



# TECHNICAL DATA SHEET (TDS)

## F2 FABRIC BAKELITE

### PRODUCT IDENTIFICATION

- **Product Name:** F2 Fabric Bakelite
- **Material Type:** Phenolic Resin with Fabric Reinforcement
- **Details:**
  - **Company:** MISCO Australia
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- **TDS Number:** MISCO – TDS - 003
- **TDS Date:** 01/12/2024
- TDS Version: 1

### PRODUCT DESCRIPTION

F2 Fabric Bakelite is a versatile, high-performance thermosetting composite material made from a phenolic resin matrix reinforced with woven fabric layers. It provides excellent mechanical strength, electrical insulation, and thermal stability. This material is ideal for applications requiring durable structural support, reliable electrical insulation, and resistance to heat and chemicals. Its balanced mechanical and electrical properties make it a preferred choice for demanding industrial and electrical environments.

## NEMA GRADE

### NEMA Grade: F2

This grade is suitable for general electrical insulation applications, offering reliable mechanical strength and electrical resistance.

### Thermal Class: Class B (130°C)

F2 Fabric Bakelite is typically rated to **Class B** thermal performance, suitable for continuous operation at temperatures up to **130°C**. The material maintains its mechanical and electrical integrity under sustained thermal loads and is capable of withstanding **short-term exposures up to approximately 160°C**, depending on application specifics.

*Thermal classification is based on typical phenolic composite behaviour under IEC 60085 and comparable thermal endurance standards.*

## MILITARY SPECIFICATIONS AND TYPE

F2 Fabric Bakelite conforms to several military specifications, including:

- **MIL-I-24768/16 Type FBM** (Phenolic laminate with fabric reinforcement)
- **MIL-PRF-13949** (Electrical insulating materials)

Note: MIL-PRF-13949 applies generally to electrical insulation and is not intended for printed wiring board (PWB) applications.

**Please verify current MIL spec versions as they are subject to updates.**

## KEY PROPERTIES

- **High Electrical Insulation:** Provides excellent dielectric strength for switchboards, electrical panels, and similar equipment.
- **Good Mechanical Strength:** Fabric reinforcement enhances dimensional stability and impact resistance.

- **Thermal Stability:** Continuous use up to 120–130°C; short-term exposure up to 150°C recommended to avoid degradation.
- **Chemical Resistance:** Resists oils, solvents, and many chemicals typically encountered in industrial environments.
- **Dimensional Stability:** Phenolic resin base limits thermal expansion and contraction.
- **Cost-Effective:** Combines performance with affordability for industrial applications.
- **High Mechanical and Impact Strength**  
Engineered for heavy-duty use, F2 Fabric Bakelite combines woven cotton reinforcement with phenolic resin to deliver exceptional strength, toughness, and fatigue resistance under load and vibration.
- **Excellent Dimensional Stability Under Load**  
Maintains precise tolerances and structural integrity even under compressive or dynamic stress, making it suitable for mechanical bearings, spacers, and load-bearing insulation parts.
- **Reliable Electrical Insulation (Dry Conditions)**  
Provides strong dielectric strength and insulation resistance for switchgear, transformers, and industrial electrical applications where mechanical and electrical properties must coexist.
- **Superior Machinability and Threading Capability**  
Cuts cleanly with standard or CNC tooling. Allows accurate drilling, turning, and threading without delamination, chipping, or tool wear typical of glass-reinforced materials.
- **Low Moisture Absorption and Thermal Expansion**  
Retains dimensional accuracy and performance in humid or thermally fluctuating environments, ensuring long-term stability in electrical and mechanical assemblies.
- **High Resistance to Oils, Greases, Solvents, and Coolants**  
Designed for industrial use where contact with lubricants and cutting fluids is common—maintains integrity without softening, swelling, or degradation.
- **Noise-Dampening and Non-Sparking**  
Naturally absorbs vibration and prevents sparking, reducing noise and improving safety in electrical machinery, automotive, and defence-related equipment.

- **Excellent Wear and Friction Resistance**  
Offers smooth bearing surfaces with low friction coefficients, ideal for gears, bushes, and mechanical linkages subject to repeated motion.
- **Thermal and Dimensional Reliability**  
Performs consistently across a wide service temperature range up to approximately 130 °C, maintaining mechanical and electrical performance under continuous operation.
- **Precision Machining Compatibility**  
Supports tight tolerances and repeatable accuracy for critical industrial parts—perfect for components requiring fine threads, smooth finishes, or press-fit assemblies.
- **Asbestos-Free and Environmentally Compliant**  
Manufactured in accordance with RoHS 3 and REACH regulations. Contains no halogens or hazardous fibres and meets current industry and defence environmental standards.
- **Long Service Life and Proven Reliability**  
Offers outstanding durability and low maintenance in both mechanical and electrical systems, reducing downtime and lifecycle costs.

## APPLICATIONS

F2 Fabric Bakelite is used across diverse industries, including:

- **Transformers & Electric Motors** – slot wedges, coil supports, terminal plates, spacers, and insulation barriers requiring both electrical resistance and high mechanical strength.
- **Switchboards & Control Equipment** – insulating panels, arc barriers, standoff plates, and support components in low- and medium-voltage assemblies.
- **Mechanical Engineering Components** – bushes, bearings, gears, and structural parts where wear resistance, toughness, and low friction are essential.
- **Machined Precision Parts** – jigs, fixtures, mounting plates, and machined hardware requiring accurate tolerances and dimensional stability.
- **Industrial Tooling & Workshop Fixtures** – used for non-sparking clamps, guides, and insulating tooling where strength and safety are priorities.

- **Automotive & Rail Equipment** – brackets, mounts, and electrical isolation parts exposed to vibration, oil, and heat.
- **Power Generation & Renewable Energy Systems** – generator spacers, turbine insulation supports, and structural insulating components.
- **Aerospace & Defence Applications** – non-sparking, vibration-resistant insulating parts for equipment exposed to demanding service environments.
- **Oil, Gas & Mining Equipment** – used for insulating mechanical supports, protective housings, and heavy-duty electrical barriers.
- **General Industrial Machinery** – spacers, bearing plates, and mechanical insulators combining strength, wear resistance, and electrical safety.

## SPECIFICATIONS

Property	Details
<b>Product Form</b>	Sheets, Rods, Machined Parts
<b>Standard Colour</b>	Brown
<b>Sheet Sizes</b>	1220 × 1220 mm / 1220 × 2440 mm (custom sizes on request)
<b>Rod Diameters</b>	10 mm – 100 mm (others available on request)
<b>Tube Dimensions</b>	Standard and custom inner/outer diameters available
<b>Thickness Range (Sheets)</b>	1.6 mm – 50 mm
<b>Manufactured To</b>	NEMA LI-1 Grade F2 / IEC 60893 PFCC 203 / MIL-I-24768/18 (PF CC)
<b>Flame Rating</b>	UL 94 HB
<b>Compliance</b>	RoHS 3 and REACH Compliant / Halogen-Free / Asbestos-Free
<b>Finish</b>	Satin-machined surface, uniform resin-rich texture
<b>Thermal Class</b>	Class B (130 °C Continuous Service Temperature)

## TOLERANCES ON SHEET THICKNESS

Nominal Thickness (mm)	Permissible Tolerance ( $\pm$ mm)
1.6 – 3.0	0.20
3.1 – 6.0	0.25
6.1 – 10.0	0.30
10.1 – 20.0	0.40
20.1 – 30.0	0.50
30.1 – 50.0	0.70

### Notes:

- Tolerances apply to standard press-cured sheets before machining.
- Closer tolerances can be supplied upon request.
- Sheets are inspected to ensure compliance with NEMA LI-1 F2 dimensional standards.

## MECHANICAL PROPERTIES

Property	Unit	Typical Value
Density	g/cm <sup>3</sup>	1.35 – 1.45
Flexural Strength	MPa	120 – 150
Compressive Strength	MPa	250 – 300
Tensile Strength	MPa	90 – 110
Shear Strength	MPa	100 – 120
Impact Strength (Charpy)	kJ/m <sup>2</sup>	10 – 14

<b>Modulus of Elasticity</b>	GPa	8 – 10
<b>Hardness (Rockwell M)</b>	—	100 – 110
<b>Coefficient of Friction (Dry)</b>	—	0.25 – 0.30
<b>Poisson's Ratio</b>	—	0.32 – 0.35

**Notes:**

- Tested on standard samples conditioned at 23 °C / 50 % RH.
- Values are typical and not intended for specification limits.
- Mechanical performance may vary slightly with fabric weave and resin content.

**ELECTRICAL PROPERTIES**

<b>Property</b>	<b>Unit</b>	<b>Typical Value</b>
<b>Electrical Breakdown Voltage (Perpendicular to Laminate)</b>	kV/mm	4 – 6
<b>Insulation Resistance (Dry)</b>	$\Omega$	$\geq 1 \times 10^{11}$
<b>Insulation Resistance (Wet)</b>	$\Omega$	$\geq 1 \times 10^9$
<b>Dielectric Constant (at 50 Hz)</b>	—	5.0 – 6.0
<b>Dissipation Factor (at 50 Hz)</b>	—	$\leq 0.05$
<b>Surface Resistivity</b>	$\Omega$	$\geq 1 \times 10^{11}$
<b>Volume Resistivity</b>	$\Omega \cdot \text{cm}$	$\geq 1 \times 10^{12}$
<b>Arc Resistance</b>	sec	100 – 120
<b>Comparative Tracking Index (CTI)</b>	V	$\geq 200$

**Notes:**

- Electrical values measured under controlled laboratory conditions (23 °C / 50 % RH).
- Electrical strength decreases with moisture absorption; F2 is intended primarily for **dry electrical service**.
- Performance meets NEMA LI-1 F2 and IEC 60893 PFCC 203 insulation classifications.

**THERMAL PROPERTIES**

Property	Unit	Typical Value
<b>Maximum Continuous Operating Temperature</b>	°C	120 – 130
<b>Short-Term Temperature Limit</b>	°C	150
<b>Thermal Conductivity</b>	W/m·K	0.25 – 0.30
<b>Coefficient of Thermal Expansion</b>	1/K × 10 <sup>-5</sup>	2.5 – 3.0
<b>Specific Heat Capacity</b>	kJ/kg·K	1.1 – 1.3
<b>Thermal Class (IEC 60085)</b>	—	Class B (130 °C)
<b>Heat Deflection Temperature (1.8 MPa)</b>	°C	150 – 160
<b>Flammability Rating (UL 94)</b>	—	HB

**Notes:**

- F2 Fabric Bakelite retains mechanical integrity and electrical insulation up to approximately 130 °C in continuous service.
- Short-term exposure to higher temperatures is permissible without loss of structural strength.
- Suitable for thermal and electrical insulation in machinery, switchgear, and transformer assemblies.

## CHEMICAL RESISTANCE

F2 Fabric Bakelite offers good resistance to many industrial chemicals, especially in dry environments. It is particularly resistant to:

Chemical Group	Resistance Level	Remarks
<b>Oils and Greases</b>	Excellent	Unaffected by lubricating and transformer oils; ideal for mechanical and electrical service.
<b>Petroleum Products</b>	Excellent	High resistance to diesel, kerosene, and mineral oils.
<b>Coolants and Cutting Fluids</b>	Excellent	Maintains stability under typical workshop fluids.
<b>Alcohols</b>	Good	Slight surface swelling may occur after prolonged exposure.
<b>Aliphatic Solvents</b>	Good	Resistant to most hydrocarbon solvents under ambient conditions.
<b>Aromatic Solvents</b>	Moderate	Extended exposure may cause softening or surface dulling.
<b>Acids (Dilute)</b>	Fair	Resistant to weak organic and inorganic acids; not suitable for strong acids.
<b>Alkalis (Dilute)</b>	Fair	Moderate resistance; prolonged exposure not recommended.
<b>Water / Moisture</b>	Good	Low water absorption; properties remain stable in dry conditions.
<b>Oxidising Agents</b>	Poor	Not suitable for concentrated oxidisers or aggressive chemical environments.

## Notes:

- F2 Fabric Bakelite performs best in **dry or lightly lubricated environments**.
- Avoid long-term immersion in strong acids, alkalis, or aromatic hydrocarbons.
- Ideal for electrical and mechanical assemblies exposed to oils, lubricants, and intermittent moisture.

## SHEET HANDLING BEFORE MACHINING

Proper storage and conditioning are critical:

- Store flat in dry, ventilated, shaded area.
- Avoid stacking heavy items to prevent warping.
- Acclimatise sheets to workshop environment 24 hours before machining.
- Dry moisture-absorbed sheets at 50–60°C if needed.
- Inspect sheets for damage and clean surfaces prior to machining.
- Handle with clean gloves or cloth to avoid contamination.

## Processing & Machining Considerations

- **Machining Characteristics**

F2 Fabric Bakelite machines cleanly using conventional or CNC equipment. Its cotton fabric reinforcement minimises tool wear and allows smooth, chip-free cutting with standard carbide or HSS tooling.

- **Cutting and Drilling**

Use sharp tools with moderate cutting speeds and light feed rates to avoid overheating. Tungsten carbide or polycrystalline diamond (PCD) cutters are recommended for high-volume or precision work.

- **Turning and Milling**

Maintain consistent clamping pressure to prevent vibration. Light finishing passes provide optimal surface finish and dimensional accuracy.

- **Sawing**

Employ fine-tooth carbide blades with controlled feed. Coolant use is optional but can improve tool life and reduce dust.

- **Threading and Tapping**

Material supports clean internal and external threads. Use sharp taps and consider thread-forming lubricants for smoother engagement.

- **Dust Extraction**

Always use an efficient dust collection system during machining. Phenolic dust should not be inhaled and must be safely contained.

- **Storage Before Machining**

Sheets and rods should be stored flat in a **dry, temperature-controlled environment ( $\leq 60\% \text{ RH}$ )** to maintain dimensional stability.

- **Finishing**

Surfaces may be machined to fine tolerances or polished for aesthetic or functional purposes. Edges can be chamfered or radiused without risk of delamination.

## ENVIRONMENTAL COMPLIANCE

F2 Fabric Bakelite complies with key environmental standards:

- **RoHS 3 Compliant (Directive 2015/863/EU)** – free from restricted substances including lead, cadmium, mercury, and hexavalent chromium.
- **REACH Compliant (EC 1907/2006)** – contains no Substances of Very High Concern (SVHC).
- **Halogen-Free** – no chlorine, bromine, or other halogenated additives.
- **Asbestos-Free** – manufactured without any fibrous asbestos reinforcement.

- **Low-Emission Composite** – phenolic resin system emits minimal volatile compounds during processing.
- **Recyclable and Non-Toxic Waste** – machining waste may be disposed of as non-hazardous industrial material in accordance with local regulations.
- **ISO & Defence Alignment** – conforms to ISO 9001 and ISO 14001 manufacturing principles, supporting Australian Defence environmental expectations.
- **Sustainable Manufacturing** – produced using controlled press-curing systems that minimise resin waste and optimise energy efficiency.

### Summary:

F2 Fabric Bakelite meets modern environmental and workplace safety standards. It is suitable for use in environmentally controlled facilities, government and defence applications, and industries with strict compliance requirements.

## SUSTAINABILITY AND ENVIRONMENTAL IMPACT

- **Resource Efficiency**  
Manufactured through precision press-curing processes that optimise resin utilisation and minimise raw-material waste. Off-cuts and machining residues are recyclable as non-hazardous industrial by-products.
- **Energy Management**  
Production facilities operate with energy-efficient curing systems and controlled heating cycles designed to reduce power consumption per unit produced.
- **Emissions Control**  
The phenolic resin system generates minimal volatile organic compound (VOC) emissions during manufacture and machining, contributing to cleaner workplace air quality.
- **Waste Management**  
Phenolic composites such as F2 Fabric Bakelite are inert and classified as non-toxic.

Waste material can be safely disposed of in accordance with standard industrial waste regulations without special treatment.

- **Longevity and Lifecycle Performance**

The extended service life and mechanical durability of F2 reduce replacement frequency and environmental impact over the product's lifetime.

- **Packaging and Transport**

Supplied in recyclable or reusable protective packaging to reduce landfill waste and improve material recovery within the supply chain.

- **Corporate Responsibility**

MISCO Australia maintains environmentally responsible manufacturing and supply practices aligned with **ISO 14001 Environmental Management** principles and Australian Defence environmental expectations.

### **Summary:**

F2 Fabric Bakelite offers long-term material sustainability through energy-efficient production, durability in service, and minimal environmental footprint — supporting MISCO Australia's ongoing commitment to responsible manufacturing and defence-aligned sustainability standards.

**MISCO Australia promotes responsible handling and disposal to reduce environmental impact.**

### **SAFETY INFORMATION**

- **General Handling**

F2 Fabric Bakelite is a cured, stable thermoset material and is **non-toxic** under normal handling conditions. It does not emit harmful vapours or particles unless mechanically processed.

- **Machining and Fabrication**

When cutting, drilling, routing, or sanding, **fine phenolic dust** may be produced.

Dust should be extracted at the source using local exhaust ventilation or an enclosed CNC system.

- **Personal Protective Equipment (PPE)**

- Safety glasses or face shield to protect against airborne dust.
- P2 or N95 respirator during machining or sanding.
- Cut-resistant gloves to prevent abrasions from sharp edges.
- Hearing protection in high-noise machining environments.

- **Health Effects**

- **Inhalation:** Dust may cause mild respiratory irritation. Avoid prolonged exposure.
- **Skin Contact:** Prolonged handling may cause slight dryness or irritation. Wash with soap and water after contact.
- **Eye Contact:** Dust may cause mechanical irritation. Flush thoroughly with clean water.
- **Ingestion:** Not expected to occur under normal industrial use.

- **Fire & Thermal Decomposition**

F2 is classified **UL 94 HB** and will char rather than melt. When overheated above 250 °C, decomposition can release trace formaldehyde or phenolic vapours. Use adequate ventilation and avoid direct flame contact.

- **Storage & Handling Precautions**

- Store flat in a **dry, covered, and temperature-controlled** environment (15–30 °C, ≤60 % RH).
- Avoid stacking heavy loads on thin sheets to prevent warping.
- Keep away from direct sunlight, moisture, and open flame.

- **Spillage & Disposal**

- Machining waste is non-hazardous and may be disposed of as **general industrial waste** in compliance with local environmental regulations.
- Avoid discharging dust into drains or open water.

**Summary:**

When properly handled and machined under controlled conditions, F2 Fabric Bakelite presents **no significant health or environmental hazard**. Observing standard industrial safety practices ensures safe, compliant use in all manufacturing environments.

**Refer to Safety Data Sheet (SDS) for full details before handling.**

**WARRANTY**

MISCO Australia guarantees that F2 Fabric Bakelite products are free from defects in material and workmanship at the time of delivery for a period of 12 months from shipment. This warranty is valid only when products are stored, handled, and processed according to MISCO Australia's guidelines and used within recommended specifications. Liability is limited to replacement or refund of defective materials and does not cover damage from improper use, machining, or exposure to unsuitable conditions. No other warranties, express or implied, are provided.

**DISCLAIMER**

*The information provided in this data sheet is intended as a general guide for the use and handling of material. It is based on current knowledge, testing, and is believed to be accurate and reliable as of the date of publication. However, **MISCO Australia** makes no warranties, express or implied, regarding the material's performance, suitability, or fitness for any specific application.*

*Users are responsible for determining the material's suitability for their intended purpose, including conducting independent tests and evaluations as necessary. MISCO Australia does not accept any liability for any loss, damage, or injury resulting from the use of this information, the products described, or reliance on the provided recommendations.*

*Specifications are subject to change without notice as part of MISCO Australia's ongoing product improvement initiatives.*

*Always refer to the latest version of this data sheet before proceeding with critical applications.*

*All sales are subject to MISCO Australia's standard terms and conditions of sale.*

Revision	Date Issued	Prepared / Reviewed By	Description of Change	Approved By
1.0	January 2025	MISCO Australia	Initial release of Safety Data Sheet for F2 Fabric Bakelite	Director, MISCO Australia

Document Control:

- **Document Title:** F2 Fabric Bakelite
- **Document ID:** MISCO – TDS - 003
- **Revision:** 1.0
- **Review Cycle:** 24 months or upon regulatory update (whichever occurs first)

**End of Technical Data Sheet.**