COMPOSITE TECHNOLOGY DEVELOPMENT, INC.

ENGINEERED MATERIAL SOLUTIONS

Material Selection Guide

Electrical and Thermal Insulation, Adhesives, and Specialty Resins for Harsh and Demanding Environments and Applications

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NANUQ®
CryoCoat™
CryoBond™
TEMBO®
KIBOKO®

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CTD Introduction

CTD materials are widely used in some of the most demanding and harsh environments including superconducting and high-performance magnets, cryogenic devices, space exploration, electrical motors, and other applications where high-strain and thermally stable materials deliver mission success.

These materials exhibit high strain-to-failure, high radiation resistance, thermal cycling between temperature extremes, low coefficient of thermal expansion (CTE), microcrack resistance, and perform both at the extremes of cryogenic temperatures and the high-temperatures of aerospace and industrial environments.

This guide is intended to apprise the community of the breadth and depth of material solutions available at Composite Technology Development. Since 1988, CTD's expertise in "achieving success where failure is not an option" serves as a foundation for market leadership. All of our systems are tailorable to achieve the specific performance required by your demanding application.

CTD's intimate knowledge of the material properties of each of these systems enables our team to optimize the solution to address your need. We also have a wide range of data available for each of these systems once the best material solution is identified to ensure you have the information you need to achieve the performance you expect.

We also offer engineering design, analysis, and testing services for your material-enabled solution that will allow for the material properties to be fully exploited. CTD looks forward to partnering with you to enable your success!

Where Failure is Not an Option

COMPOSITE TECHNOLOGY DEVELOPMENT, INC.

ENGINEERED MATERIAL SOLUTIONS

NANUQ®

Epoxy Resins (CTD-100 Series)

Epoxy-based systems developed and tested for cryogenic applications below liquid helium temperatures (4.2 K / -269 °C / -452 °F) as well as for its resistance to high levels of radiation. These epoxy resins set the performance standards in cryogenic and high radiation applications and is backed by performance data that meet all applicable test specifications. With good room temperature performance and handling characteristics such as low viscosity and long pot-life, these systems are suitable for a wide range of applications.

In general, the CTD-100 series is non-carcinogenic with very low toxicity. It is a non-solvent based system, and will not give off volatiles on cure, even within a closed mold.

Process compatibility include: Resin Transfer Molding (RTM), Resin Injection Molding (RIM), Filament Winding (FW), Vacuum Pressure Impregnation (VPI), Casting with or without filler, Wet-winding (WW)

Advantages:

- Non-Carcinogenic
- Low Toxicity
- Long Pot-Life, Low Viscosity
- Excellent adhesion to fibers and fillers
- Radiation resistance (~ 10 MGy)
- Specific Gravity 1.1 g/cc
- Mixing Temperature 40 - 60° C

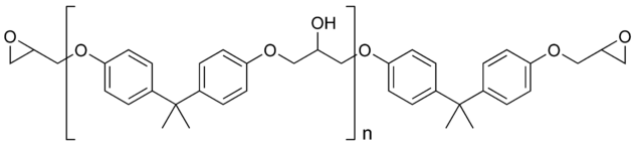
FReSCa2 Nb_3Sn Dipole Magnet

Photo courtesy of CERN

NHMFL 45T coil insulated with CTD-101K

NANUQ®

Epoxy Resins (CTD-100 Series)



INSULATIONS FOR MAGNETS, MRI COILS, & EV MOTORS		
CTD-100 Series	CTD-101G	Alumina-filled CTD-101 for thermal management and CTE match
	CTD-101GY	CTD-101G with increased alpha phase filler for increased thermal conductivity
	CTD-101H	Silica-filled CTD-101 for CTE match
	CTD-101K	Cryogenic insulation for superconducting coil, provides superior wetting and impregnation, and radiation resistance
	CTD-103G	Cryogenic, radiation resistant, thermally-conductive filled system
	CTD-103K	Multi-purpose, cryogenic-compatible, radiation resistant resin with adhesive properties
	CTD-115P	Cryogenic prepreg epoxy resin
	CTD-121P	Economical prepreg cryogenic epoxy system used for electrical insulation, filament winding, etc. Available on S-glass or E-glass or as a multi-layered system with Kapton (CTD-121P-GUG, CTD-121P-UG)
	CTD-151	Epoxy potting resin for electric motor applications
	CTD-151G	Thermally conductive epoxy resin for electric motor applications. Compatible with potting and trickle processes.
	CTD-153G	Toughened thermally conductive epoxy resin for electric motor applications. Compatible with potting and trickle processes. Consistent electrical performance up to 150°C
	CTD-155	Toughened, low viscosity, long pot life system for electrical insulation. Compatible with vacuum impregnation and potting processes
	CTD-170	One-part epoxy insulation with long working life at 80°C. Compatible with vacuum impregnation and potting processes. Long shelf life.
	CTD-171	Low viscosity one-part epoxy insulation with long working life at 80°C. Compatible with vacuum impregnation and potting processes. Long shelf life.

NANUQ®

Cyanate Ester Resins (CTD-400 Series)

CTD's Cyanate Ester-based systems are thermosetting resins that are typically utilized in high-performance magnets, including Niobium Tin (Nb_3Sn), such as those requiring high-radiation and or high-temperature operation using resistive conductors. These two-part systems generally exhibit very low viscosities and long pot lives from 35° to 60° C. Additionally, they are available as prepreg systems. Many of CTD-400 series materials are blended with epoxy or other polymers to moderate cost or performance to better meet customer's needs.

Most of these materials are designed for use in vacuum-pressure impregnation processes consistent with those used in the production of magnets and other electrical windings. Once cured, these materials exhibit very good electro-mechanical performance at both cryogenic and elevated temperatures.

Because these are not epoxy resins, there are some unique handling considerations that must be adhered to in the use of these materials. Contact CTD for detailed handling and processing procedures.

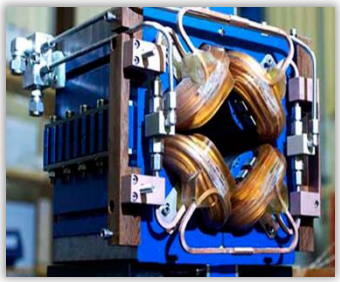
Process compatibility include: Vacuum Pressure Impregnation (VPI), Hot-melt prepreg

Advantages:

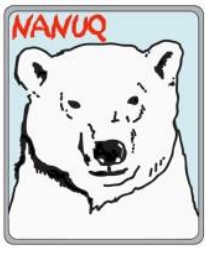
- Excellent performance from cryogenic to elevated temperatures
- Low temperature processing
- Low dielectric loss characteristics
- Good fracture toughness
- Excellent resistance to various harsh environments including high levels of 100 MGy to > 250 MGy)
- Low outgassing

ITER Toroidal Field Coil

Photo courtesy of F4E

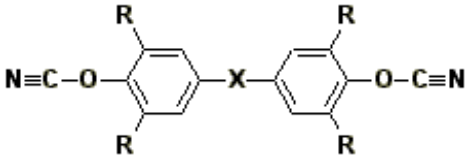


Proton Therapy Magnet Coil



NANUQ®

Cyanate Ester Resins (CTD-400 Series)



FUSION, HIGH ENERGY PHYSICS, COMMERCIAL MAGNETS, TF COILS		
CTD-400 Series	CTD-403	All cyanate ester resin system; VPI and wet-winding, extreme radiation resistance
	CTD-403B	Cost-effective cyanate ester system with high stability
	CTD-406	Cyanate ester / Polyimide hybrid VPI system, high radiation resistance
	CTD-410	Cyanate ester / Bismaleimide hybrid VPI system with high radiation resistance
	CTD-413P	Solvent prepreg
	CTD-415P	Cyanate ester / Bismaleimide blend hot melt prepreg
	CTD-422	Cyanate ester / Epoxy blend
	CTD-422B	Cyanate ester / Epoxy blend modified for ease of use and process control
	CTD-422-FM6	Filled version of CTD-422B for viscosity control
	CTD-422PC	Cyanate ester potting compound used to fill large gaps in magnetic coil structures
	CTD-423	Epoxy / Cyanate ester and Bismaleimide (BMI) blend
	CTD-425	Epoxy / Cyanate ester blend (ITER qualified)
	CTD-428	Economical Epoxy / Cyanate ester blend
	CTD-429	CTD-425 Epoxy / Cyanate ester blend modified for ease of use
	CTD-430	CTD-429 (importable to Japan)
	CTD-435	ITER qualified Epoxy / Cyanate ester blend for TF coils
	CTD-439	CTD-435 Epoxy / Cyanate ester blend with extended pot life
	CTD-450	Cyanate ester-based primer for improved bonding to copper

NANUQ®

Super Tuff Resins (CTD-500 Series)

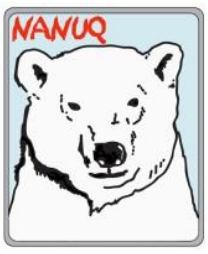
These high performance, tough resins are ideal for wet-winding applications, and several are useful in vacuum impregnation processes. They provide long pot life and room temperature cure for handling in less than 24 hours (full cure achieved in approximately seven days) which enables quick curing without the need for large, expensive curing equipment. The special "super tuff" formulation, with a primary amine cure, delivers very low viscosity, low vapor pressure, and a high amine content.

This resin series is ideally suited for applications where extended pot life and low to moderate exothermic heat of reaction is needed. The CTD-500 series performs well offering a wide range of properties for a variety of applications, whether utilized as a neat resin for fiber reinforcement or with particulate fillers that allow the physical properties (thermal expansion, thermal and electrical conductivities) to be tailored to meet differing requirements.

Process compatibility include: Resin Transfer Molding (RTM), Resin Injection Molding (RIM), Filament Winding (FW), Vacuum Pressure Impregnation (VPI), Casting with or without filler, Wet-winding (WW)

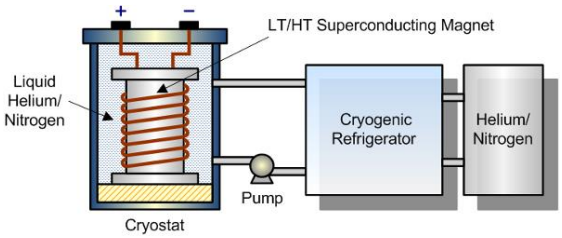
Advantages:

- Non-carcinogenic
- Low toxicity
- Long pot-life
- Low radiation resistance (< 0.5 MGy)
- Very low – low viscosity, ~400 cP – 1,000 cP at 25 °C
- Room temperature cure
- Excellent adhesion to fibers and fillers
- Specific gravity < 1.2 g/cc

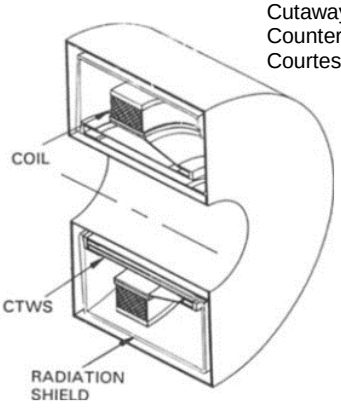


NANUQ®

Super Tuff Resins (CTD-500 Series)



Superconducting Magnet Energy Storage (SMES)
Courtesy of General Atomics



Cutaway of Magnetic Mine Countermeasure Coil
Courtesy of US Navy

Unmanned Influence Mine Sweep
Courtesy of Textron

MRI, MILITARY AND COMMERCIAL MAGNETS		
CTD-500 Series	CTD-521	Toughened epoxy resin for cryogenic applications, ambient cure
	CTD-521-A20	CTD-521 with alumina filler
	CTD-521-S32	CTD-521 with silica filler
	CTD-521-S40	CTD-521 with alternative silica filler loading
	CTD-522	Accelerated cure CTD-521, low viscosity for ease of processing
	CTD-523	Similar properties to CTD-522 with improved wetting capability
	CTD-525	Resin for cryogenic tanks and rocket structures
	CTD-525T	CTD-525 with very high filler loading, trowel application
	CTD-528	Low viscosity infusion version of CTD-521 resin
	CTD-528-FM3	Filled version of CTD-528 for viscosity control and CTE match
	CTD-540	Accelerated cure cryogenic epoxy resin version of CTD-528
	CTD-555-MT	Solvent-modified epoxy prepreg resin

NANUQ®

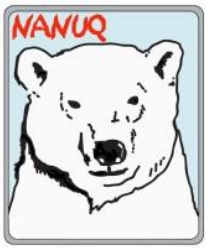
High Temperature Silicon-Based Resins (CTD-1000 series)

This series is comprised of silicon-based materials intended for use with superconductors that require high temperature heat treatment prior to use, such as Niobium Tin, or applications requiring flexible insulation for round wire (e.g. geothermal and motor). A subset of this series includes Polymer-Derived Ceramic (PDC) based hybrid that provide an insulation with a higher modulus, which reduces coil deflections. The thermal expansion characteristics very closely match those of the superconductor, unlike conventional fiberglass reinforced insulation, in turn reducing internal stresses resulting from differential thermal contractor of the superconductor and its insulation. This results in a lower cost, more robust coil. The resin is first cured, or green staged, to form a polymer. Thereafter, pyrolysis conducted concurrently with the conductor heat treatment converts the green polymer to a ceramic. As a ceramic, the resin exhibits high dielectric breakdown strength. CTD-1000 series outperforms alternative insulations in key electrical parameters of dielectric strength, electrical strength constant and resistivity.

Process compatibility include: Prepreg, Filament Winding (FW), Resin Transfer Molding (RTM), Vacuum Pressure Impregnation (VPI). Utilized in conjunction with CTD-101K or CTD-403 to provide toughness and strength

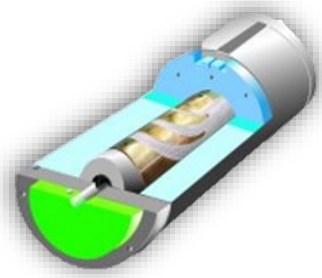
Advantages:

- Wind-and-react insulation system
- Highly radiation resistant
- Easy to process
- Low viscosity resin, 10 cP at 25 °C
- Long working life, > 24 hours at 25 °C
- Long-term heat stability



NANUQ®

High Temperature Resins (CTD-1000 series)



HIGH TEMPERATURE SYSTEMS		
CTD-1000 Series	CTD-1002†	Ceramic system used with an organic hybrid system
	CTD-1008	Ceramic system used with an organic hybrid system
	CTD-1012P	Ceramic prepreg used with an organic hybrid system
	CTD-1202†	Polymer-Derived Ceramic (PDC) insulation for Nb_3Sn magnets
	CTD-1203	High temperature insulation for harsh environment stator windings
	CTD-1205	High temperature insulation for harsh environment stator windings
	CTD-1210R	High Temperature glass fiber-reinforced electrical insulation for high temperature motor windings up to 300 °C
	CTD-1210F	Similar properties to CTD-1210R, enhanced with particulate reinforcement rather than fiber reinforcement
	CTD-1212	Modified fiber-reinforced version of CTD-1210R
	CTD-1219	Modified fiber-reinforced version of CTD-1210R
	CTD-1261	High temperature fiber-reinforced electrical insulation
	CTD-1265	High temperature fiber-reinforced electrical insulation
	CTD-1280	Inorganic resin and adhesive system with orthotropic elasticity for high temperature, high-aspect-ratio, multi-layer circuits and boards. Excellent thermomechanical and dielectric properties.
	CTD-1290	Low temperature green cure PDC insulation for superconducting magnets

†Pre-ceramic Polymers

Benzoxazines

Benzoxazine Resins (CTD-800 Series)

Benzoxazine resins are a novel development that enables lower void content, low shrinkage, reduced moisture absorption, heat resistance and overall high-wear tolerance. This class of thermosetting polymers provide unique advantages for materials requiring flame and moisture resistance. These factors enable these resins to be utilized in operating environments with higher temperatures than typical epoxies.

Primarily utilized in aerospace (e.g. aircraft cabins, waste tanks), marine vessels, consumer goods (e.g. adhesives in electronic systems) industrial and heavy machinery applications, CTD's low-viscosity benzoxazine resins are used to improve mechanical strength for structural applications. Compared to other high-performance polymers such as cyanate esters, the CTD 800-series are delivered at lower costs.

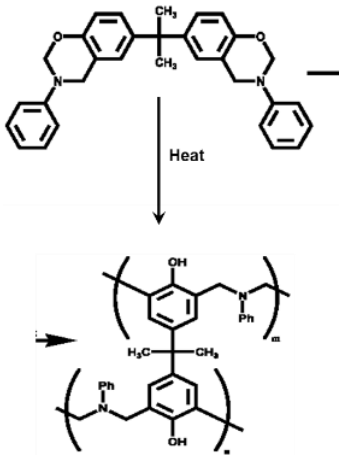
Process compatibility include: Resin Transfer Molding (RTM), Vacuum Assisted Resin Transfer Molding (VARTM), Filament Winding (FW), Casting with or without filler, Vacuum Pressure Impregnation (VPI)

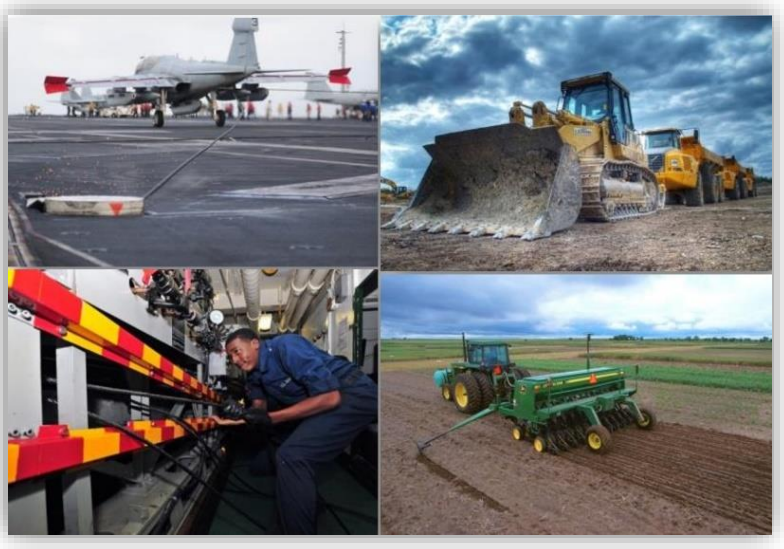
Advantages:

- Low toxicity
- Low smoke
- Enhanced wear resistance
- Low moisture absorption (< 1%)
- Viscosity <200 cP at processing temperature
- Self-extinguishing
- Near zero cure shrinkage (< 1%)
- Excellent adhesion to fibers and fillers

Benzoxazines

Benzoxazine Resins (CTD-800 Series)





LOW SMOKE, TOXICITY, HIGH TEMPERATURE		
CTD-800 Series	CTD-804	Benzoxazine (BZ) resin
	CTD-813	RTM processable resin system (Strengthened CTD-804)
	CTD-813L	Benzoxazine resin laminate VARTM system
	CTD-851	Rapid cure, high Tg benzoxazine resin
	CTD-852	Toughened benzoxazine resin (high strain, micro-crack resistant)
	CTD-858	Prepreg resin system, optional nanomaterial filled
	CTD-861	Component benzoxazine resin additive
	CTD-862	Enhanced electrical properties benzoxazine resin
	CTD-870	High temperature benzoxazine (Tg ~320°F)
	CTD-878	High temperature, (Tg ~470°F) economical alternative to BMI
	CTD-879	High temperature (Tg ~520°F) BZ blend (epoxy / cyanate ester)
	CTD-880	High temperature benzoxazine blend (epoxy / cyanate ester)

CryoCoat™ and CryoBond™

Thermal Insulation and Thermal Adhesive Resins

CryoCoat™ and CryoBond™ are epoxy-based systems for cryogenic insulation and adhesion. They are designed for compatibility with various substrates (metals, composites, and ceramics) and to withstand thermal cycling to cryogenic temperature. The systems are mixed at room temperature and applied in high humidity environment to a properly prepared surface.

These solutions succeed where others fail due to their viscosity and ability to adhere to wet surfaces. It is well-suited to retrofit applications and exhibits long-lasting performance. These tough materials withstand numerous thermal cycles, are UV and impact resistant, and are non-sparking and self-extinguishing in LOX environments.

The high strain-to-failure capability and bond strength across a wide temperature range makes it especially well-suited to space applications where thermal cycling causes other solutions to fail.

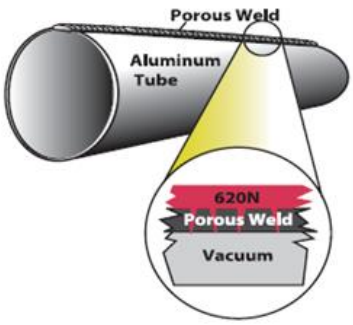
Process compatibility include: Spray, mold, trowel, formable tiles, paste adhesive

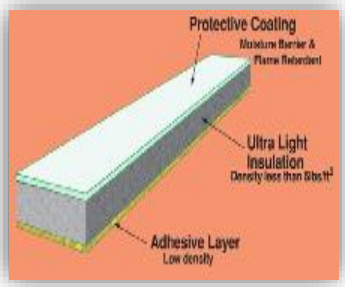
Advantages:

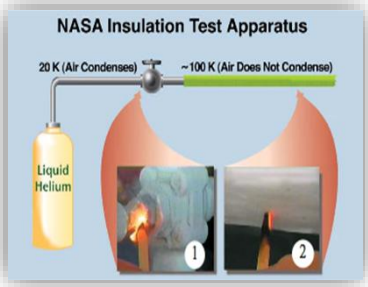
- Low density adhesive system
- Extremely flexible, even at cryogenic temperatures
- Room temperature cure
- Excellent adhesive properties on metals, composites and ceramics

CryoCoat™ and CryoBond™

Thermal Insulation and Thermal Adhesive Resins





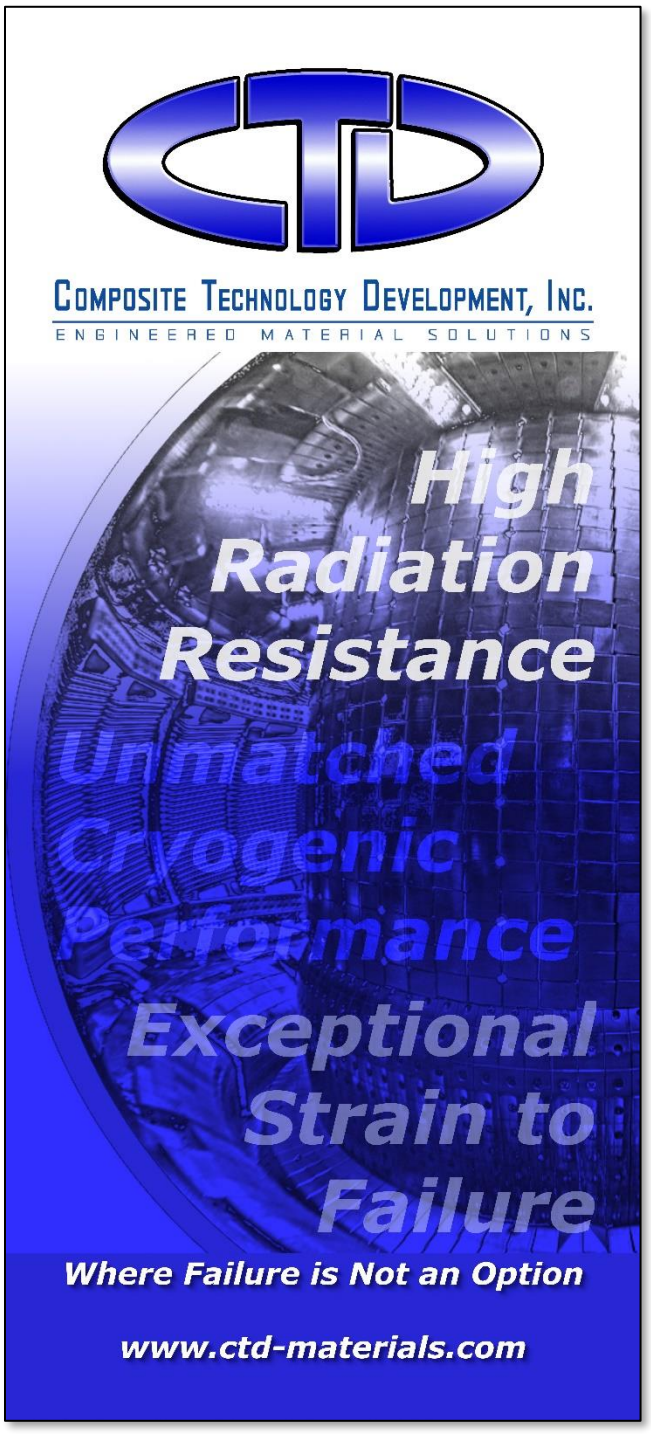


THERMAL INSULATION AND ADHESIVES		
CryoCoat™	CryoCoat UL10	Cryogenic insulation paste / solid (low density), supports multiple application methods
	CryoCoat UL31	Cryogenic insulation paste / solid (low density), supports multiple application methods
	CryoCoat UL79	Cryogenic insulation paste / solid (lowest density), supports multiple application methods
	CryoCoat 706	Sprayable insulation for fuel delivery and propellant systems
	CryoCoat 708	Enhanced formulation of CryoCoat for ease of use
	CryoCoat 728	Moldable cryogenic thermal insulation
	CryoCoat 729	Lower density version of CryoCoat 728
	CryoCoat 620T	Syntactic foam insulation (high density) for cryogenic applications. Designed to prevent formation of LOX on cryogenic pipes and structures

CryoCoat™ and CryoBond™

Thermal Insulation and Thermal Adhesive Resins

THERMAL INSULATION AND ADHESIVES		
CryoBond™	CryoBond 609	Low density flexible insulation with excellent adhesive properties at 30 pcf, suitable for flight and aerospace
	CryoBond 615	Cryogenic adhesive capable of high thermal cycles for electronic components and sensors
	CryoBond 616	Similar to CryoBond 615 with higher thermal conductivity to minimize cool-down stresses
	CryoBond 617	Modified CryoBond 615 for adhesion to metals and polyamide films
	CryoBond 618	Modified CryoBond 617 for higher strength, lower thermal contraction, and higher thermal conductivity
	CryoBond 620N	Low viscosity and high strength cryogenic adhesive liquid; extremely thin bond line (suitable for film applications)
	CryoBond 621	Cryogenic adhesive with optimized CTE for metals
	CryoBond 622	Modified CryoBond 621 with matched CTE for stainless steel
	CryoBond 919	Similar to CryoBond 920 with higher density and modified physical properties
	CryoBond 920	Low density and extremely flexible, moderate viscosity cryogenic and elevated temperature adhesive with room temperature cure, solvent free – for carbon fiber; utilized a part of complete insulation system when paired with UL-79 and CTD-XVC
	CryoBond 940	Developed for automotive to maintain adhesive integrity up to 450° F with low temperature cure
	CTD-943AD	Fast, ambient cure adhesive with high temperature properties up to 600° F
	CryoBond XVC	Low viscosity liquid, Moisture barrier coating


COMPOSITE TECHNOLOGY DEVELOPMENT, INC.
ENGINEERED MATERIAL SOLUTIONS
High Radiation Resistance
Unmatched Cryogenic Performance
Exceptional Strain to Failure
Where Failure is Not an Option
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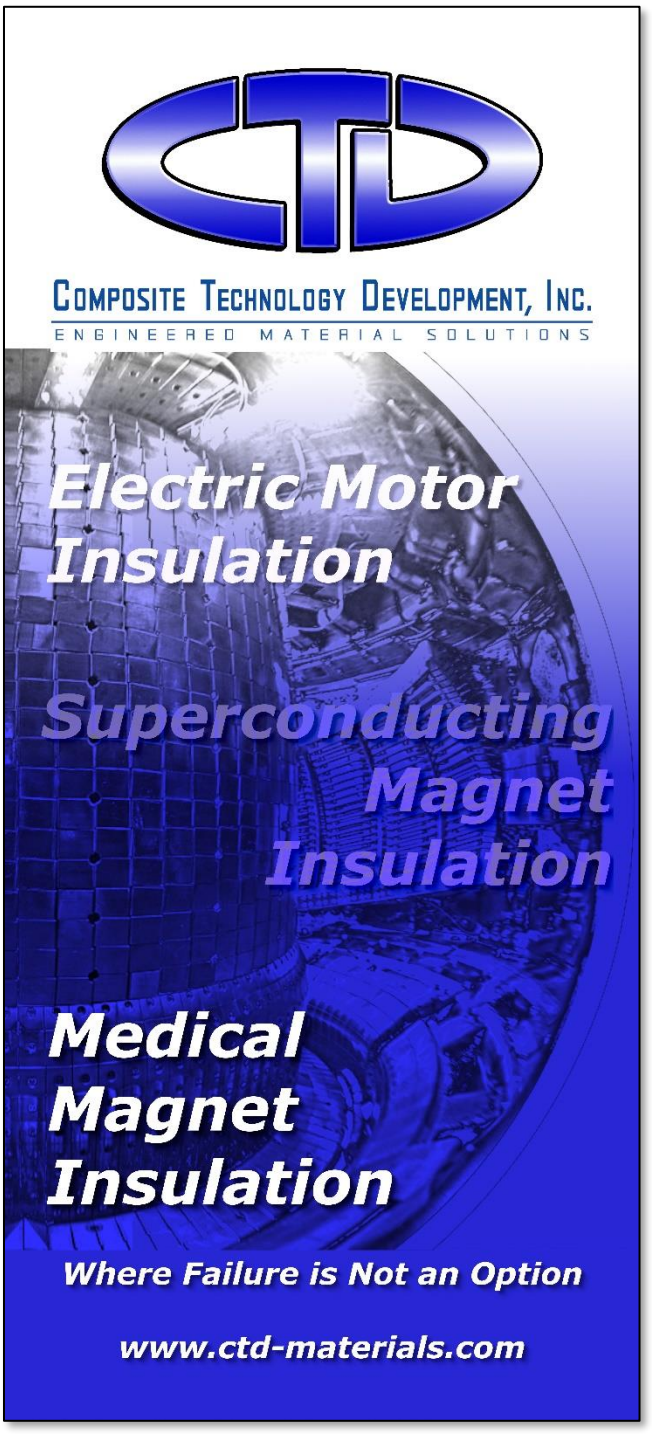

COMPOSITE TECHNOLOGY DEVELOPMENT, INC.
ENGINEERED MATERIAL SOLUTIONS
Electric Motor Insulation
Superconducting Magnet Insulation
Medical Magnet Insulation
Where Failure is Not an Option
www.ctd-materials.com

TEMBO®

Elastic Memory Polymer Resins

TEMBO® elastic memory polymer materials have the ability to regain their original shape after being deformed. The materials utilize fully cured polymers that can be combined with reinforcements and fillers. Products fabricated from these materials can be deformed and reformed repeatedly with the application of heat. Products utilizing elastic memory polymers can be fabricated with the same processes used for other polymer materials.

Polymer materials have a softening temperature called the glass transition temperature. At this temperature a polymer becomes soft and ductile. Below this temperature the polymer is hard and rigid, or glassy. The elastic memory polymer is designed to become very flexible enabling it to be deformed into a different shape, such as folded. If held in this shape during cooling, it retains the new folded shape indefinitely. However, when reheated the product fabricated with the elastic memory polymer reforms to its original shape without external force. Thus, a tubular structure could be collapsed and reformed simply by heating.

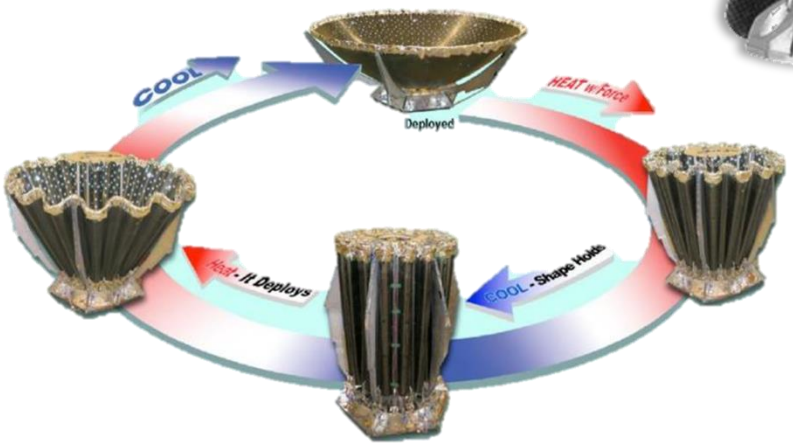
Process compatibility include: SCRIMP, Filament Winding (FW), Resin Transfer Molding (RTM), Resin Injection Molding (RIM), Vacuum Pressure Impregnation (VPI), Prepreg and Casting.

Advantages:

- Excellent wetting of fibers and other surfaces
- Strong adhesion to fibers and fillers
- Non-carcinogenic
- Low toxicity
- Specific gravity < 1.2 g/cc
- Mixing temperatures 25° - 60°C

TEMBO®

Elastic Memory Polymer Resins



LAUNCH VEHICLES, SATELLITES, AIRCRAFT, HINGES		
TEMBO®	CTD-5.1	Elastic memory polymer, Tg: 75°C
	CTD-5.3	Carbon fiber, solvent-less prepreg
	CTD-5.4	Elastic memory polymer
	CTD-5.5	Elastic memory polymer
	CTD-8.8P	Prepreg toughened epoxy (hot-melt type) for filament winding, Tg: 101°C
	CTD-9.1P	High elongation, toughened epoxy towpreg (hot-melt type) for filament winding, Tg: 120°C
	CTD-9.2P	Modified CTD-9.1 for higher Tg
	CTD-1.0KP	High storage modulus, elevated Tg: 127°C
	CTD-2.1SF	High storage modulus, moderate Tg: 119°C
	CTD-PVB	Solid epoxy laminate
	CTD-BG1.3	Cyanate ester-based prepreg, high Tg: 164°C
	CTD-4PRA	Low storage modulus, low Tg (marine applications) – Extremely high strain to failure system

KIBOKO®

Structural Resins

The KIBOKO® family of high-performance, microcrack resistant resins are suitable for filament winding and infusion processes. With unparalleled strain to failure and compatibility with a wide-range of cryogenic fluids, these resins as the only choice for cryogenic structural resin systems for liner-less composite pressure vessels.

At room temperature, the structural resins exhibit low viscosity and long pot-life making them ideal for filament-wound pressure vessels and other composite structures. These systems can be utilized as neat resins or as prepregs to facilitate various manufacturing processes.

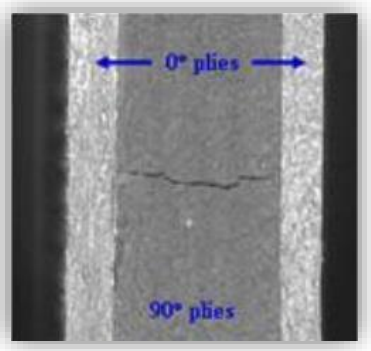
Process compatibility include: Filament Winding (FW), Resin Transfer Molding (RTM), Vacuum Pressure Impregnation (VPI)

Advantages:

- Low Viscosity, 5000 cP at 22° C
- Non-Carcinogenic, Low Toxicity
- 3.5-hour pot life at 22°C
- Processing Temperature 22° – 80° C
- 0.7% transverse strain at LN_2
- Low Coefficient of Thermal Expansion (CTE)

KIBOKO®

Structural Resins



STRUCTURES AND COMPOSITE TANKS		
KIBOKO®	CTD-7.1	Toughened, microcrack resistant epoxy resin for filament winding
	CTD-7.1B	Low viscosity, toughened, microcrack resistant epoxy resin for infusion processing
	CTD-7.1C	Low viscosity, toughened epoxy suitable for use with fillers, compatible for infusion processing
	CTD-7.1D	Low viscosity, toughened epoxy, compatible for infusion processing
	CTD-7.1E	Low viscosity, toughened epoxy, compatible for infusion processing
	CTD-7.1V	Toughened epoxy with dispersed carbon nanofibers for filament winding; for improved mechanical and thermal properties
	CTD-8.8	Towpreg toughened epoxy (hot-melt type) for filament winding
	CTD-9.1	High elongation toughened epoxy towpreg (hot-melt type) for filament winding, Tg: 120°C
	CTD-9.2	Modified CTD-9.1 for higher Tg
	CTD-133	Extremely high strain to failure at cryogenic conditions. Toughened epoxy prepreg or film adhesive; very long out-life at room temperature for processing ease of very large structures and components. Suitable for both filament winding and advance fiber placement

Specialty Materials

Application Specific Materials

Often, an off-the-shelf solution delivers a capability that doesn't quite check all of the boxes for a specific application. As a result, CTD provides materials that deliver a tailored solution based on specific customer needs. These specialty materials range from tackifiers to high temperature wire insulations for down-hole applications. In each configuration, the representative material properties are based on the foundational off-the-shelf resin systems across the CTD portfolio, allowing for increased performance for the application in question.

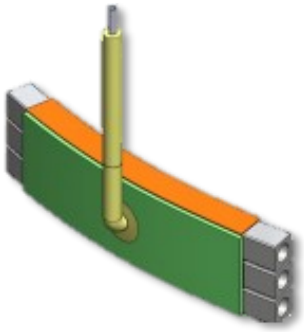
Process compatibility include: Various

Advantages:

- Tailored material properties
- Market and application specific solutions
- Custom material color
- Adjustable setup and cure times

Specialty Materials

Application Specific Materials



SPECIALTY SYSTEMS		
Specialty Resin Systems	CTD-BDR-1.0	Tackifier used to hold fiber preforms prior to infusion with no residual solvent
	CTD-BDR-1.1	Modified CTD-BDR-1.0 with improved green strength
	FC-12	Additive to reduce gel time, decreasing processing time
	CTD-10XN	Epoxy novolac for harsh condition applications; chemical resistance to brines and drilling muds
	CTD-201	Polyimide coating electrical barrier for complex structures
	CTD-220P	Pure Bismaleimide (BMI) system; high temperature applications
	CTD-DX7	Pre-ceramic inorganic silicon polymer system for high temperature composites
	CTD-1357	Thermoplastic insulation for High Temperature Superconductor (HTS) wire
	CTD-1358	High Temperature Superconductor (HTS) wire insulation

COMPOSITE TECHNOLOGY DEVELOPMENT, INC.

ENGINEERED MATERIAL SOLUTIONS

Insulation Product Matrix for Fusion and HEP magnets

Tailored materials for specific conductors and fabrication methods

		Fabrication Method					
		Vacuum Pressure Impregnation	Prepreg	High Pressure Laminate (HPL)	Coated Polyimide Film (Kapton)	Co-processed Ceramic Hybrid	Wet Winding
Conductor Type	Copper / NbTi	CTD-100 Series CTD-400 Series	CTD-100 Series CTD-400 Series	CTD-400 Series	CTD-100 Series		CTD-100 Series CTD-400 Series CTD-500 Series
	Nb_3Sn	CTD-100 Series CTD-400 Series	CTD-100 Series CTD-400 Series	CTD-400 Series	CTD-100 Series	CTD-1000 Series	CTD-500 Series
	HTS	CTD-100 Series CTD-400 Series CTD-500 Series	CTD-100 Series		CTD-100 Series		CTD-500 Series

High radiation resistant replacement for G10 HPL

2600 CAMPUS DRIVE, SUITE D | LAFAYETTE, CO 80026 | PHONE: 303-664-0394 | FAX: 303-664-0392| WWW.CTD-MATERIALS.COM

Composite Technology Development, Inc.

ENGINEERED MATERIAL SOLUTIONS

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Fusion, HEP and Superconducting Magnetics Partners

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