COMPOSITE TECHNOLOGY DEVELOPMENT, INC.

ENGINEERED MATERIAL SOLUTIONS

CTD-101K
Epoxy Resin System

High Performance Resins for Cryogenic and Radiation Applications

- An anhydride cured epoxy system that was developed and tested for cryogenic applications down to liquid helium temperatures (-269ºC/-452ºF) as well as for its resistance to high energy radiation.
- Sets the performance standards in cryogenic and high radiation applications and is backed by performance data that meet all applicable test specifications.
- Good room temperature performance and handling characteristics: low viscosity and long pot-life.
- Non-carcinogenic resin system with very low toxicity. It is a non-solvent based system, and will not give off volatiles on cure.
- Improved wetting and excellent impregnation of large coils with highly tortuous paths.

Cure: 1 1/2 hrs at 135° C; No Post Cure or
5 hrs at 110° C with a post cure of 16 hrs at 125° C

Process Compatibilities	Material Advantages
• Filament winding (FW) • Resin Transfer Molding (RTM) • Vacuum Pressure Impregnation (VPI) • Casting with or without filler	• Non-Carcinogenic • Low Toxicity • Long Pot-Life, 60 hours at 40° C • Low Viscosity, 400 cP at 40° C • Excellent adhesion to fibers and fillers • Specific Gravity 1.03 g/cc • Processing Temperature 40 - 60° C

Material Properties

Viscosity @ 60º C [cP]	Glass Transition Temp [ºC]	Linear Shrinkage* [%]	Dielectric Strength with S-2 Glass, 0.5 mm thick, at 76 K [KV/mm]
<100	113º	<1	76.3

*Neat resin linear cure shrinkage, cured 1.5 hrs at 135° C. Cure schedule will effect linear shrinkage.

CTD-101K, with 50% V_f satin weave S-2 Glass, Through Thickness: Unirradiated Compressive Properties

Temperature [K]	Compression Strength [MPa]	Compression Modulus [GPa]
295	790	12.9
76	1300	16.7
4	1360	19.7

Shear Properties

Temperature [K]	Shear Strength [MPa]	Flexural Modulus [GPa]
76	108.0	27.9
4	120.0	34.1

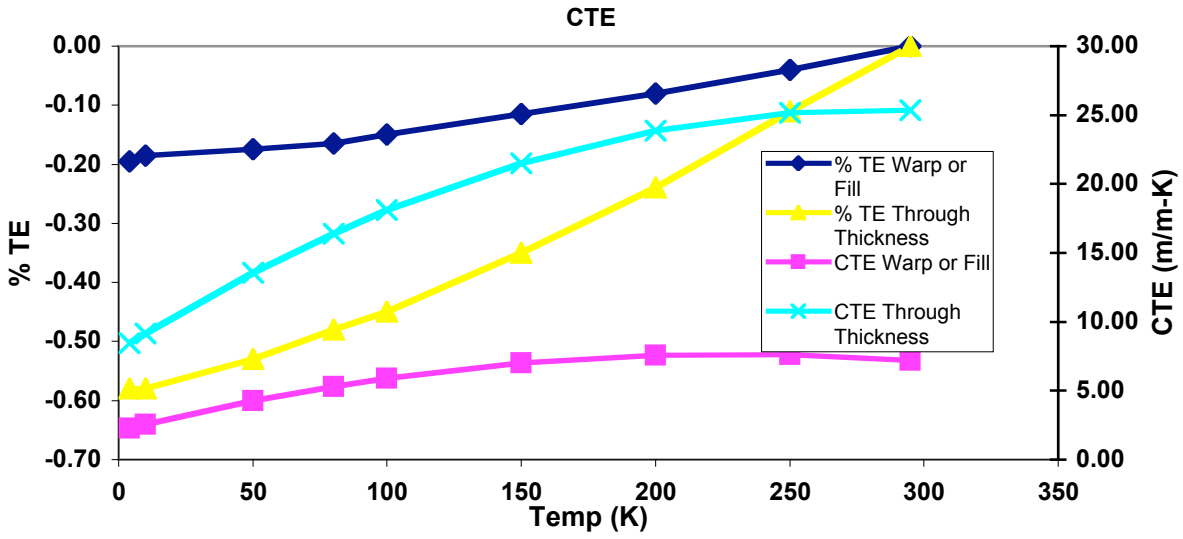
Combined Shear/Compressive Properties

Temperature [K]	Fixture [deg.]	Shear Strength [MPa]	Compressive Strength [MPa]
76	15	101.5	29.6
76	45	175.8	175.8
76	75	247.5	933.2
76	84	127.1	1207.7
4	15	104.1	27.9
4	45	178.3	178.3
4	75	277.2	1034.3
4	84	125.0	1197.3

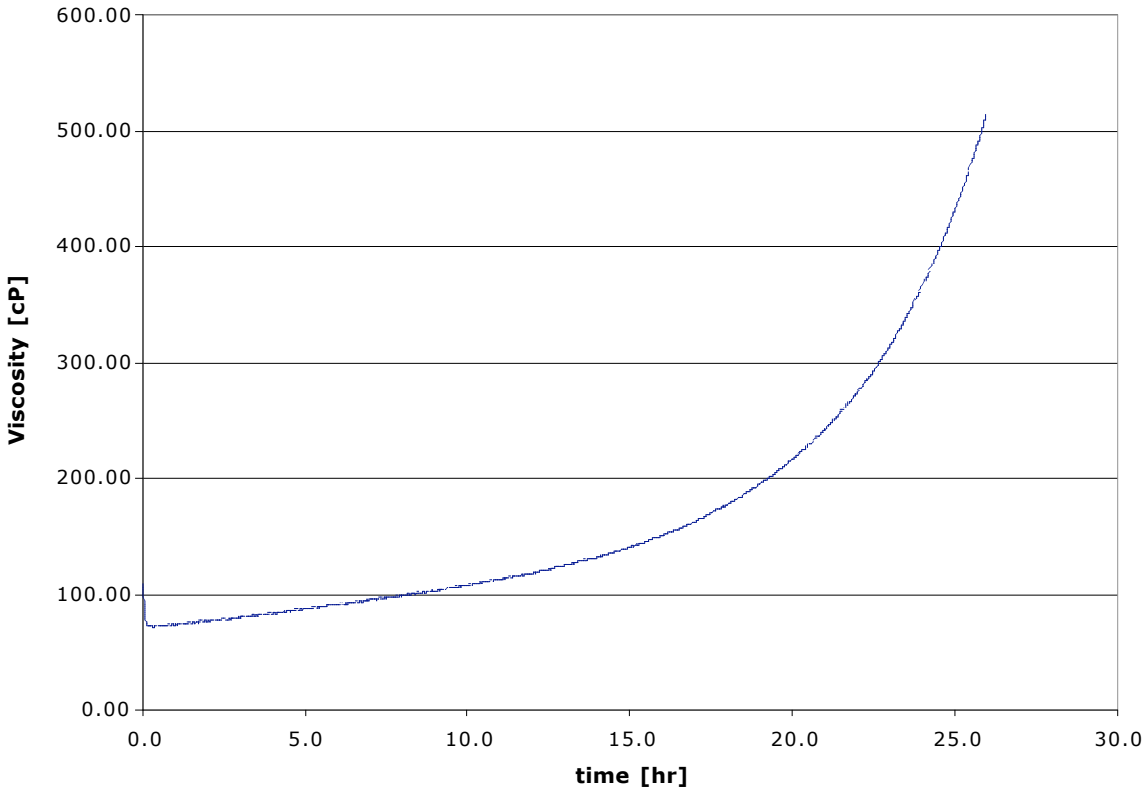
Irradiation Results

Irradiation Temp [K]	Dose [Rads]	Compressive Strength at 76K [GPa]	Compressive Modulus at 76K [GPa]	Shear Strength at 76K [MPa]	Flexural Modulus at 76K [GPa]	Fracture Resistance G_{1C} at 76K [KN/m]
4	4.7E9	1.23	19.5	85.0	27.5	-
4	8.8E9	1.20	13.0	41.3	20.6	-
4	1.6E10	1.08	13.5	6.7	15.6	-
330	-	1.30	16.7	108.0	27.9	0.36
330	4.7E8	-	-	-	-	0.28
330	4.7E9	-	-	-	-	0.15
330	2.3E10	-	-	-	-	0.16

Coefficient of Thermal Expansion of CTD-101K, with 50% V_f satin weave S-2™ Glass



Viscosity Profile of CTD-101K at 60°C



Disclaimer: The information and recommendations contained herein are based upon data believed to be accurate. However, no guarantee or warranty of any kind expressed or implied is made with respect to the information contained herein.

April 03