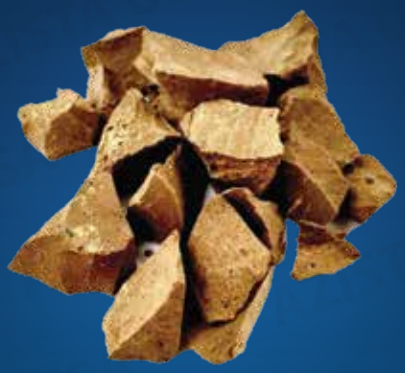
Azista COMPOSITES

PHTHALONITRILE

Phthalonitrile (PN) belongs to a family of high performance thermosetting resins capable of satisfying the stringent requirements of demanding applications.

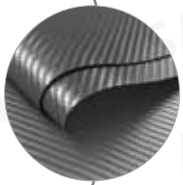
With a glass transition temperature (Tg) of 435°C, phthalonitrile resin unlocks opportunities for applications that were previously unattainable through alternative thermoset resin systems. PN composites exhibit superior high-temperature performance compared to any other thermoset composites employed in aerospace, defence, marine and other high-temperature applications.



435°C Tg

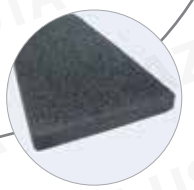
AZKLM0301NX

Single part resin system for vacuum infusion and Resin Transfer Moulding (RTM)



AZKLM0402

Hot melt prepregs & towpregs for advanced manufacturing methods



AZPNF01

Highly porous and rigid core (foam) material for sandwich structures

APPLICATIONS

NEAR ENGINE COMPONENTS

Excellent Thermal Stability

- Phthalonitrile resin systems offer higher working temperatures compared to conventional thermoset resins.
- Mass loss after 6000hrs of aging at 250°C (482°F) : ~2.88%
- ILSS : ~54 MPa (7.8 ksi) at 20°C (68°F)

Simple Manufacturing

- Phthalonitrile resin is available as a single-part system, requiring no additional curing agent and thereby making manufacturing faster and easier.

Applications

- Engine pylon parts, casings and cowls.
- Near engine structures.

KEY PROPERTIES

Test	Standard	Property
Working Temperature	-	350 - 400°C (662 - 752°F)
Tensile Strength	ASTM D3039	510 MPa (73.97 ksi)

NOZZLES

Nozzle Development

- Phthalonitrile based composite divergent section.
- Excellent mechanical properties at working temperatures beyond 300°C (572°F).
- Linerless alternative to the traditional epoxy wound metallic liner-based nozzles.

RADOMES

PN Process and Advantages

- Excellent dielectric properties
- Single part resin system replacing two and three part system with enhanced radio frequency transparency and weight advantage.
- Phthalonitrile resin is injected into quartz socks through vacuum infusion process, resulting in the final product.

High-Performance Missile and Aircraft Radomes

EM PROPERTIES
(Quartz- PN301NX laminate of 2.5mm thick)

Test	Property
Dielectric Constant (Dk) (10 GHz)	3.12
Dielectric Loss (Df)	0.002

AEROSPACE PCBs

High Flexibility and Durability

- The composite/resin system offers high tensile strength.

Thermal Stability

- compatible to work at temperatures >250°C (~482°F).

Chemical Resistance

- Resistant to corrosion and galvanisation.

COMMERCIAL PCB APPLICATIONS

High Performance Computers

- High Tg PN resin for long duration high performance computation requirements.

Automobile Electronics

- Supports high-powered battery systems with efficient thermal control and optimization.

PHTHALONITRILE - AZKLM0301NX

TECHNICAL DATA SHEET

AZKLM0301NX is a high performance and high temperature resin with a high glass transition temperature of 435°C. The resin system is designed to operate in challenging environments required for various aerospace & defence applications. This single-part PN Resin systems is suitable for advanced manufacturing processes such as vacuum infusion and Resin Transfer Moulding (RTM).

Features:

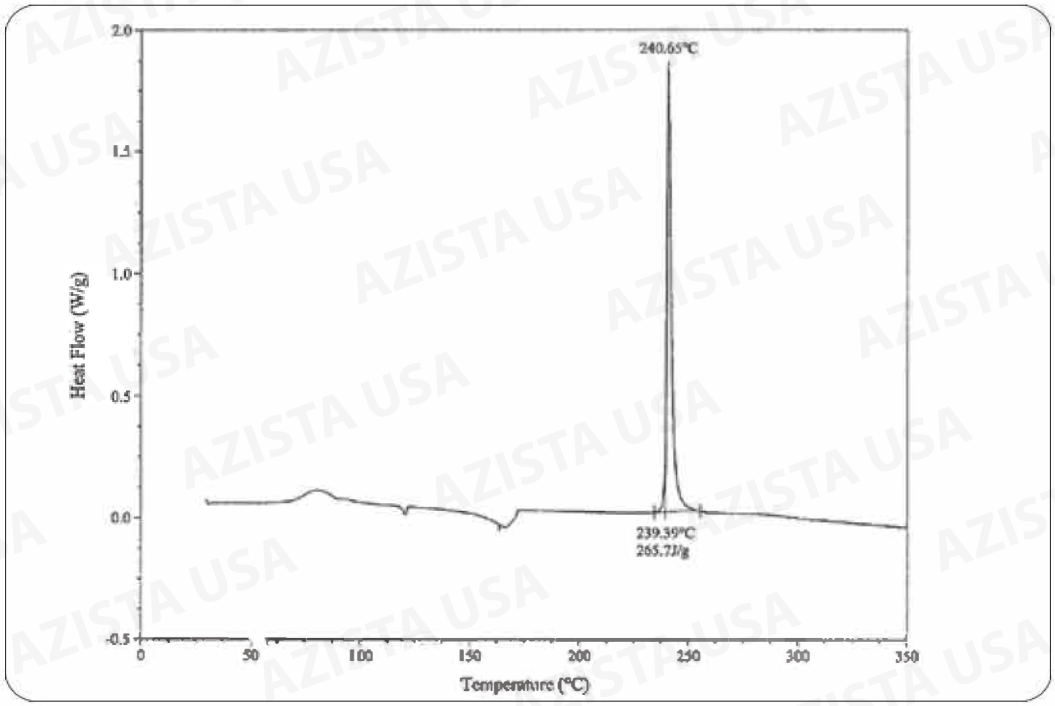
- Enhanced thermal resistance & operational stability
- Excellent mechanical properties at high-temperatures
- Out-of-Autoclave and Autoclave manufacturing
- Single part resin system (no added solvents)

Applications:

- Jet engine components
- Thermal protection systems
- High temperature leading edges and radomes
- Precursor for carbon-carbon composites

NEAT RESIN CHARACTERISTICS	CURED AT 375°C (707°F)
Flexural Strength, 3-Point Bending	120 MPa (17.4 ksi)
Glass Transition Temperature (Tg by DSC)	435°C (815°F)
Char Yield	72% upto 900°C (1652°F) (inert atm)
Moisture Absorption (54 hr at 60°C (140°F) water)	1.27
Density	1.33 g/CC
Melt Viscosity	< 75 cps at 180°C (356°F)
Dielectric Constant (8.2 GHz)	3.5
Dielectric Loss (8.2 GHz)	0.005

DSC (UNCURED)



Uncured resin, Ramp 1°C (1.8°F)/min to 350°C (662°F)

OPTIMISED PROCESS PARAMETERS FOR PHTHALONITRILE COMPOSITES (RESIN TRANSFER MOLDING METHOD)

OPTIMISED CURE CYCLE

Resin to be melted at 180°C (356°F) and infiltrated at this temperature

Initial cure (in mold)

a. 2 hr hold at 180°C (356°F)
b. 6 hr hold at 200°C (392°F)

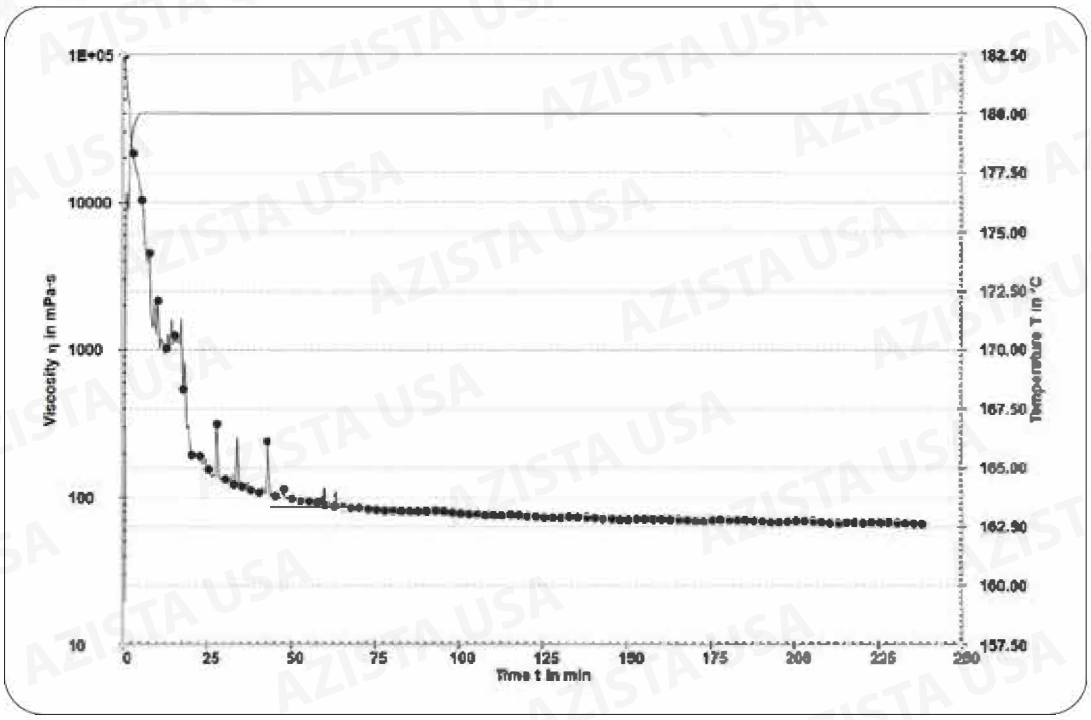
Ramping and Cooling at 1°C/min

External pressure upto 5bar is recommended for RTM process for uniform infiltration

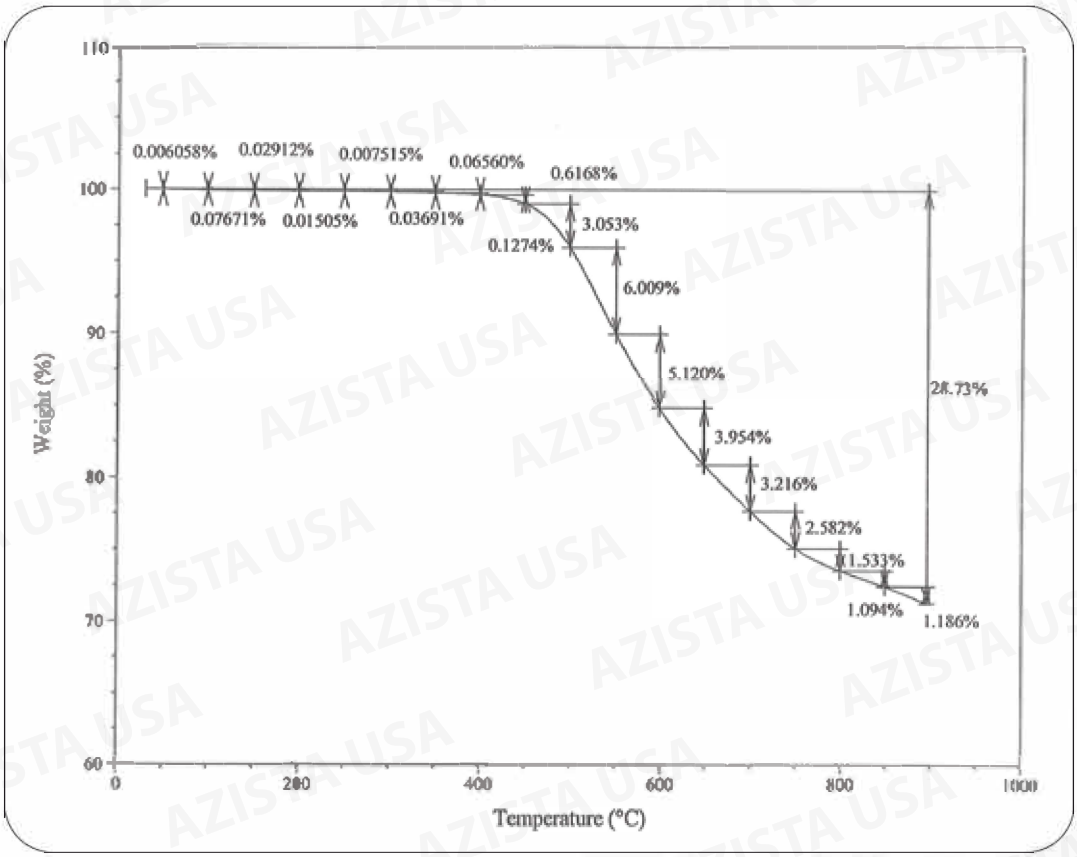
Additional post-cure (out of mold)

a. 2 hr hold at 200°C (392°F)
b. 2 hr hold at 220°C (428°F)
c. 2 hr hold at 250°C (482°F)
d. 2 hr hold at 280°C (536°F)
e. 2 hr hold at 300°C (572°F)
f. 2 hr hold at 320°C (608°F)
g. 6 hr hold at 350°C (662°F)

RHEOLOGY CURVE



THERMOGRAVIMETRIC ANALYSIS (INERT ATM.)



MECHANICAL PROPERTIES OF PHTHALONITRILE MATRIX COMPOSITES

(8H Satin Weave Carbon Fabric, T-300, 380GSM, 3.5Gpa)

Test Charecteristic	Standard	Cured at 375°C (707°F)
Tensile Strength	ASTM D3039	682 Mpa (99 ksi)
Flexural Strength	ASTM D790	706.2 Mpa (102 ksi)
Interlaminar Shear Strength	ASTM D2344	40 Mpa (5.8 ksi)
Interplanar Shear Strength	ASTM D3518	70 Mpa (10.1 ksi)
Compression Strength	ASTM D3410	320 Mpa (46.4 ksi)
Coefficient of Thermal Expansion (RT) (IN-PLANE)		4.36 µm/(m. °C)
Transverse Thermal Conductivity (RT)		1.070 $W.m^{-1}.K^{-1}$

MECHANICAL PROPERTIES OF PHTHALONITRILE MATRIX COMPOSITES

(8H Satin Weave E-glass Fabric 7781, 300GSM)

Test Charecteristic	Standard	Cured at 375°C (707°F)
Interlaminar Shear Strength	ASTM D2344	53 Mpa (7.7 ksi)
Dielectric Constant (8.2 GHz)		4.67
Dielectric Loss (8.2 GHz)		0.042

AGED MECHANICAL PROPERTIES OF PHTHALONITRILE MATRIX COMPOSITES

(8H Satin Weave Carbon Fabric, T-300, 380GSM, 3.5Gpa)

SAMPLE/PROPERTY	TENSILE STRENGTH			FLEXURAL STRENGTH		
	RTAS	100 HRS AGING AT 300°C (572°F)	RETENTION AFTER AGING	RTAS	100 HRS AGING AT 300°C (572°F)	RETENTION AFTER AGING
2D GLASS FABRIC LAMINATE	410 (59.5) MPa (ksi)	350 (50.8) MPa (ksi) (RT)	85%	520 (75.4) MPa (ksi)	442 (64.1) MPa (ksi) (RT)	85%
2D CARBON FABRIC (STD. MOD.) LAMINATE	682 (99) MPa (ksi)	541 (78.4) MPa (ksi) (RT)	79%	706.2 (102.4) MPa (ksi)	522 (75.7) MPa (ksi) (RT)	74%

Drop Weight Impact Test

PEAK FORCE (N)	PUNCTURE FORCE (N)	PEAK ENERGY (J)	TOTAL ENERGY (J)	PUNCTURE ENERGY (J)
11,599.134	5,782.936	17.637	19.872	21.073

EROSION TEST

SET HEAT FLUX = 300 W/CM2 (APPROX.)

S.No	Sample Name/Sample Code	Weight Before Test (g)	Weight After Test (g)	Weight After char removal (g)	Final Weight Reduction (g)	Thickness Before Test (mm)	Thickness After Test (mm)	Thickness After Char removal (mm)	Change in thickness (mm)	Erosion Rate (mm/ sec)
1	Phthalonritile/ PAN CARBON 01	44.7	36.5	36.5	8.2	3	1.5	1.4	1.6	0.0088
2	Phthalonritile/ PAN CARBON 02	44.3	36.6	36.6	7.8	2.9	1.5	1.4	1.6	0.0083

Test Charecteristic	Standard	Cured at 375°C (707°F)
Limiting Oxygen Index	ASTM D2863	>70%
Flamability Test	ASTM D635	Flame does not reach 25mm reference mark

Insulation Index Table

Temperature,°C (°F)	Time Instant, s		Insulation Index (sec/ mm)	
	Sample 1	Sample 2	Sample 1	Sample 2
180 (356)	6.8	9.5	2.267	3.275
360 (680)	18.3	20.9	3.10	7.206
540 (1004)	24.8	26.9	8.267	9.275

PHTHALONITRILE FOAM – AZPNF01

TECHNICAL DATA SHEET

AZPNF01 is a highly porous rigid core material developed using Azista's proprietary phthalonitrile resin, with its impressive glass transition temperature and insulation properties, PN foam proves to be ideal for high temperature and high-performance sandwich structures. It can be fabricated economically in large and complex forms.

Features:

- Low density
- Stable at elevated temperatures
- Machinable
- High strength to weight ratio

Applications:

- Core materials for sandwitch stuctures
- Thermal protection systems - Ablative layer
- Near engine - Load bearing sandwich panels

PROPERTIES	VALUE
Working Temperature	≥ 300°C
Low Density	0.25 g/cc
Density can be varied from	0.25 to 0.3 g/cc
High Glass Transition Temperature	435°C
Compressive Strength	~ 5 MPa

PHTHALONITRILE PREPREG – AZKLM0402

TECHNICAL DATA SHEET

AZKLM0402 is a high performance and high temperature prepreg suitable for mass manufacturing of high temperature structures for aerospace and defence industry. The prepreg is highly customizable as per the engineering needs of the customers. The process friendly PN prepreg is highly versatile and can be processed efficiently using various methods such as autoclave, vacuum bagging and compression moulding.

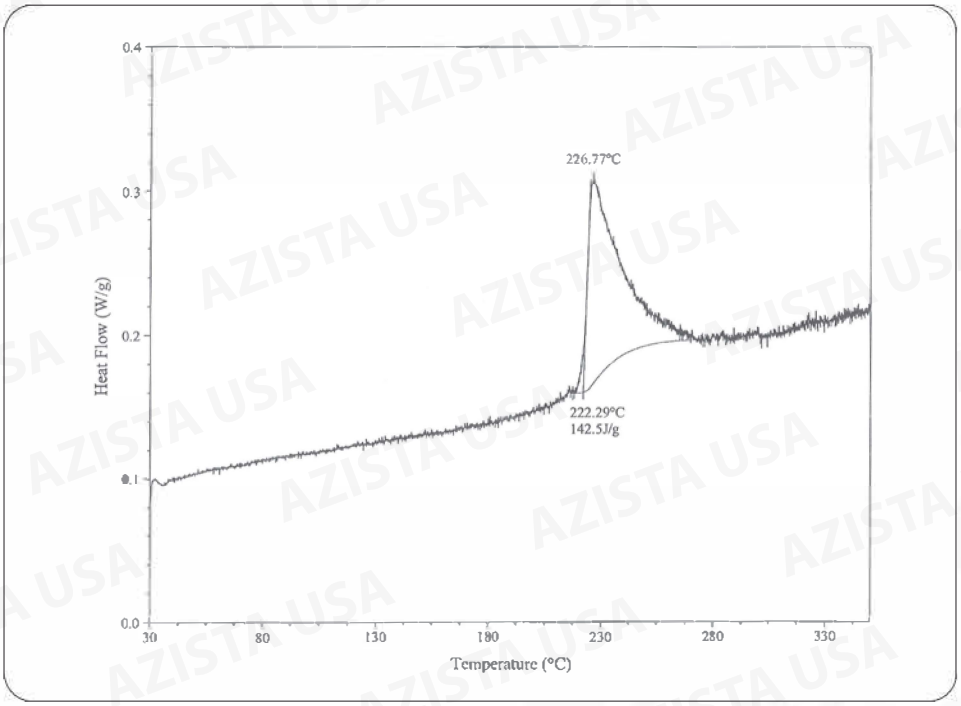
Features:

- Solvent free, hot melt prepregs
- Ease of processing
- Enhanced thermal resistance
- Operational stability at elevated temperatures
- Medium tack and drape characteristics

Applications:

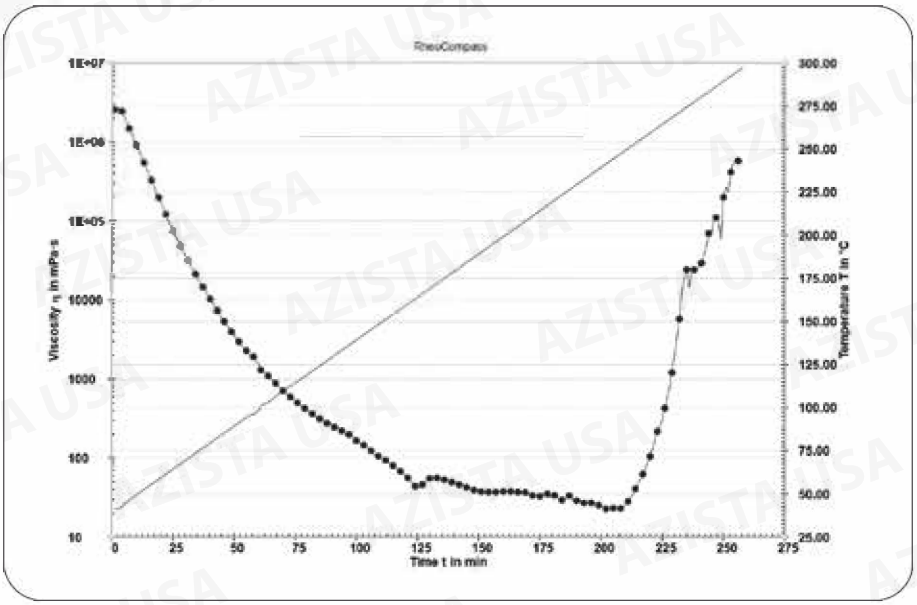
- Near engine components
- Thermal protection systems
- High temperature leading edges
- Maritime structures

DSC (UNCURED)



Uncured resin, Ramp 1°C (1.8°F)/min to 350°C (662°F)

RHEOLOGY CURVE



Mechanical Properties

(C-Epoxy Laminate - T-300, 3K 8H Satin Weave Carbon BD Fabric) [Hand-layup]

Properties	Units	Values	Test Method
Tensile Strength	MPa	647	ASTM D3039
Flexural Strength	MPa	911	ASTM D790
ILSS	MPa	56	ASTM D2344

OPTIMISED PROCESS PARAMETERS FOR PHTHALONITRILE COMPOSITES (VACUUM BAGGING WITH NON-POROUS PEEL PLY)

OPTIMISED CURE CYCLE

Initial cure (in Vacuum bag)

- 1 hr hold at 100°C (212°F), ramp rate 3°C/min
- 4 hr hold at 200°C (392°F), ramp rate 1°C/min

Additional post-cure (Free stand)

- 1 hr hold at 200°C (392°F), ramp rate 3°C/min
- 2 hr hold at 250°C (482°F), ramp rate 1°C/min
- 4 hr hold at 300°C (572°F), ramp rate 1°C/min

Ramping and Cooling at 1°C/min

» Storage condition: Recommended to store at -18°C.

» Out life: up to 45 days at 22°C.

» Shelf life: 12 months at -18°C.

Azista
COMPOSITES

AZISTA COMPOSITES PRIVATE LIMITED

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