


Advanced Materials

Araldite® Benzoxazine Thermoset Resins

Selector Guide

BENZOXAZINES FROM 



Introduction

The demand for advanced thermosetting resin systems that meet the performance and environmental requirements for use in such industries as civil engineering, aerospace, oil exploration, and electronics is at an all-time high.

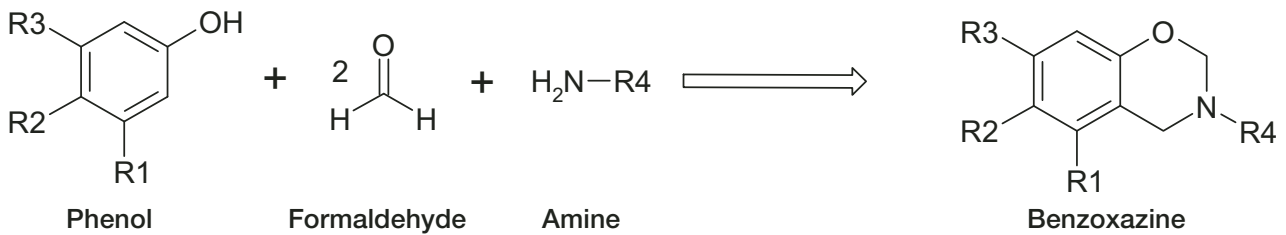
As part of an ongoing program to respond to the challenges of the marketplace, the Huntsman R&D team has formulated several new high-performance materials. The new benzoxazine thermoset resins complement the broad line of multifunctional epoxies, cyanate esters and bismaleimides for which Huntsman has long been known.

Benzoxazines thermoset resins are, in general, the reaction

products of an amine, a phenol and formaldehyde. The resulting products exhibit excellent performance properties including:

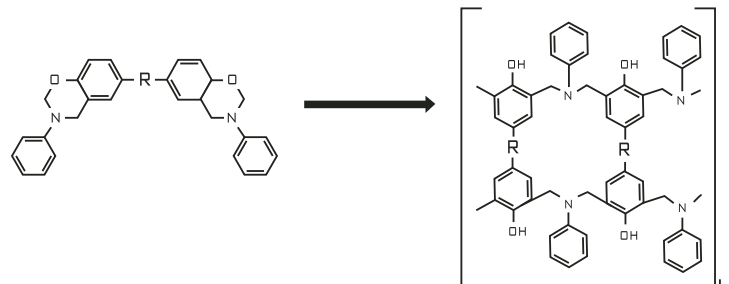
- Flame retardance
- Dimensional stability
- Low water absorption
- Low dielectric constant
- High temperature resistance
- Thermal mechanical properties

With these qualities, benzoxazines offer many advantages for formulating halogen-free systems to be used in producing composites, coatings, adhesives and encapsulants, among others.



Cure Mechanism

Benzoxazine thermoset resins, when heated, homopolymerize to form a rigid polymer that can be used for manufacturing products such as high-temperature composites and electronic components. These homopolymer formulations allow for excess curing agent stoichiometry.

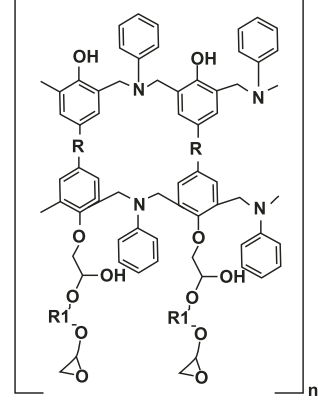


Bi-functional Benzoxazine Homopolymerization

Araldite® Benzoxazine Thermoset Resins

When combined with epoxy resins under heat, benzoxazines produce new-generation thermo-setting materials.

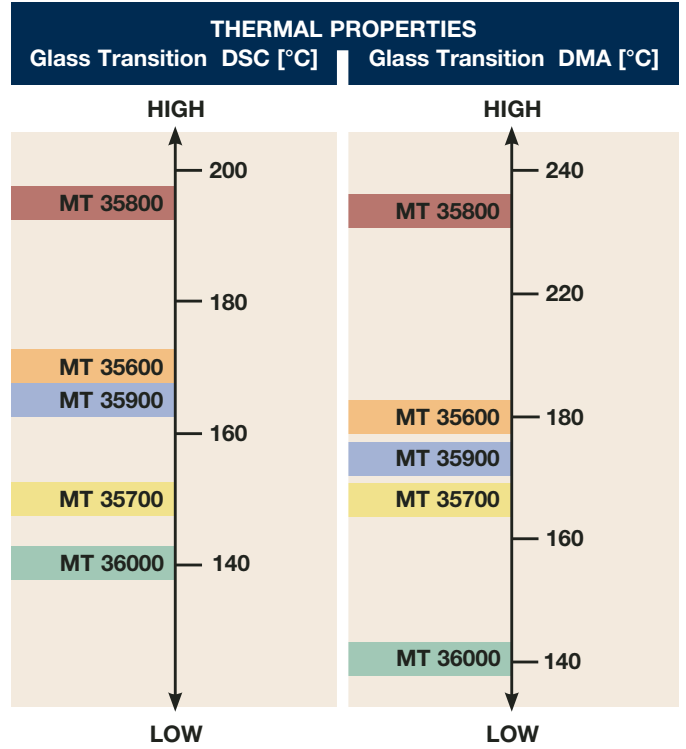
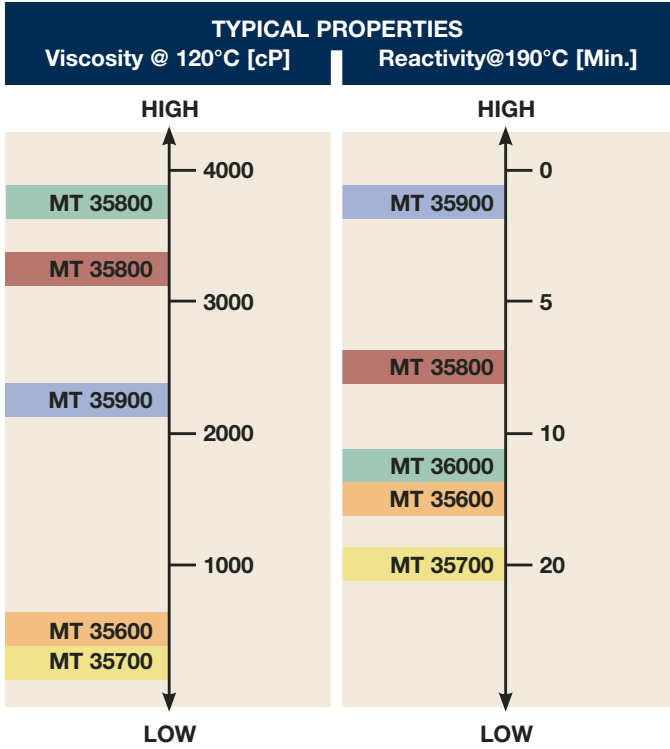
Formulations based on benzoxazine / epoxy reactions feature very high glass transition temperatures (Tg) and control reactivity. Huntsman testing demonstrates that catalysts can be used to modify reactivity behavior.



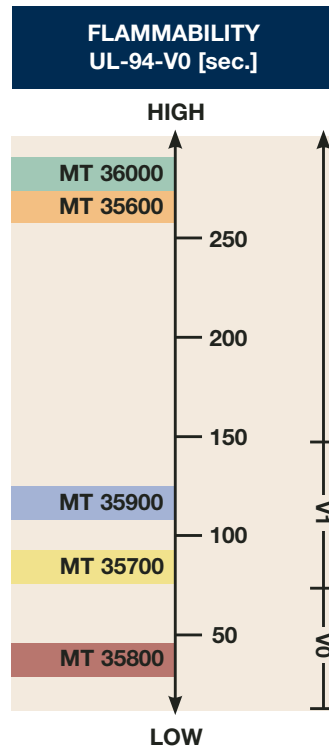
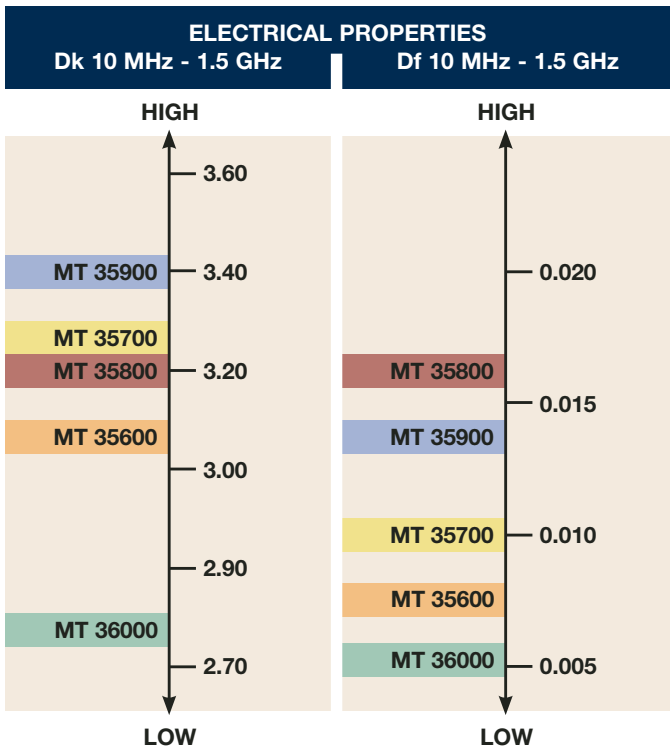
PRODUCT PORTFOLIO – SOLID BENZOXAZINES

ARALDITE® MT 35600	BISPHENOL A	
ARALDITE® MT 35700	BISPHENOL F	
ARALDITE® MT 35800	PHENOLPHTHALEIN	
ARALDITE® MT 35900	THIODIPHENOL	
ARALDITE® MT 36000	DICYCLOPENTADIENE	

GENERAL PERFORMANCE COMPARISON



Note: Glass transition measured on sample cured at 2hs 180°C + 2-4hs 200°C



Araldite® Benzoxazine Thermoset Resins

CATALYSTS FOR BENZOXAZINE FORMULATIONS

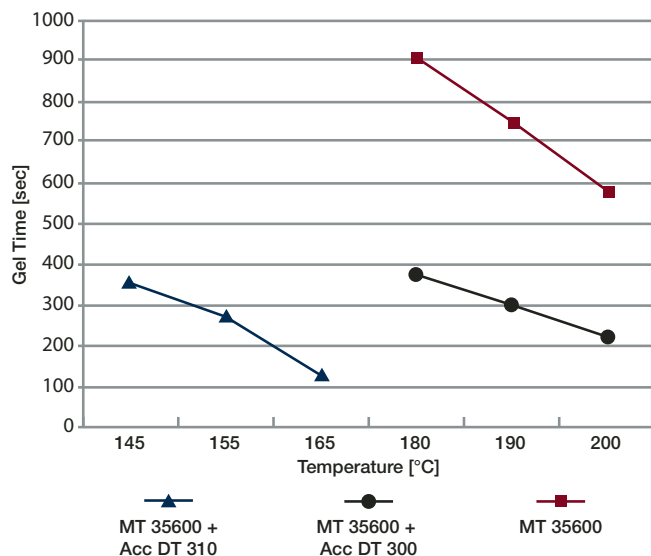
Benzoxazines typically are very latent materials, requiring high temperatures for gelation and curing. This characteristic is demonstrated by DSC analysis, in which the typical reaction peak temperature is $> 200^{\circ}\text{C}$ and the onset of reaction can be above 180°C .

Catalysts such as Accelerator DT 300 and Accelerator DT 310 can be used to improve reactivity for both benzoxazine homopolymerization and benzoxazine/epoxy combinations. The type of catalyst selected and its loading level in a formula depend on factors such as desired cure time/temperature, epoxy content and other additives being incorporated. The performance of these catalysts are illustrated in Figure 1.

Figure 1 shows how reactivity is affected by the addition of 10phr of catalysts.

Araldite® MT 35600 bisphenol A-based benzoxazine is the reference resin.

FIGURE 1. CATALYST PERFORMANCE



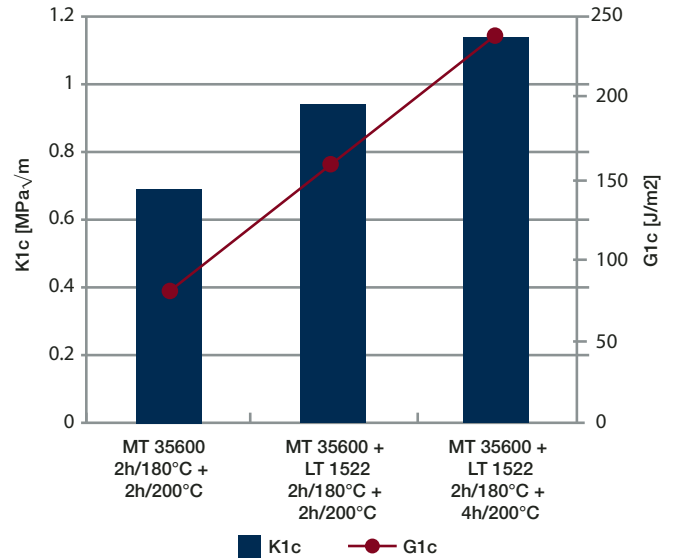
TOUGHENING OF BENZOXAZINE FORMULATIONS

Benzoxazine resins can be toughened by using traditional toughening agents such as thermoplastic rubber and nanoparticles. The addition of Araldite® LT1522 epoxy toughener can further improve the fracture resistance of benzoxazine-based formulations. The loading level of toughener and resin cure cycle will affect performance in Bend Notch Testing.

Figure 2 shows results of the Bend Notch Test after 10phr of Araldite® LT1522 toughening agent is added using two different cure schedules.

Araldite® MT 35600 bisphenol A-based benzoxazine is the reference resin cured for 2h at 180°C + 2h at 200°C.

FIGURE 2. BEND NOTCH TEST



Summary

Benzoxazine thermoset resins represent a new-generation of halogen-free materials that can perform in a broad range of advanced applications. The products feature a unique combination of flame retardancy, dimensional stability, low water absorption, low dielectric constant and high

temperature resistance. Among the industries that will reap the benefits of the innovative new materials are composites, coatings, adhesives and encapsulants manufacturing.

Huntsman Advanced Materials

We are a leading global supplier of synthetic and formulated polymer systems for customers requiring high-performance materials which outperform the properties, functionality and durability of traditional materials. Over 2,300 associates at 13 locations worldwide work to fulfill this promise day by day.

More than 9,000 companies around the world use Huntsman Advanced Materials technologies in key markets such as adhesives and inks, aerospace, automotive, coatings, construction, electronics, medical, marine, power transmission and distribution, sports equipment and wind power generation.

Specialty Components

High performance chemistry for creative industrial solutions

Huntsman Advanced Materials produces and develops knowledge-based specialty components for high-end performance industrial products. Its unique portfolio appeals to formulators, chemists and scientists working in challenging markets who want to be at the forefront of innovation and product development.

Global presence – 13 manufacturing sites



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