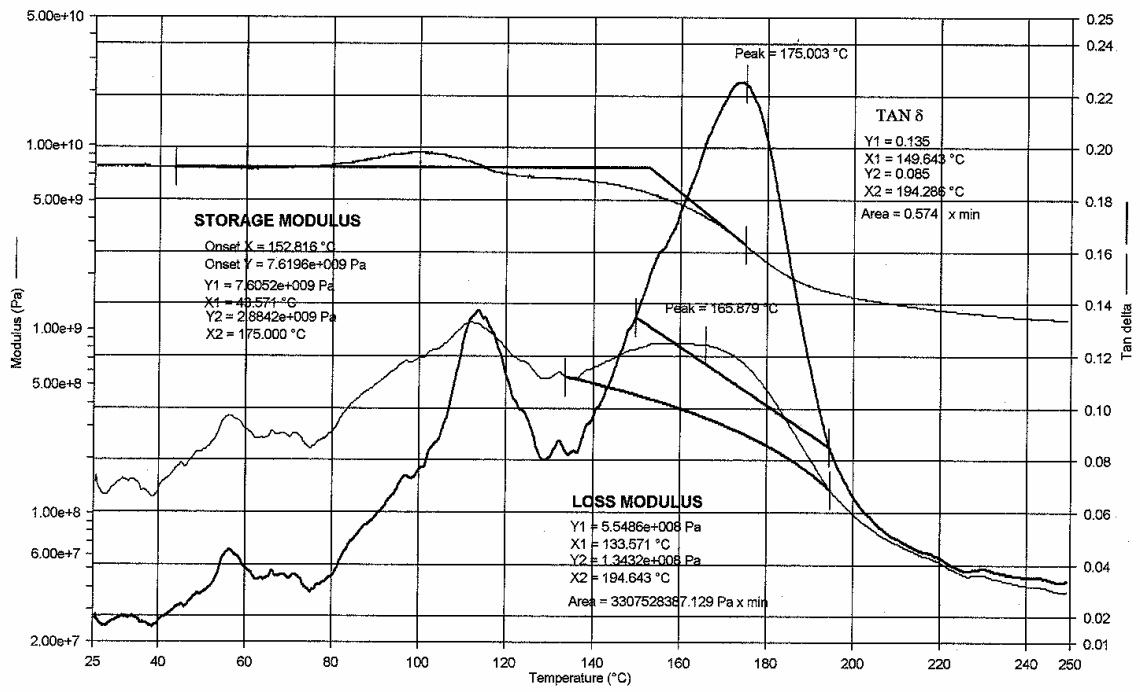
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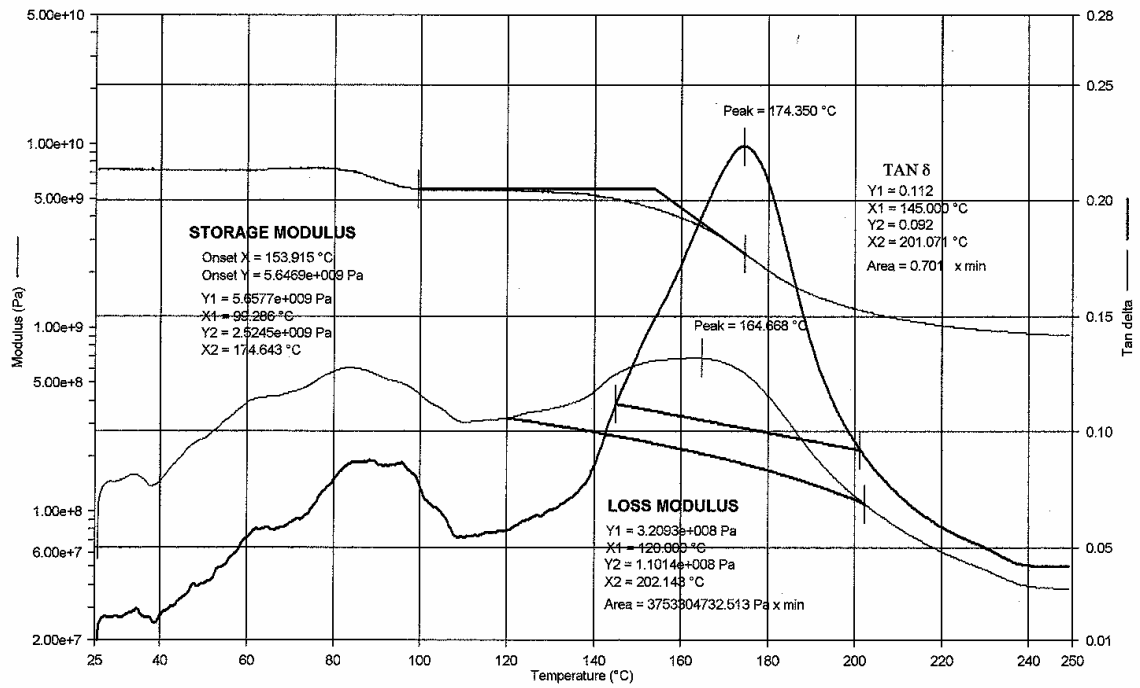
TAD311-1A



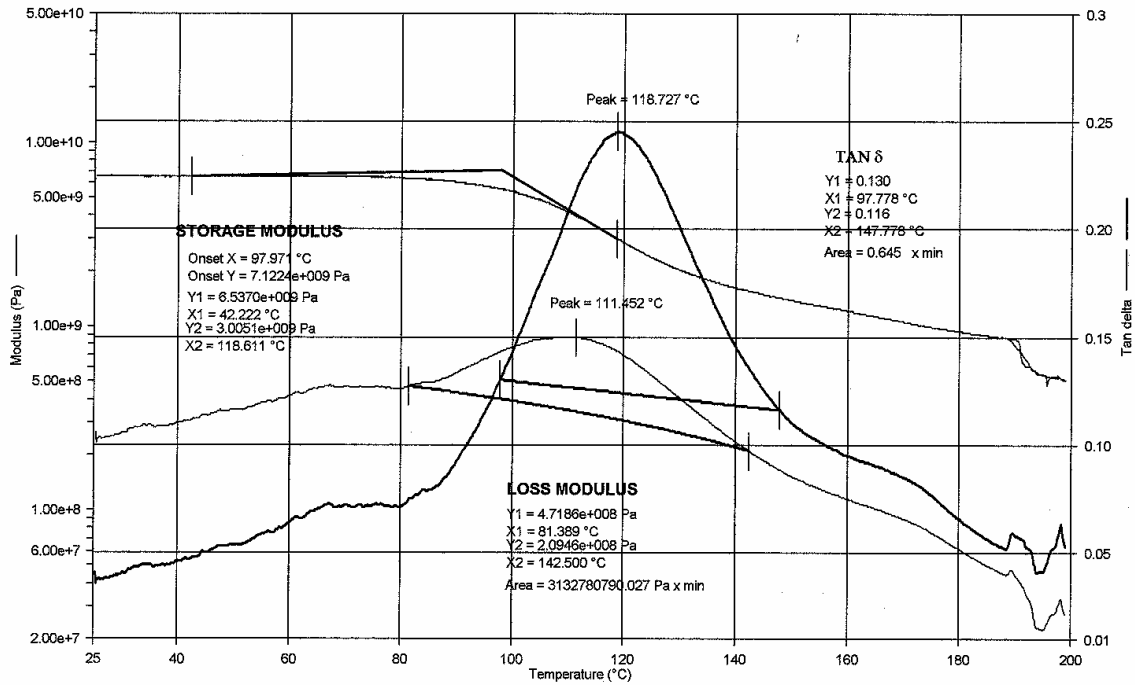
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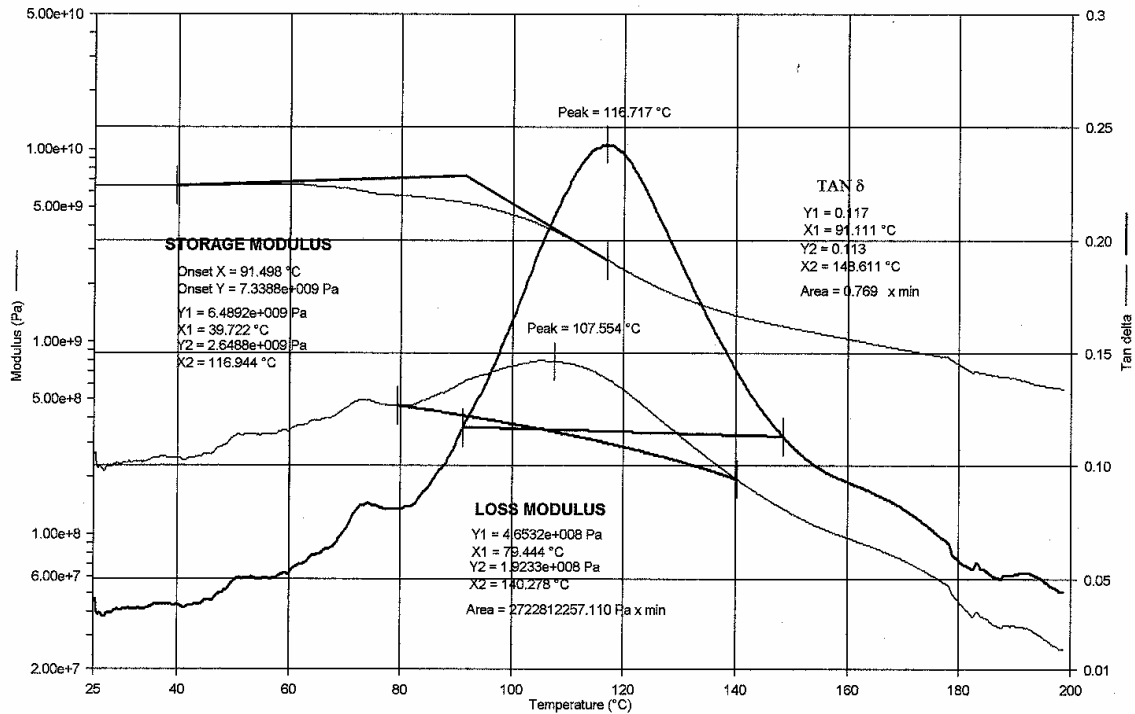
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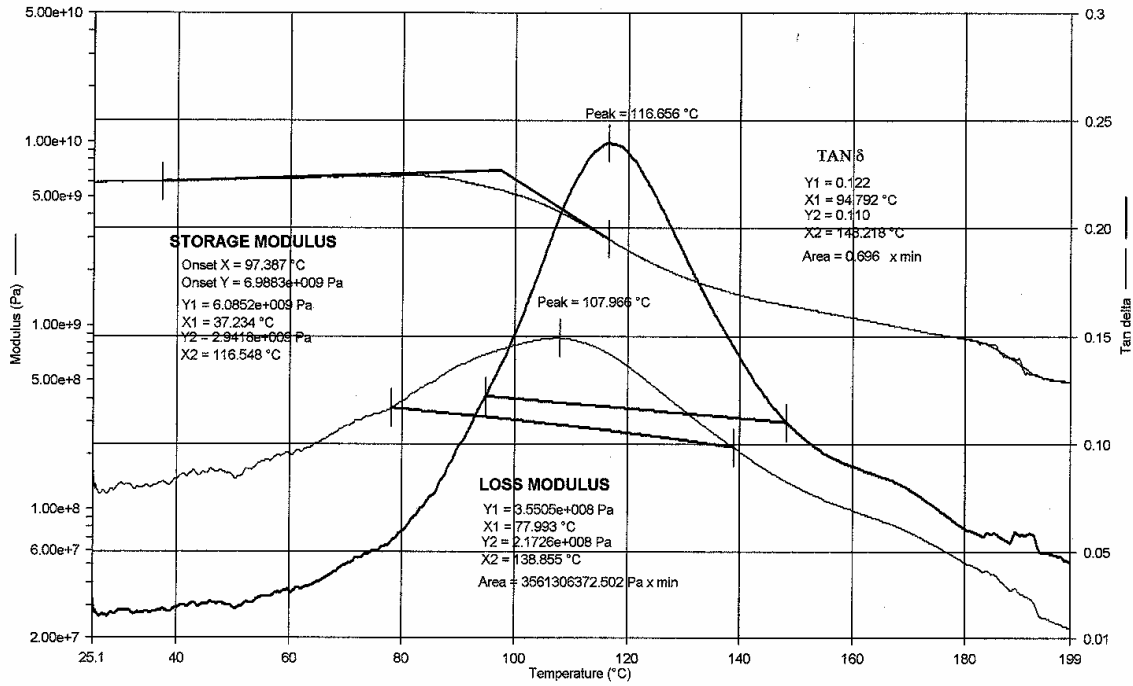
TAD311-4A



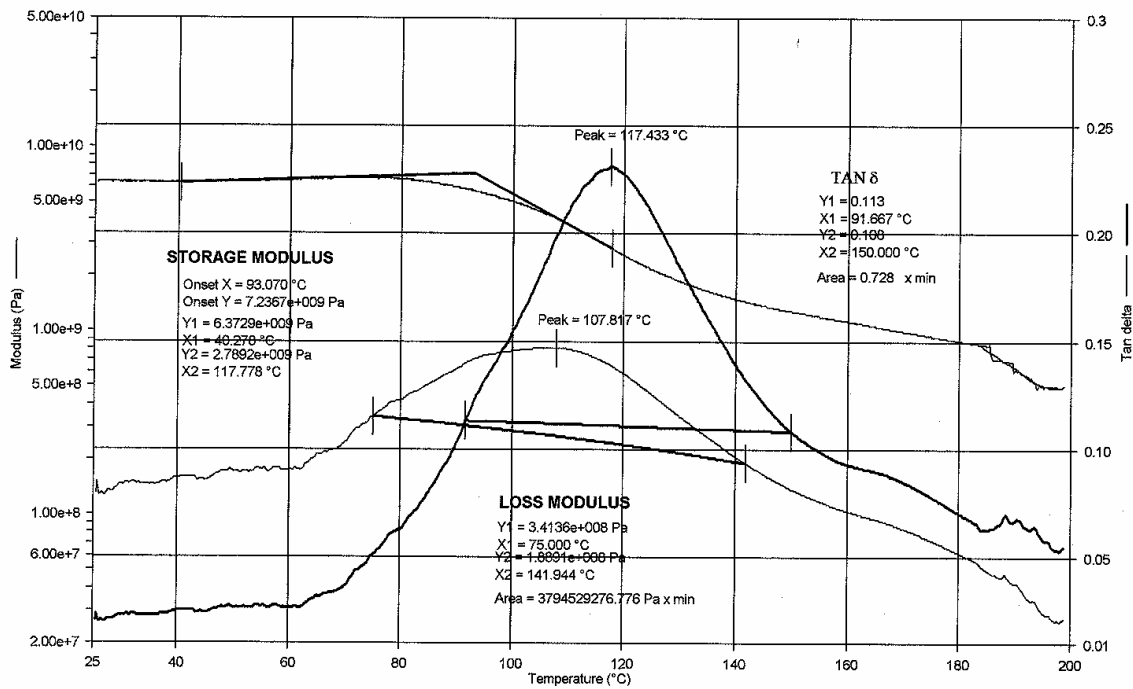
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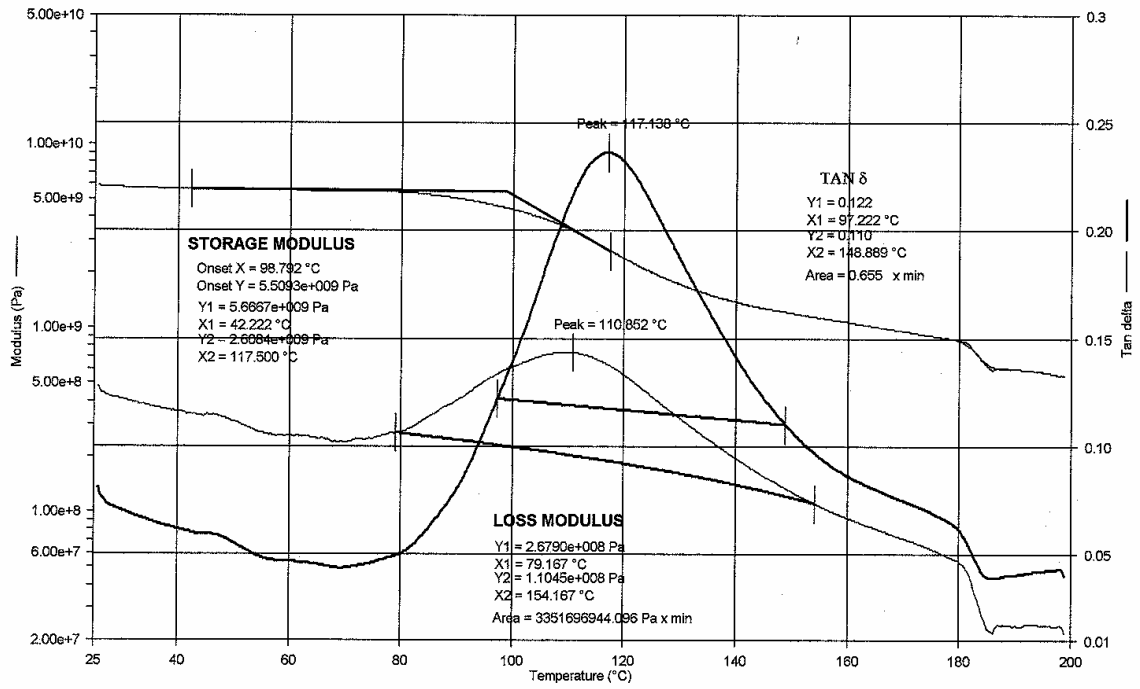
TAD311-2C



TAD311-3C



TAD311-4C



TAD311-5C

4.0 TESTING AND REPORTING COMMENTS

4.1 E-765 Resin Components

The components used in the certification resin batches were:

Component A	Shell
Component B	Ciba
Component C	Phenoxy Associates
Component D	Air Products
Component E	SKW

The identification of Components A, B, etc is proprietary to FiberCote. Details of the actual identifications are given in a letter from FiberCote to the FAA-Seattle, dated June 30, 1999 (ref. Project #TC1616SE-A).

The identification will be made available to users of the material after the execution of a confidentiality agreement.

4.2 Fiber Distortion

Nine (9) panels, TAU21, 22, 23, 24, 25, TAW21, 22, TAZ21, TAK31, exhibited individual fiber tow distortions, or waviness, on the surface ply. This phenomena is caused by a “pucker” in a prepreg tow produced during the prepregging operation. The distortions measured approximately 0.1” wide at a frequency of one or two in the noted panels. No differences are observed for the test data from these panels.

4.3 Panel TAJ221

This panel tested lower in ETD and ETW than the other tensile panels. On inspection, no reason can be assigned for these lower numbers. The results are, therefore, included. See pages 48 through 51.

4.4 Panel TAZ121

Transverse comparison modulus measured at 2.5 msi versus 1.5 to 1.7 measured on the other test panels. There is no physical explanation and it is unrealistic compared to the others – possibly the result of a strain gauge malfunction. The number was, therefore, eliminated. See page 68.

4.5 Humidity Aging

During the humidity exposure, the fan ceased to operate. The specimens were transferred to a second chamber, but unfortunately, the cabinet door was not securely fastened which resulted in a lower humidity for a period before being corrected. This is evidenced by the dip in the conditioning curves.

This may account for the lower wet Tgs measured for the unidirectional versus the fabric.

APPENDIX A. PHYSICAL TEST DATA SUPPLIED BY MATERIAL VENDOR

Data File C:\HPCHEM\1\DATA\INSTCHCK\SIG10034.D

Sample Name: 121897-IT2

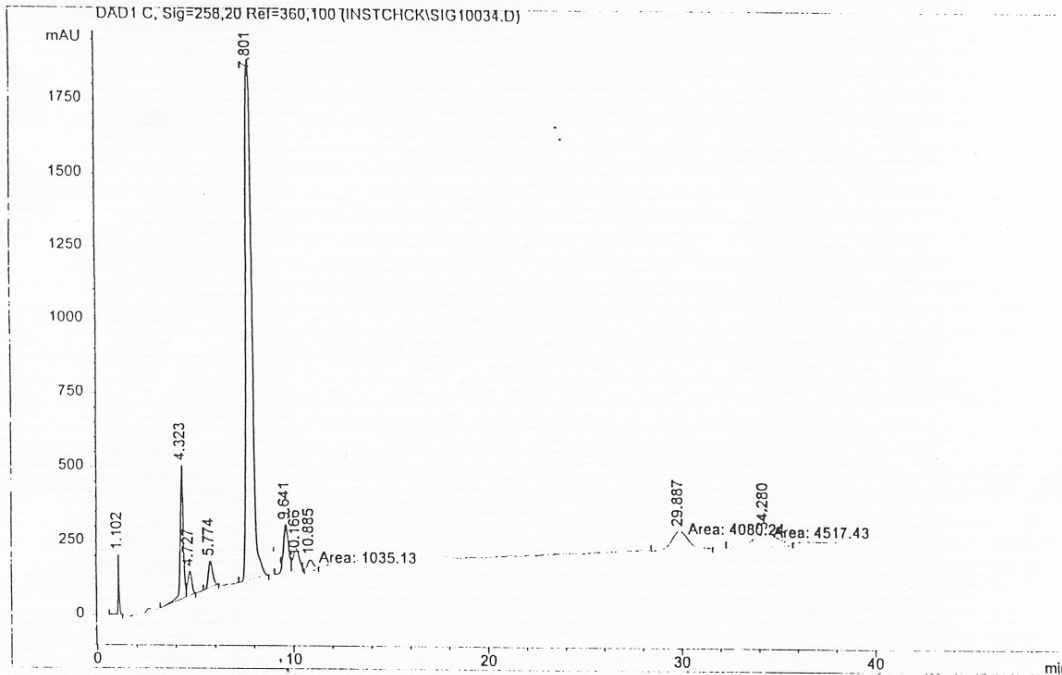
```

=====
Injection Date   : 5/11/98 11:09:47 AM
Sample Name     : 121897-IT2
Acq. Operator   : tc
Vial            : 5
Inj Volume     : 10 µl

Acq. Method     : C:\HPCHEM\1\METHODS\E-765.M
Last changed    : 5/11/98 11:05:58 AM by tc
                  (modified after loading)

Analysis Method : C:\HPCHEM\1\METHODS\E-765.M
Last changed    : 5/11/98 5:02:23 PM by tc
                  (modified after loading)
  
```

This is a fingerprint of E-765 on carbon for FAA qualification. This method is for resin as well as prepreg samples.



=====
 Area Percent Report
 =====

```

Sorted By       : Signal
Multiplier      : 1.0000
Dilution        : 1.0000
Sample Amount   : 1.00000 [ng/ul] (not used in calc.)
  
```

Data File C:\HPCHEM\1\DATA\INSTCHCK\SIG10034.D

Sample Name: 121897-IT2

Signal 1: DAD1 C, Sig=258,20 Ref=360,100
Results obtained with standard integrator!

Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	1.102	BB S	0.0746	955.99011	202.37204	1.5645
2	4.323	BV	0.1724	5029.59131	449.60104	8.2310
3	4.727	VB	0.2146	1125.56775	81.85951	1.8420
4	5.774	BB	0.2263	1300.89587	88.13672	2.1289
5	7.801	BB	0.3480	3.86598e4	1761.87891	63.2674
6	9.641	BV	0.2671	2805.36377	162.25995	4.5910
7	10.166	VV R	0.3244	1595.37610	32.27757	2.6109
8	10.885	MM T	0.4359	1035.12842	39.57526	1.6940
9	29.887	MM T	1.0418	4080.24438	65.27827	6.6774
10	34.280	MM T	1.7469	4517.43066	43.09941	7.3929

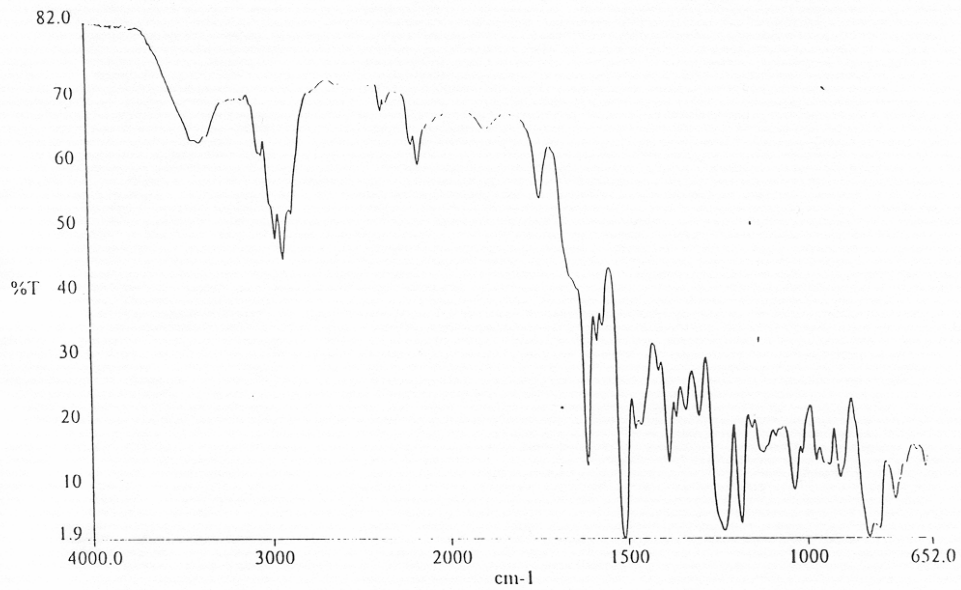
Totals : 6.11054e4 2926.33868

=====

*** End of Report ***

Software Version: Report Builder, Rev. 1.60

Date: 5/7/98 Time: 1:01:43 PM



Spectrum Pathname: C:\PEL_DATA\SPECTRA\E765.SP

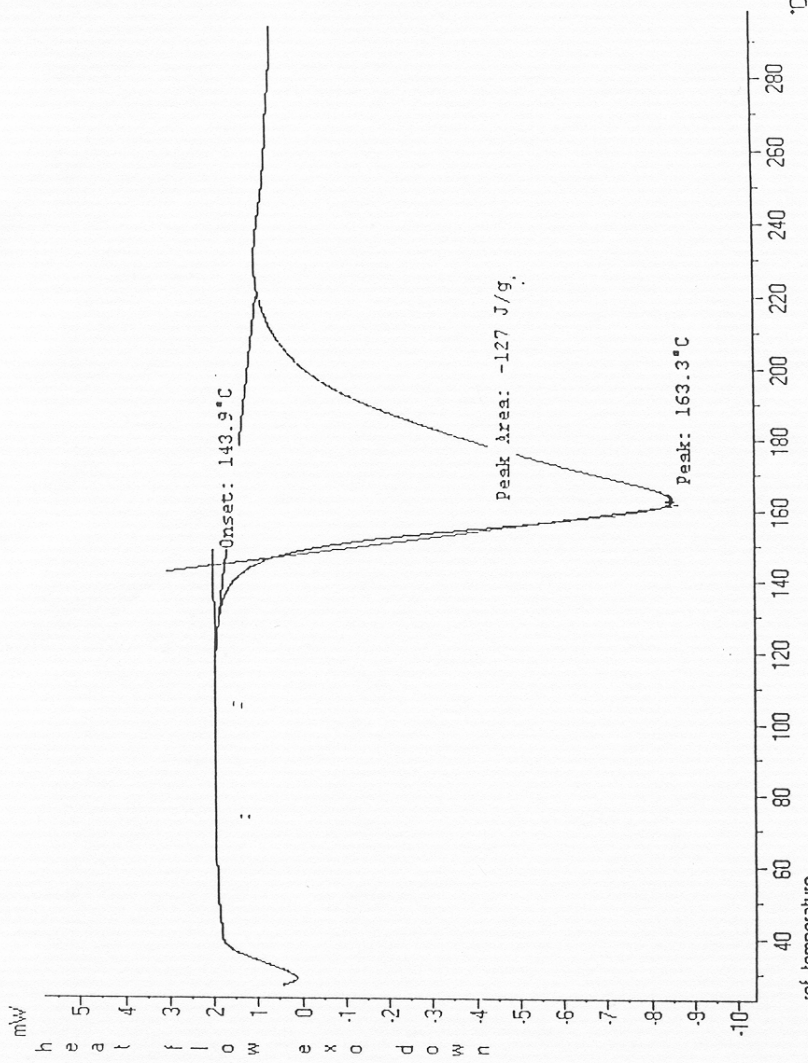
Date Created: Thu May 07 12:55:04 1998

Analyst:

Description: 12897-it2 Run#2

Thermal Analysis DSC 6 date: 5/7/98 3:01:30 PM page: 1

PERKIN ELMER



File Name: 121897-IT2 Run#2 Bry...E765Tg
Run Date: 5/7/98 2:42:37 PM
Sample ID: 121897-IT2 Run#2 Bryte
Sample Weight: 7 mg
Method Title: E765Tg
Method Information:
Comments:
Operator ID: J. Z.
Date Created:
This method contains 1 step.
1: dyn. 30 - 300°C 20°C/min

Data File C:\HPCHEM\1\DATA\INSTCHCK\SIG10039.D

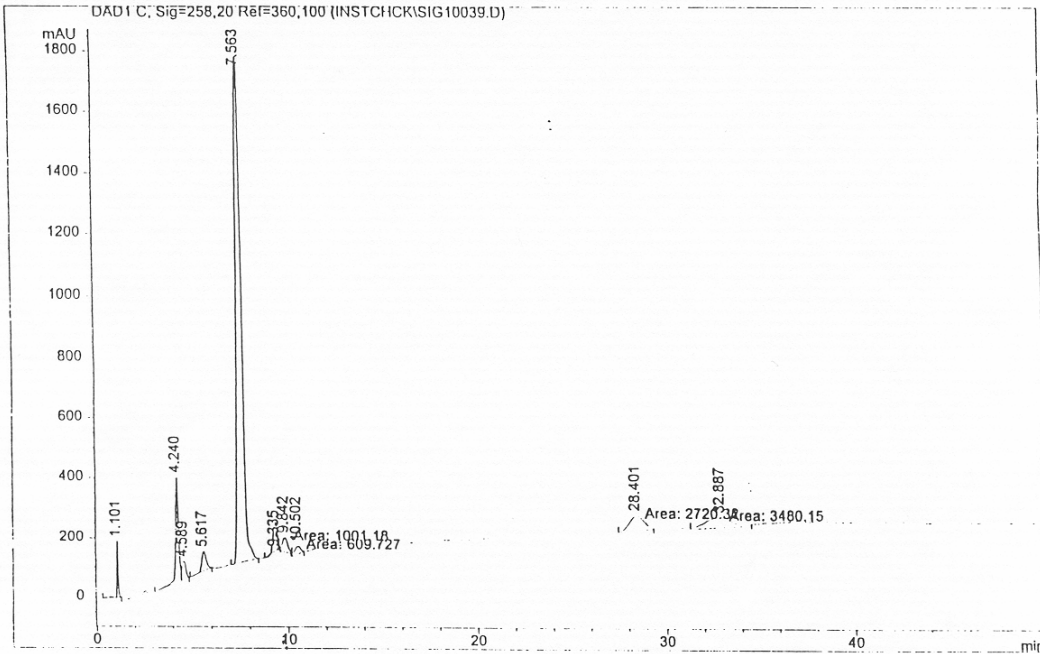
Sample Name: 123097-IT2

```

=====
Injection Date   : 5/12/98 10:42:15 AM
Sample Name     : 123097-IT2
Acq. Operator   : tc
Vial           : 7
Inj Volume     : 10 µl

Acq. Method    : C:\HPCHEM\1\METHODS\E-765.M
Last changed   : 5/12/98 8:54:09 AM by tc
                (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\E-765.M
Last changed   : 5/12/98 11:59:54 AM by tc
                (modified after loading)
  
```

This is a fingerprint of E-765 on carbon for FAA qualification. This method is for resin as well as prepreg samples.



=====
 Area Percent Report
 =====

```

Sorted By      : Signal
Multiplier     : 1.0000
Dilution       : 1.0000
Sample Amount  : 1.00000 [ng/ul] (not used in calc.)
  
```

Data File C:\HPCHEM\1\DATA\INSTCHCK\SIG10039.D

Sample Name: 123097-IT2

Signal 1: DAD1 C, Sig=258,20 Ref=360,100
Results obtained with standard integrator!

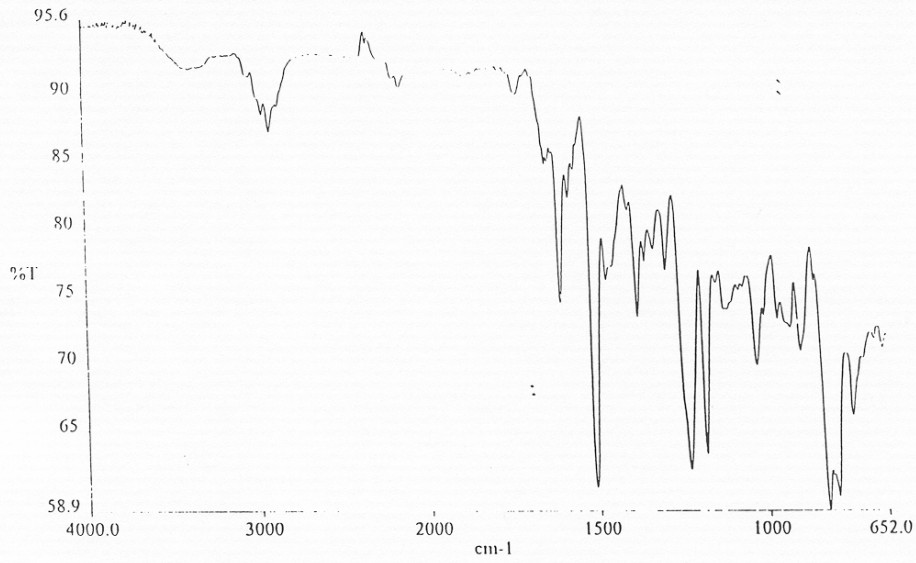
Peak #	RetTime [min]	Type	Width [min]	Area [mAU*s]	Height [mAU]	Area %
1	1.101	BB S	0.1138	907.79602	189.63033	1.8741
2	4.240	BV	0.1690	3873.44775	351.42661	7.9966
3	4.589	VB	0.2034	813.08307	61.31213	1.6786
4	5.617	BB	0.2355	1039.08093	66.98481	2.1452
5	7.563	BB	0.3095	3.26280e4	1666.94336	67.3597
6	9.335	BV R	0.2249	1365.65710	1.21569e-14	2.8194
7	9.842	MM T	0.3661	1001.17914	49.65144	2.0669
8	10.502	MM T	0.3573	609.72650	28.44020	1.2588
9	28.401	MM T	0.8952	2720.32373	50.64414	5.6160
10	32.887	MM T	1.7220	3480.15234	33.68317	7.1847

Totals : 4.84384e4 2498.71618

=====
*** End of Report ***

Software Version: Report Builder, Rev. 1.60

Date: 5/7/98 Time: 2:30:51 PM



Spectrum Pathname: c:\pel_data\spectra\7653.sp

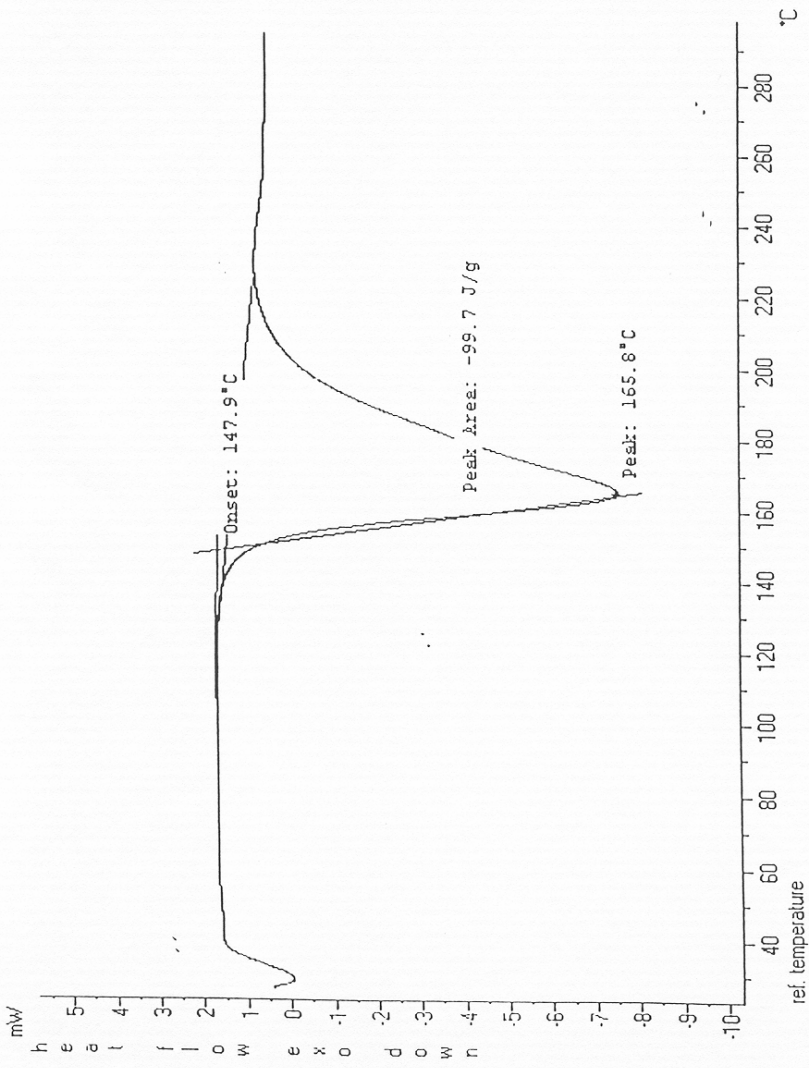
Date Created: Thu May 07 14:20:10 1998

Analyst:

Description: 123097-IT2 Run#3

Thermal Analysis DSC 6
date: 5/7/98 3:24:42 PM
page: 1

PERKIN ELMER



File Name: 123097 IT2 Run#3 Bry.../E765Tg
Run Date: 5/7/98 3:08:58 PM
Sample ID: 123097 IT2 Run#3 Bryle
Sample Weight: 7.5 mg
Method Title: E765Tg
Method Information:
Comments:
Operator ID: JZ
Date Created:
This method contains 1 step.
1: dyn. 30 - 300°C 20°C/min

Data File C:\HPCHEM\1\DATA\INSTCHCK\SIG10036.D

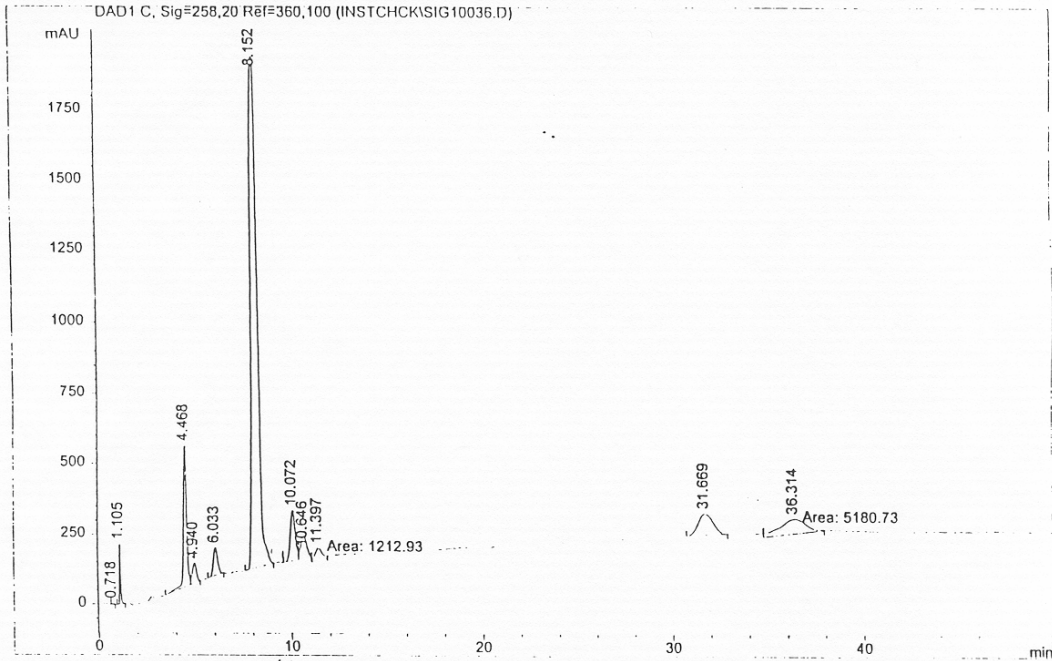
Sample Name: 121997-IT2

```

=====
Injection Date   : 5/11/98 4:06:40 PM
Sample Name     : 121997-IT2
Acq. Operator   : tc
Vial            : 6
Inj Volume      : 10 µl

Acq. Method     : C:\HPCHEM\1\METHODS\E-765.M
Last changed    : 5/11/98 11:05:58 AM by tc
                  (modified after loading)
Analysis Method : C:\HPCHEM\1\METHODS\E-765.M
Last changed    : 5/11/98 5:02:23 PM by tc
                  (modified after loading)
    
```

This is a fingerprint of E-765 on carbon for FAA qualification. This method is for resin as well as prepreg samples.



=====
 Area Percent Report
 =====

```

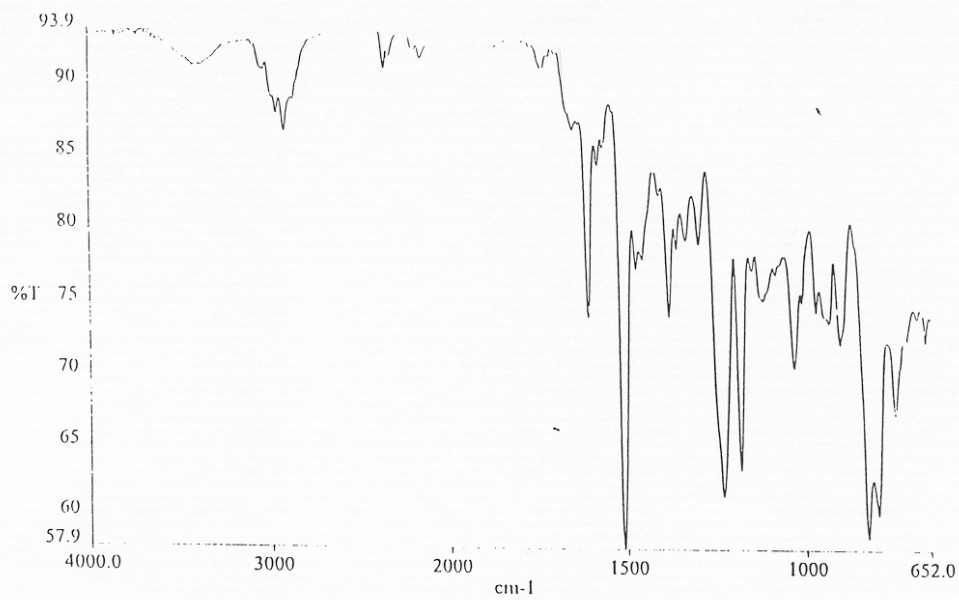
Sorted By      :      Signal
Multiplier     :      1.0000
Dilution       :      1.0000
Sample Amount  :      1.00000 [ng/ul] (not used in calc.)
    
```

Instrument 1 5/11/98 5:12:22 PM tc

Page 1 of 2

Software Version: Report Builder, Rev. 1.60

Date: 5/7/98 Time: 1:38:57 PM



Spectrum Pathname: C:\PEL_DATA\SPECTRA\E7652.SP

Date Created: Thu May 07 13:28:58 1998

Analyst:

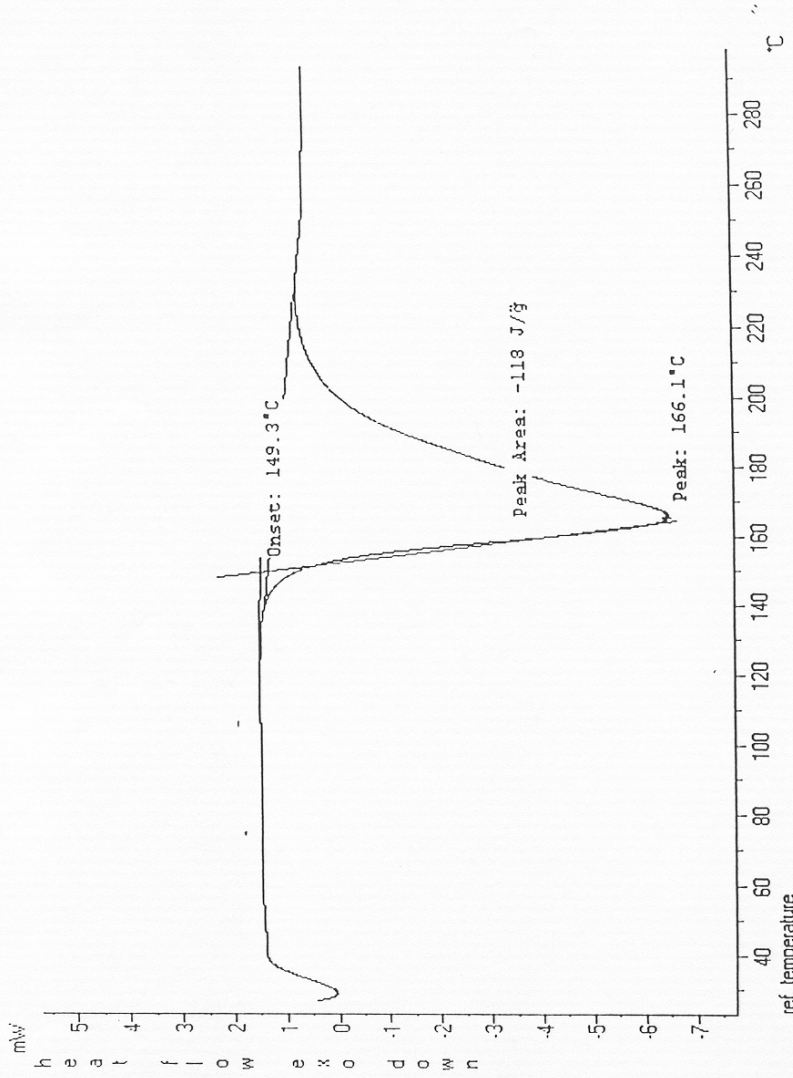
Description: 121997-IT2 Run#2

Thermal Analysis DSC 6

page: 1

date: 5/7/98 4:58:13 PM

PERKIN ELMER



File Name: 121997-IT2 Run#2 Bry.../E765Tg
Run Date: 5/7/98 3:38:21 PM
Sample ID: 121997-IT2 Run#2 Bryte
Sample Weight: 5.4 mg
Method Title: E765Tg
Method Information:
Comments:

Operator ID: J. Z.
Date Created:
This method contains 1 step.
1: dyn. 30 - 300°C 20°C/min

**APPENDIX B. DATES OF PANEL MANUFACTURE AND COPY OF FAA FORM
8130-3**

1. UNITED STATES		2. FAA FORM 8130-3 AIRWORTHINESS APPROVAL TAG U.S. Department of Transportation Federal Aviation Administration		3. System Tracking Ref. No. FC105	
4. Organization PAC USA / FiberCote, 172 East Aurora St., Waterbury, CT 06708-2024		5. Work Order, Contract, or Invoice Number. P.O. 11517			
6. Item	7. Description	8. Part Number	9. Eligibility *	10. Quantity	11. Serial/Batch Number
1	Test Panels	See Remarks	Lancair LC-4D	57	N/A
12. Status/Work Prototype					
13. Remarks CONFORMITY ONLY: Ship to Wichita State University Part Numbers: TAJ11, TAJ12, TAJ13, TAJ14, TAJ15 TAJ21, TAJ22, TAJ23, TAJ24 TAJ31, TAJ32, TAJ33, TAJ34 TAU11, TAU12, TAU13, TAU14, TAU15, TAU16, TAU17 TAU21, TAU22, TAU23, TAU24, TAU25 TAU31, TAU32, TAU33, TAU34, TAU35 TAK11, TAK12, TAK13 TAK21, TAK22, TAK23 TAK31, TAK32, TAK33 TAW11, TAW12, TAW13, TAW14, TAW15, TAW16, TAW17 TAW21, TAW22, TAW23, TAW24, TAW25 TAW31, TAW32, TAW33, TAW34, TAW35 TAN11, TAN12, TAN13, TAN14, TAN15, TAN16, TAN17 TAN21, TAN22, TAN23, TAN24, TAN25 TAN31, TAN32, TAN33, TAN34, TAN35 TAQ11, TAQ12, TAQ13, TAQ14, TAQ15, TAQ16, TAQ17 TAQ21, TAQ22, TAQ23, TAQ24, TAQ25 TAQ31, TAQ32, TAQ33, TAQ34, TAQ35					
14. Limited life parts must be accompanied by maintenance history including total time/total cycles/time since new.					
15. Signature Newly Overhauled <input checked="" type="checkbox"/> <input type="checkbox"/>		16. FAA Authorization No. DAR NE800856AC		20. Authorized Signature: <i>N/A</i>	
17. Name (Typed or Printed): Al Pereira		18. Date: 7-30-98		21. Certificate Number:	
19. Return to Service in Accordance with FAR 43.9 Certifies that the work specified in block 13 (or attached) above was carried out in accordance with FAA airworthiness regulations and in respect to the work performed the part(s) is (are) approved for return to service. NOTE: In case of parts to be exported, the special requirements of the importing country have been met.		22. Name (Typed or Printed)		23. Date:	

* (Optional) Installer must cross check eligibility with applicable technical data.

~~E-795~~ ⁷⁰⁰ OP1000 QUALIFICATION PLAN
 UNI GRAPHITE

PANEL BUILD - E-765 PS1000

Page 1 of 3

PANEL #	KIT DATE	DATE LAYUP	CURE DATE/TIME	CURE CYCLE NO.	COMMENTS <i>CURE OK</i>
TAJ11			<i>6/30/98</i>	<i>1</i>	<i>13.10</i>
TAJ12			<i>7/1/98</i>	<i>2</i>	<i>11.50.</i>
TAJ13				<i>1</i>	
TAJ14				<i>2</i>	
TAJ15				<i>1</i>	
TAJ21				<i>2</i>	
TAJ22				<i>1</i>	
TAJ23				<i>2</i>	
TAJ24				<i>1</i>	
TAJ31				<i>2</i>	
TAJ32				<i>1</i>	
TAJ33				<i>2</i>	
TAJ34				<i>1</i>	
TAU11				<i>2</i>	
TAU12				<i>1</i>	
TAU13				<i>2</i>	
TAU14				<i>1</i>	
TAU15				<i>2</i>	
TAU16				<i>1</i>	
TAU17				<i>2</i>	
TAU21				<i>1</i>	

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^{F65}
 E-765 QP1000 QUALIFICATION PLAN
 UNI GRAPHITE

PANEL BUILD - E-765 PS1000

Page 2 of 3

PANEL #	KIT DATE	DATE LAYUP	CURE DATE/TIME	CURE CYCLE NO.	COMMENTS CURE-DUTY
TAU22				2	
TAU23				1	
TAU24				2	
TAU25			7/17/98	3	114-05.
TAU31			7/20/98	4	19-30.
TAU32				3	
TAU33				4	
TAU34				3	
TAU35				4	
TAK11				3	
TAK12				4	
TAL11				3	
TAK21				4	
TAK22				3	
TAL21				4	
TAK31				3	
TAK32				4	
TAL31				3	
TAW11				4	
TAW12				3	
TAZ11				4	

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