

Polyurethane Specialty Products Group

VERSALINK™ Oligomeric Diamines for Epoxies

Considerable interest exists in using Versalink oligomeric diamines and Versalink 740M as curatives in epoxy systems. Versalink oligomeric diamines have found utility as epoxy tougheners/flexibilizers, while Versalink 740M curative is effective as an epoxy curing agent. Both of these materials are nonhazardous and offer the benefit of safe processing and handling.

Versalink 740M As An Epoxy Curing Agent

Versalink 740M is a diamine curative specifically designed and patented as a safe, high-performance curative for polyurethane prepolymers. Because of its health and safety advantages, it offers an alternative to other epoxy curing agents. The utility of Versalink 740M curative has been clearly shown when used in combination with diglycidyl ether of bisphenol-A (DGEBA), sold as Epon® 828, Araldite® 6010 and DER® 331.

Representative curing conditions and glass transition temperatures (Tg) for Versalink 740M curative and other amine/DGEBA combinations are shown in Table 5A. In general, the Tg is 5-15 °C higher than the heat deflection temperature in most epoxy systems.

In addition to the health and safety benefits associated with the use of Versalink 740M curative, the moderate melting point, 259 °F (126 °C), and good solubility in epoxy resins are added benefits to those engaged in the processing of such materials.

TABLE 5A - EPOXY FORMULATIONS*

CURATIVE	CURE CONDITIONS	Tg
Methylene Dianiline (MDA)	2 hr @ 80 °C 2 hr @ 150 °C	159 °C
Versalink 740M	2 hr @ 80 °C 2 hr @ 150 °C	121 °C
Versalink 740M and 1.0 phr BF3 Monoethylamine	2 hr @ 80 °C 2 hr @ 150 °C	158 °C
Diaminodiphenylsulfone (DDS)	5 hr @ 125 °C 1 hr @ 200 °C	179 °C
Versalink 740M	5 hr @ 125 °C 1 hr @ 200 °C	145 °C

* All systems are based on DGEBA epoxy resin.

TABLE 5B -- EFFECT OF RUBBER MODIFIERS ON Tg IN EPOXY SYSTEMS

EPOXY RESIN	CURATIVE	FLEXIBILIZER	Tg
DER 331	Versalink 740M	—	169 °C
DER 331	Versalink 740M	Versalink P-2000	148 °C
DER 331	Versalink 740M	ECTBN K-293	162 °C
DER 331	Versalink 740M	ECTBN K-272	157 °C
XD 7342	Versalink 740M	—	268 °C
XD 7342	Versalink 740M	Versalink P-2000	256 °C

DER 331—Diglycidyl ether of bisphenol-A (Dow Chemical)

XD 7342—Triglycidyl ether of tris (hydroxyl phenyl) methane (Dow Chemical)

ECTBN K-272—Rubber filler (Spencer-Kellogg Co.)

ECTBN K-293—Rubber filler (Spencer-Kellogg Co.)

TABLE 5C - Tg OF VERSALINK OLIGOMERIC DIAMINES	
CURATIVE	Tg
Versalink P-250	- 18°C
Versalink P-650	- 45°C
Versalink P-1000	- 56°C
Versalink P-2000	- 40°C

Versalink Oligomeric Diamines as Epoxy Tougheners/Flexibilizers

Versalink oligomeric diamines, analogs of Versalink 740M curative, are nonhazardous materials that have potential to replace modified rubber as an epoxy flexibilizer. Such modifiers are useful in applications where efficient toughening and resistance to oxidation are important. A study by J. K. Gillham, et al. (Princeton University) that appeared in *Polymeric Materials—Science and Engineering* preprints, Volume 51 (1983) supports this finding. The following comments are based on this study.

By the addition of reactive liquid elastomers, the fracture resistance of high hardness, high glass transition temperature (Tg) epoxy resins can be improved. During cure, phase separation occurs, resulting in the formation of very small elastomer-rich domains (0.1 to 5 microns) which are chemically bonded to the epoxy matrix. These elastomer domains act as "shock absorbers," flexibilizing the epoxy and interrupting the crack propagation mechanism by which these high-Tg systems typically fail.

Classical hydrocarbon rubbers, modified for epoxy reactivity, have often been used for this purpose. However, they often have residual unsaturation which can contribute to poor aging characteristics of the modified epoxy, especially under oxidative conditions (such as under high temperature, radiation, or in the presence of oxidation promoters like active metals). Moreover, these modified rubbers do not react into the system and have only limited compatibility with the uncured epoxy. This incompatibility can lead to poor distribution of the rubbery phase in the cured product and can lead to the resultant loss of toughening efficiency.

In contrast, Versalink oligomeric diamines offer a number of potential benefits in epoxy systems. For instance, Versalink oligomeric diamines are chemically more straightforward, thus eliminating the need for a prereaction step. They also react into the epoxy matrix and are more compatible with most epoxy resins, creating more uniform rubber particles which could improve physical properties. Specifically, Versalink P-2000 oligomeric diamine exhibits excellent compatibility in the uncured state, with efficient formation of incompatible rubber phase after cure. In addition, Versalink P-2000 oligomeric diamine's saturated backbone makes it relatively inert under oxidative conditions. The results are provided in Table 5B. Table 5C lists the glass transition temperatures for all molecular weight versions of Versalink oligomeric diamines currently available.

Overall, Versalink oligomeric diamines can be used effectively as co-curatives to improve the toughness and flexibility of epoxy systems. Compared with conventional rubber modifiers, they offer ease in processing, create more uniform structures and provide wider formulating capabilities.

Safety and Handling Information

For all safety and handling information, please refer to the Versalink oligomeric diamine Material Safety Data Sheets, available upon request from Air Products.



*To Order or Obtain
More Information*

If you would like to place an order or receive additional information, please write or call Air Products at the following location.

Corporate Headquarters
Air Products and Chemicals, Inc.
7201 Hamilton Boulevard
Allentown, PA 18195-1501 USA

Tel 800-345-3148
Tel 610-481-6799 (Outside the U.S. and Canada)
Fax 610-481-4381
www.airproducts.com/psp

The information contained herein is offered without charge for use by technically qualified personnel at their discretion and risk. All statements, technical information and recommendations contained herein are based on tests and data which we believe to be reliable, but the accuracy or completeness thereof is not guaranteed and no warranty of any kind is made with respect thereto.

tell me more
www.airproducts.com/psp