HUNTSMAN

Enriching lives through innovation

Advanced Materials

Benzoxazine Thermoset Resins

High-Performance Materials for Extreme Environments

Our history

Huntsman Advanced Materials has a long heritage of providing engineered solutions for our customers using a wide range of high-performance thermoset chemistries and formulations.

Today, we remain a global leader and innovator in benzoxazine chemistries. We have more than 25 years' experience developing and working with these advanced products and are currently the only manufacturer in North America.

Each day our scientists work with designers and engineers to help bring lightweight, high-strength, durable products to market and help solve increasingly complex design issues. Our growing portfolio of specialty resin systems and adhesives serve the aerospace, automotive, coatings, electronics, energy and industrial composite markets.

Go beyond the traditional limitations of conventional resin systems and choose Huntsman benzoxazine thermoset resins for your toughest applications.

How benzoxazine resins can help you solve your toughest challenges

With Huntsman's benzoxazine resins, customers are producing stronger, lighter-weight composite parts than ever before. Next-generation benzoxazines combine excellent stiffness and high-temperature performance with the ability to withstand exposure to moisture, chemicals and other corrosive materials. The new products are ideal for use in extreme environments and offer low flammability. In addition, several of these systems are designed to cure out of autoclave.

Today's generation of benzoxazine resins are safer and easier to handle and process. Huntsman has formulated diluents and accelerators that reduce viscosities as well as cure temperature and cycle times. Moreover, Huntsman's benzoxazine products release approximately 20% less energy[1] during cure and do not generate volatiles[2] during cure.The products are storage stable at room temperature.

1. When compared to traditional epoxy resins
2. When compared to phenolics

Benzoxazine resins vs. traditional resin chemistries

For challenging applications, Huntsman benzoxazine resins are an ideal alternative to conventional epoxy, phenolic and BMI resin systems.

Epoxy: Benzoxazine resins are 50% stiffer than traditional epoxies with flexural moduli in the 4,500 – 5,300 MPa range. The hot/wet performance of the new resins is also better than that of epoxy materials. The benzoxazines also offer lower shrinkage during cure.

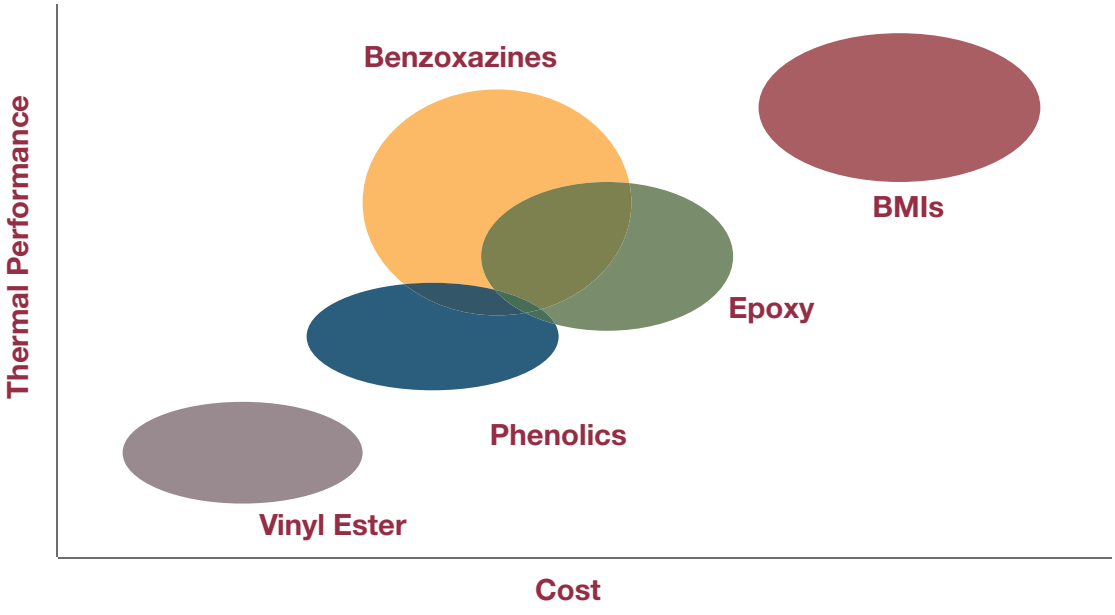
Phenolic: Benzoxazine resins produce higher part accuracy with less micro-cracking than phenolic resins and do not generate volatiles during cure – which means higher-quality laminates with reduced chance of voids.

Bismaleimide: While bismalemides (BMIs) currently offer the highest Tgs, they require longer processing times and an autoclave cure, resulting in higher manufacturing costs than benzoxazine resins.

Benzoxazine performance vs. traditional resins

Property	Benzoxazine	Epoxy	Phenolic	BMIs
Tg	Good	Good	Good	Excellent
Stiffness	Excellent	Good	Good	Good
Shrinkage	Excellent	Poor	Good	Good
Flammability	Excellent	Poor	Excellent	Good
Hot/Wet	Excellent	Poor	Average	Excellent
Chemical Resistance	Excellent	Average	Good	Good
Toughness	Average	Good	Average	Average
CTE	Good	Average	Average	Good
Processability	Good	Good	Poor	Average
Storage Stability	Good	Average	Poor	Good

Thermal performance and cost comparison among traditional resin chemistries



Benzoxazine applications

Huntsman benzoxazine resins are ideal for such diverse applications as:

Aerospace: primary and secondary structures as well as interior panels, bulkheads, galleys, lavatories and tray tables.

Transportation: automotive under-the-hood components as well as frames, body panels and structural reinforcements for trucks, buses and light rail cars.

Oil/Gas: composite pipes, risers, down-hole plugs and high-pressure vessels.

Out-of-autoclave tooling: prepregs and infusion resins for high-performance, elevated-temperature tooling.

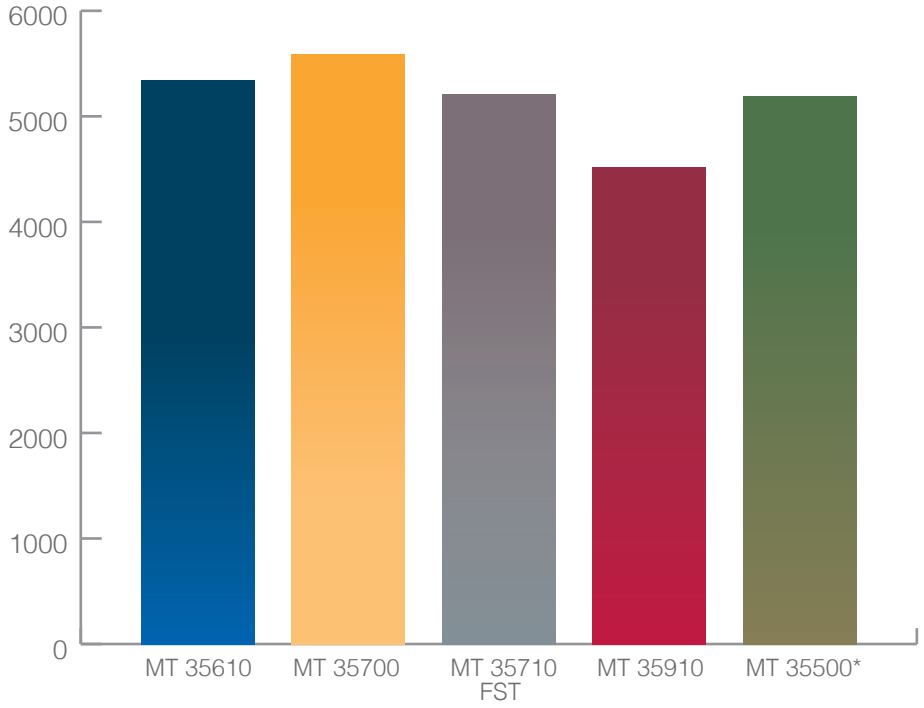
Electronic: halogen-free laminates for printed circuit boards.

Benzoxazine product family performance overview

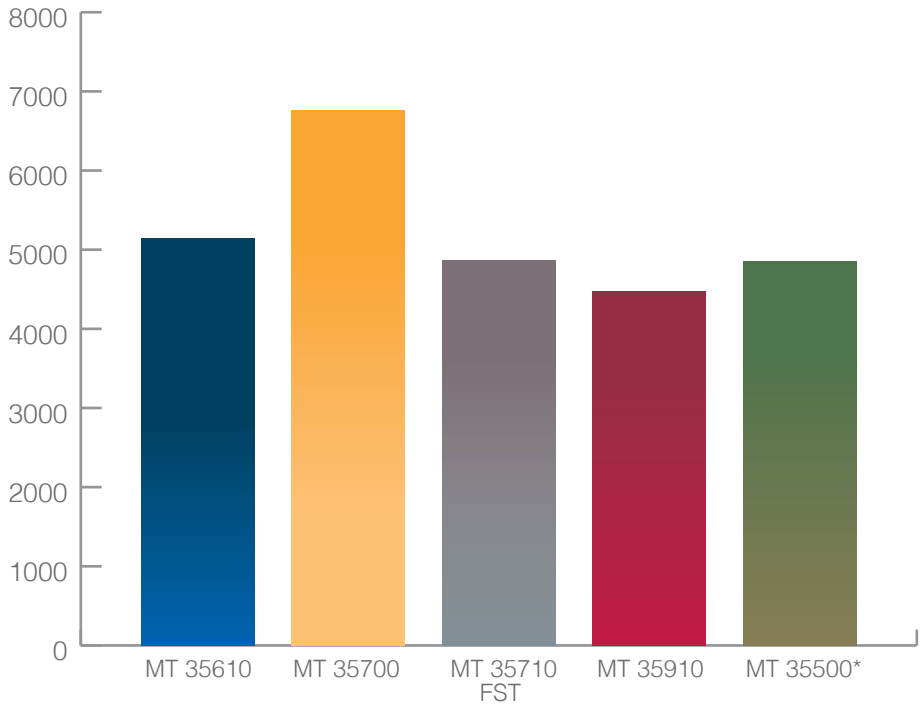
Product	Viscosity, cP	Gel Time, sec.	Tg, by DSC, ˚C	Features/Advantages
Araldite® MT 35610 (BPA)	200-600 at 125˚C	150-450 at 220˚C	161	• Does not generate volatiles during cure • Good solvent solubility • High temperature resistance • Good electrical properties • Low water absorption • Good dimensional stability
Araldite® MT 35700 (BPF)	500-2,500 at 100˚C	200-450 at 220˚C	145-155	• Good chemical resistance • UL 94 V-1 flammability resistance • Low water absorption • Dimensionally stable
Araldite® MT 35710 FST	30-100 at 100˚C	300-450 at 200˚C	137	• FST/meets FAR 25.853 requirements • Lower temperature (177˚C) curing • Low cost • Volatile/void free during curing
Araldite® MT 35910 (Thiodiphenol)	100-500 at 110˚C	150-300 at 200˚C	206	• High Tg/Modulus • Lower temperature (177˚C) curing • Good hot/wet performance • Long shelf life
Araldite® MT 35500 (Cardanol)	100-200 at 25˚C	90-150 mins at 200˚C	N/A	• Reactive diluent to reduce viscosity • Improves tensile/flexural strength and tack • Green chemistry
DT 300	N/A	N/A	N/A	• Accelerator • Shortens cure time
DT 310	N/A	N/A	N/A	• Accelerator • Lowers cure temperature

Stiffness Comparison

Flexural Modulus, MPa



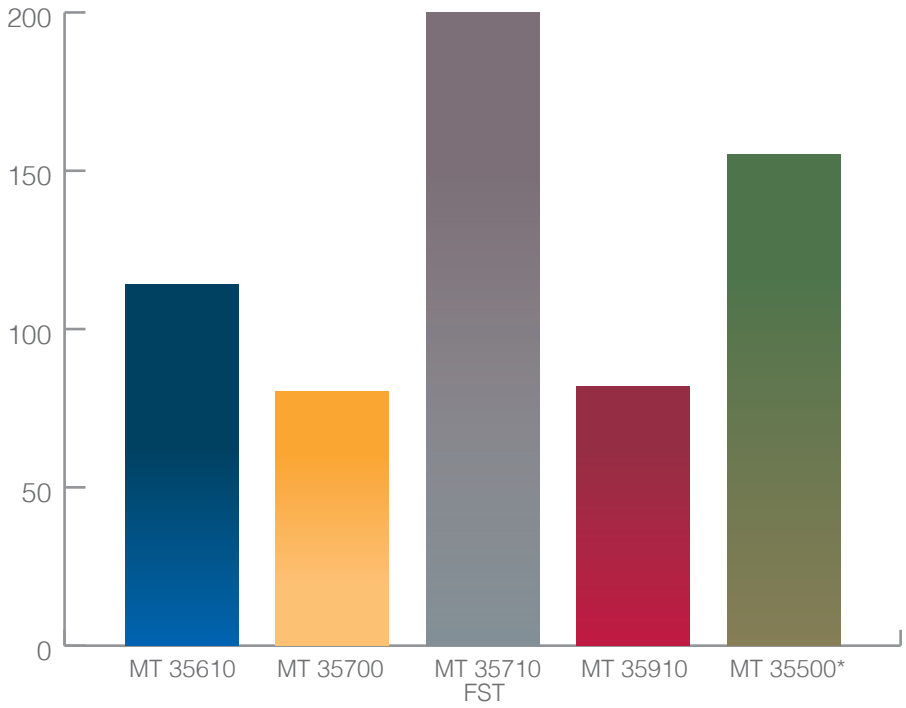
Tensile Modulus, MP



* MT 35500 values represent a blend of 80% MT 35610 and 20% MT 35500

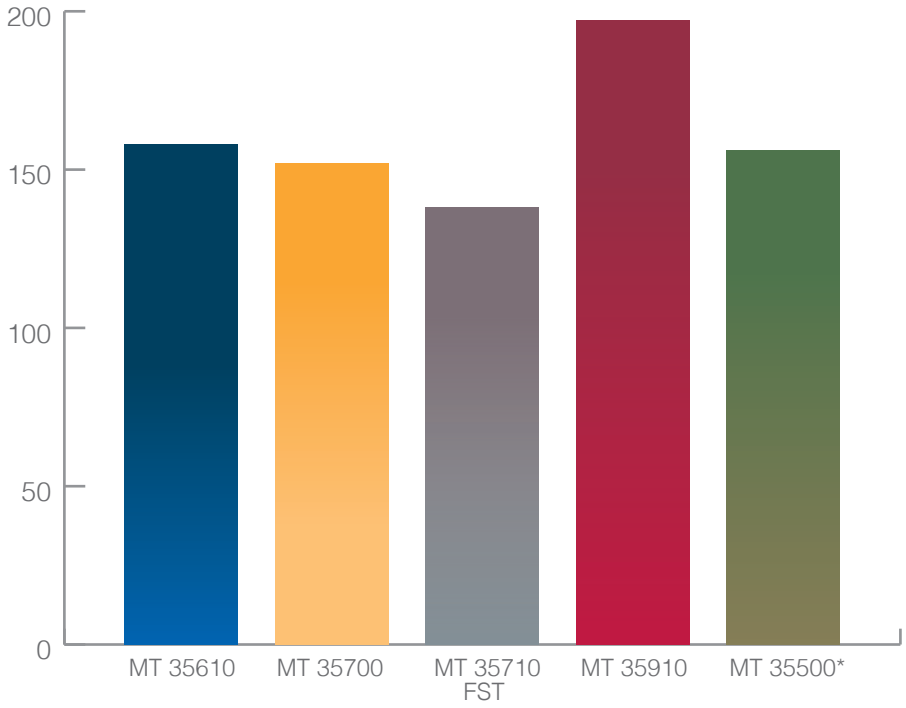
Toughness Comparison

G_{1c}, J/m²



Thermal Performance Comparison

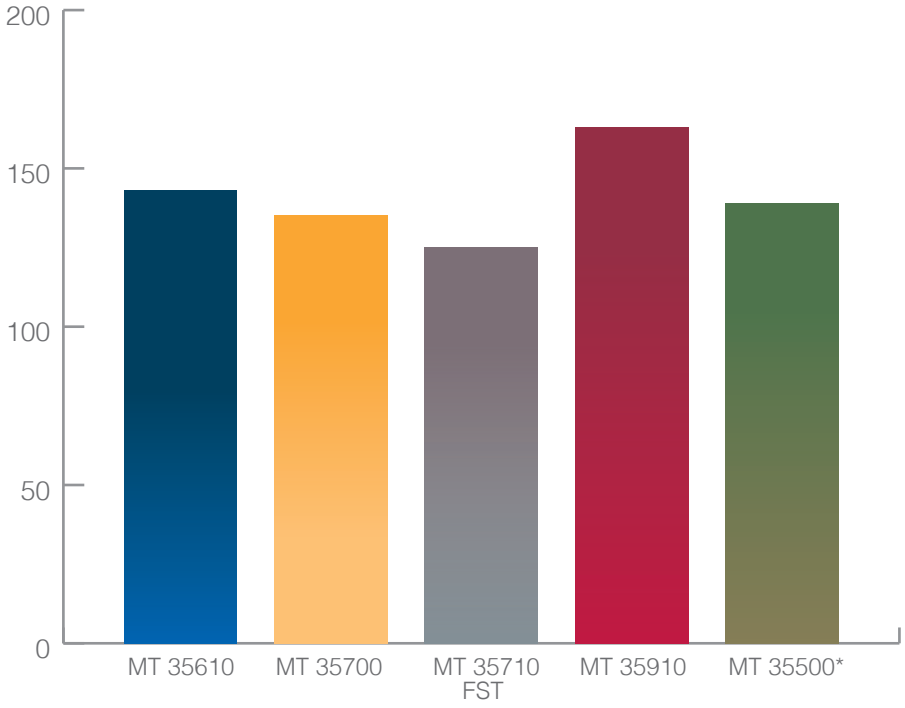
Dry Tg (by DMA (E´), °C



* MT 35500 values represent a blend of 80% MT 35610 and 20% MT 35500

Moisture/Chemical Resistance Performance Comparison

Wet Tg (after 48 hrs in boiling water, °C)



* MT 35500 values represent a blend of 80% MT 35610 and 20% MT 35500

Global Presence – 13 Manufacturing Sites, 5 Advanced Technology Centers

HUNTSMAN

Enriching lives through innovation

For More Information

www.huntsman.com/BOX

Americas:

Huntsman Advanced Materials Americas LLC
10003 Woodloch Forest Drive
The Woodlands
Texas 77380
USA
Tel. +1 888 564 9318
Fax +1 281 719 4047

Europe:

Huntsman Advanced Materials (Switzerland) GmbH
Klybeckstrasse 200
P.O. Box
4002 Basel
Switzerland
Tel. +41 61 299 20 41
Fax +41 61 299 20 40

Asia/Pacific:

Huntsman Advanced Materials (Guangdong) Co., Ltd.
Rooms 4604 – 4606, 46F Maxdo Center
8 Xing Yi Road
Shanghai, 200336
P.R. China
Tel. +86 21 2208 7588
Fax +86 21 2208 7511
Customer Free Call Inquiry +86 20 8484 5000