

*Materials designed for the most demanding LNG environments*



# A history of leadership behind today's thermoset composite materials

Through each step in our evolution, we have led the development of new and advanced materials for industry and consumer goods. Norplex-Micarta consistently develops and supplies quality materials to OEMs and fabricators for some of the most demanding applications around the world.



**1909:** The thermoset composite industry is born when Leo Baekeland obtains a patent for the production of phenol.

**MICARTA**



Bakelite® is popular with consumers for radios, phones and more.

**1945:** The Northern Plastics Corp. that becomes Norplex is formed in Wisconsin USA.

**NORPLEX**



This era brings power generation, electronics, heavy industry manufacturing, automotive and aerospace innovation.

**1965-75:** Northern Plastics becomes Norplex and is acquired by Universal Oil Products Company, later called UOP.

**NORPLEX MICARTA**



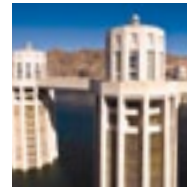
**2013:** Norplex-Micarta opens plant in China.

**1900 | 1910 | 1920 | 1930 | 1940 | 1950 | 1960 | 1970 | 1980 | 1990 | 2000 | 2010 | TODAY**

**1909:** Using Leo Baekeland's phenolic resin, George Westinghouse invents Micarta for electrical insulation.



**Westinghouse**

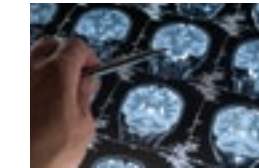


**1936:** The largest generators at Hoover Dam produce 130 megawatts. Micarta provides electrical insulation and structural stability.



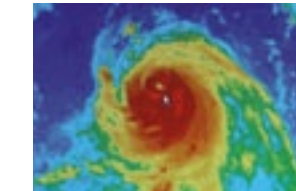
**1955:** The Micarta division of Westinghouse Electric is relocated to South Carolina USA to produce sheets, rolled tubes, molded shapes and other specialty materials.

**1965:** Composite plastics are used to provide insulation and structural stability in electronic assemblies and small motors.



**1990s:** An era of medical breakthroughs: Non-conductive, light, non-magnetic, sterilization-ready components offer quiet operation and low attenuation.

**2008:** Delicate sensors released into the eyes of hurricanes are protected by a rugged Norplex-Micarta casing.



Norplex-Micarta continues to develop specialized thermoset materials for the next generation of applications.



**Oil & Gas**  
Designed for extreme environments



**Electrical Devices**  
Precise properties for advanced tech



**Power Generation**  
Reliability and performance



**Transportation**  
Durable solutions on the move



**Medical Equipment**  
Supporting innovation



**Aerospace**  
Proven in deep space



**Military**  
Critical ballistic protection



**Heavy Industrial**  
Tough, versatile, easy to machine

## Materials that define performance

### Specialty composites are ready for the most challenging assignments

Each individual thermoset composite from Norplex-Micarta is designed to solve a specific set of challenges. Composites can be engineered to provide structural reliability under a wide variety of conditions. They protect product, plant and equipment by minimizing heat transfer, vibration, thermal expansion, abrasion and corrosion.

### Designed and produced for specific applications

Norplex-Micarta thermoset composites are made by combining a resin matrix with a reinforcing substrate. Each combination is chosen for its ability to deliver controlled and repeatable performance to match the application's requirements. After the matrix and substrate are combined, a high-temperature curing operation creates a cross-linked molecular structure, which produces a material that does not melt.

Pioneered by Norplex-Micarta, this process distinguishes our composites. Unique processing techniques can be used to combine any of several resins with multiple substrates to produce materials with innate properties that are superior to those of its individual components.

### New solutions are always in development

Because industry demand for increasingly specialized materials continues to grow, significant development of new Norplex-Micarta composites is continually underway, providing custom solutions for customers with specific needs.

We work directly with customers to solve complex problems. Our engineers design customized materials and provide testing services to support the development of application-specific solutions.



## Innovative thinking, backed by optimized production

Composite materials are designed and produced to yield specific properties

- Thermal insulation
- Electrical insulation or conductivity
- Chemical resistance
- Dimensional stability
- Structural strength
- Resistance to arcing and combustion

## Highly capable materials for LNG applications

### Unparalleled quality

Norplex-Micarta produces a full line of high-performance composites for energy production, refining, transport and storage, including specialty materials for cryogenic applications.

### The material of choice for cryogenic environments

NP500CR is preferred when the needs for superior thermal insulation and structural support converge with cryogenic temperatures. Because of its low moisture absorption, NP500CR performs at specific temperatures, and also when repeatedly cycling between low and high temperatures—properties not available with densified wood products, foam, thermoplastic or other alternatives.

NP500CR is widely used in the LNG industry for pipe and storage applications (both stationary and over-the-road tanks) as well as insulator blocks for ladders, walkways and scaffolding where dangerous icing can occur. Furthermore, this material is used in engine rooms of LNG-powered ships.

### Electrical insulation, gaskets, bearing and non-sparking materials

Norplex-Micarta manufactures a series of products designed to be electrical insulators. These combine high-strength mechanical properties with superior electrical characteristics, even in high humidity and corrosive environments. Some materials have a unique ability to resist arc tracking. When exposed to an arc, the non-conductive surface prevents an arc path from forming, making them useful for fuse tubes and arc barriers.

Several of these same electrical insulation materials, when clad with metals and other materials, are used in gaskets. Because of their inherent strength and stability, they prevent galvanic corrosion while tolerating the repeated loading and unloading common in pipeline applications.

Norplex-Micarta also makes a range of products used as bearings. These materials have long been accepted in the marine industry because they withstand corrosion and handle heavy rotational loads of large ship propellers. Finally, Norplex-Micarta materials can be engineered to be non-sparking, making them an option in sensitive and explosion-proof environments.



### The exclusive source

#### Micarta G-10CR

(Westinghouse/International Paper Cryogenic Grade 56 G12) materials are made only by Norplex-Micarta. This grade has been relabeled as NP500CR.



*Pipe shoe photo courtesy of Piping Technology and Products, Inc.*



## Advanced manufacturing and quality

Each of Norplex-Micarta's two manufacturing facilities has a set of unique capabilities.

The company headquarters, primary design center and manufacturing complex in Postville, Iowa, USA, processes a variety of resin and substrate combinations in pre-preg, sheet, convolute rolled tube and molded shape form. This 13,000 square meter facility has six pre-preg processing lines and the capability to produce sheets up to 3 meters in length and tubes with an inside diameter up to 1.2 meters.

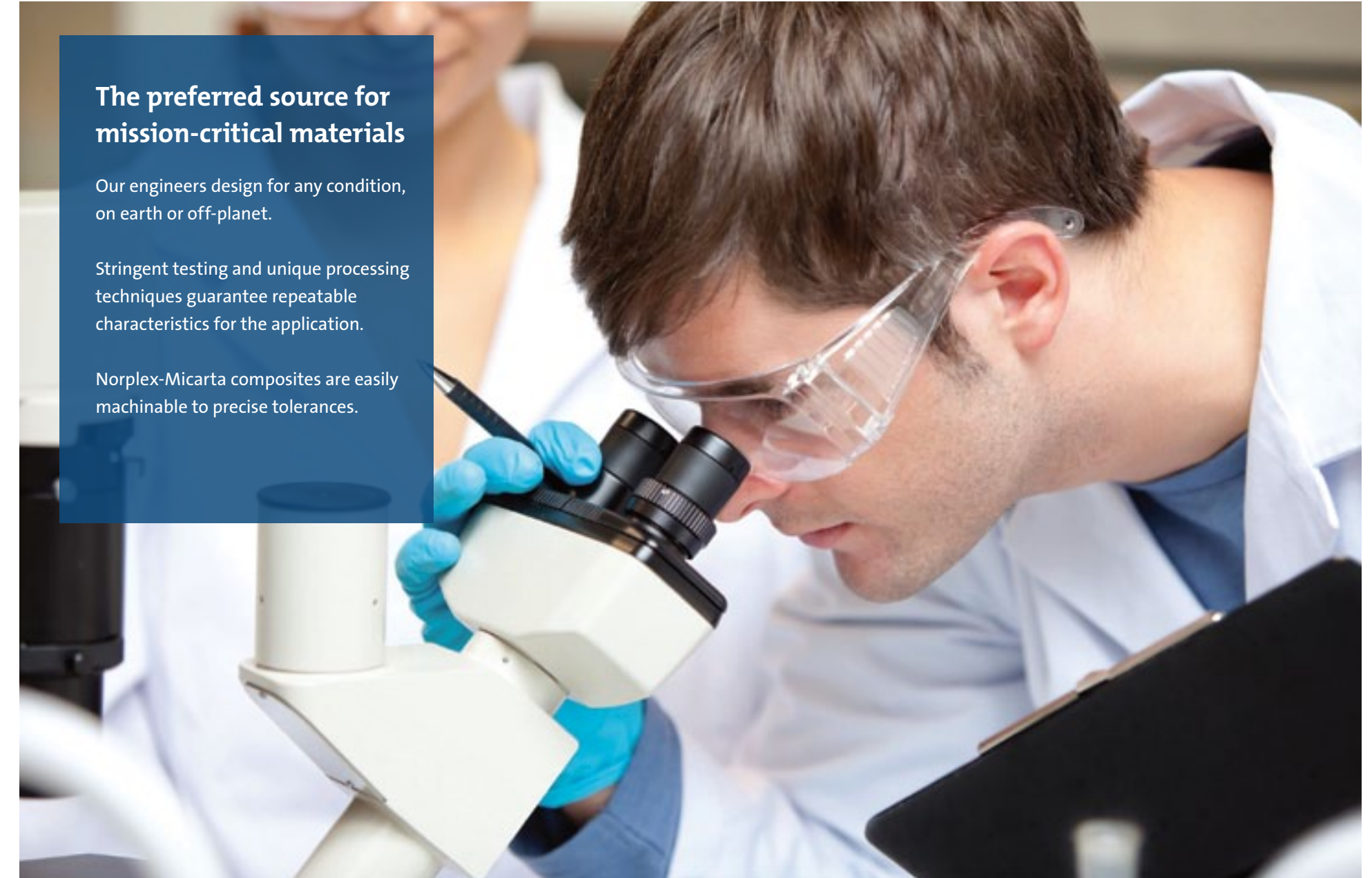
A state-of-the-art facility in Changzhou, P.R. China, was built in 2013. It focuses on the design, production and fabrication of glass-epoxy materials. The 10,000 square meter facility has two processing lines to produce pre-preg, two press lines and several fabrication work centers to machine finished parts. The Changzhou facility has the capability of machining 150mm thick monolithic blocks to meet the needs of the LNG industry and has the capability to produce sheets up to 1.45 meters wide.

### High-performance composites demand advanced manufacturing systems

Both facilities share technology, production and manufacturing systems and processes representing significant ongoing investments. These include investments in state-of-the-art environmental protection equipment as well as advanced safety and health systems to ensure safe, stable, sustainable and repeatable production.

### Both facilities are ISO 9001-certified

The Quality Management Systems of each facility are designed to support continuous improvement and deliver a superior customer experience. From the sourcing of raw materials to the specialized testing requested by customers, Norplex-Micarta's investment in quality management is significant and recognized by its customers. This includes laboratories in each facility equipped with sophisticated test equipment to support development, and ongoing verification of materials to industry or customer specifications.



### The preferred source for mission-critical materials

Our engineers design for any condition, on earth or off-planet.

Stringent testing and unique processing techniques guarantee repeatable characteristics for the application.

Norplex-Micarta composites are easily machinable to precise tolerances.

## Significant LNG project experience

### Sabine Pass Liquefaction

NP500CR parts used as an insulation in the construction of pipe supports, cold shoes and washer

### Wheatstone

NP500CR parts used as an insulation in the construction of pipe supports and cold shoes

### Corpus Christi Liquefaction

NP500CR parts used as an insulation in the construction of pipe supports and cold shoes, washer and RT521M

### Cameron LNG

NP500CR parts used as an insulation in the construction of pipe supports. NP500CR machined rod used for radial support between inner pipe and outer jacket. The sheets are to be cut to a ring for restraining purposes

### Petronas FLNG

NP500CR parts applied to the lower part and wall of tank for sliding and prevention of transfer heat

### Freeport LNG

NP500CR sheet used for the restraining ring assembly within the vacuum insulated pipe spool. NP500CR machined rod used for supporting the outer jacket from the inner core pipe



## Featured Norplex-Micarta composites for LNG applications

**Grade NP500CR** cryogenic insulation material  
(Micarta G-10CR, Westinghouse/International Paper Cryogenic Grade 56 G12)

Operating Temperature Range		<b>Minimum:</b> Anecdotal Evidence of Surviving Deep Space	<b>Maximum:</b> 130° C
Compressive Strength	ASTM D695	65,000 psi	
In-Plane Shear Strength	ASTM D3846	<b>LW:</b> 9,400 psi	<b>CW:</b> 8,600 psi
Water Absorption (0.062")	ASTM D570	0.10%	
Dielectric Strength (0.062")	ASTM D149	670 Volts/mil	

### Thermal Conductivity (Normal Direction)

Expressed as

$$\text{Thermal Conductivity [W/(m·K)]} = 10a + b(\log_{10} T) + c(\log_{10} T)^2 + d(\log_{10} T)^3 + e(\log_{10} T)^4 + f(\log_{10} T)^5 + g(\log_{10} T)^6 + h(\log_{10} T)^7 + i(\log_{10} T)^8$$

Where

T is the target temperature in °K, and constants a – i for NP500CR are

NP500CR (temperature range 10–300°K)					
a	-4.1236	d	26.2720	g	-0.6905
b	13.7880	e	-14.6630	h	0.0397
c	-26.0680	f	4.4954	i	0.0000

Source: Cryogenic Technologies Group, National Institute of Standards and Technology (NIST) Material Measurement Laboratory

*This data, while believed to be accurate and based on reliable analytical methods, is for informational purposes only. The terms and conditions of the agreement under which it is sold will govern any sales of this product. Data supplied above are "typical values," not to be considered "specification values."*

*To assure the material's performance is adequate for a specific application, customers should verify, independent of Norplex-Micarta, performance characteristics of interest.*

*It is the responsibility of the users of this information to make sure that they have the latest version of the Technical Data Bulletin, and are urged to check our website, [www.norplex-micarta.com](http://www.norplex-micarta.com), to determine if information is most current.*

*Specification writers: Contact Norplex-Micarta for specification values before submission.*

**Grade NP511EM** electrical insulation and gasket material

Operating Temperature Range		<b>Minimum:</b> Anecdotal Evidence of -40° C	<b>Maximum:</b> 180° C
Compressive Strength	ASTM D695	89,000 psi	
Shear Strength (0.062")	ASTM D732	24,000 psi	
Water Absorption (0.062")	ASTM D570	0.10 %	
Breakdown Voltage	ASTM D149	70 kVolts	
Dielectric Strength (0.062")	ASTM D149	350 Volts/mil	

**Grade NP510A** electrical insulation and gasket material

Flexural Strength (0.062")	ASTM D790	<b>LW:</b> 65,000 psi	<b>CW:</b> 52,000 psi
Izod Impact Strength (0.500")	ASTM D256	<b>LW:</b> 7.90 ft-lb/in	<b>CW:</b> 7.30 ft-lb/in
Dielectric Strength (0.062")	ASTM D149	630 Volts/mil	
Arc Resistance	ASTM D495	130 sec	
Comparative Tracking Index	ASTM D3638	600 Volts	

**Grade MC223** bearing material

Rockwell Hardness	ASTM D785	105	
Compressive Strength	ASTM D695	38,000 psi	
Shear Strength (0.062")	ASTM D732	13,000 psi	



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