

# IMICURE® EMI-24 Curing Agent

## DESCRIPTION

Imicure EMI-24 curing agent is a liquid imidazole which functions as both a curing agent and a cure accelerator for high-performance epoxy resin systems. This unusually versatile imidazole is readily processed, and provides excellent physical properties across a wide range of curing temperatures.

## KEY FEATURES

Imicure EMI-24 curing agent is 2-ethyl-4-methyl Imidazole. The positioning of the alkyl groups allows both nitrogen atoms to participate actively in the cure. The secondary nitrogen, much like an aliphatic amine curative, opens an epoxide ring which contributes to the unusually high degree of crosslinking found in systems cured with Imicure EMI-24 curing agent. The tertiary nitrogen acts like a tertiary amine to accelerate the polymerization reaction, and also gives a fast B-stage cure. The exceptional performance of Imicure EMI-24 curing agent is attributable to this dual functionality.

## BENEFITS

Imicure EMI-24 curing agent provides the following advantages over other imidazole and amine curing agents and accelerators:

- Printed Circuit Board Laminates—shorter B-stage cure times, reduced solvent requirements, excellent glass transition ( $T_g$ ) temperatures.
- Filament Winding Applications—long pot life, excellent physical properties, high heat distortion temperatures.
- Casting Applications—long pot life, ease of handling, high heat distortion temperatures.
- Adhesives—outstanding adhesion to wood, metal and glass.
- Coatings—excellent shelf stability

## USAGE LEVEL

Typical use concentrations, depending on the resin system used and the cure conditions, are in the range of 0.5–5.0 parts per hundred resin. These levels yield systems with excellent properties and handling characteristics at low applied cost.

## SHELF LIFE

At least 24 months from the date of manufacture in the original sealed container at ambient temperature. Store away from excessive heat and humidity in tightly closed containers.

## STORAGE AND HANDLING

Refer to the Safety Data Sheet for Imicure EMI-24 curing agent.

**TABLE 1: TYPICAL PROPERTIES**

<b>Appearance</b>	Yellow to Amber Liquid
<b>Color (Gardner)</b>	18
<b>Viscosity @ 77°F (cP)</b>	6,500
<b>Specific Gravity @ 77°F</b>	0.990
<b>Recommended Use Level (phr)</b>	1-4

**TABLE 2: TYPICAL HANDLING PROPERTIES**

<b>Gel Time (150g mix @ 212°F) (min)</b>	4
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## PERFORMANCE DATA

**Casting and Fabricating Operations:** Systems using Imicure EMI-24 curing agent exhibit long pot lives, low initial viscosity, low rate of change of viscosity and excellent property retention at elevated temperatures.

**TABLE 1: CASTING<sup>1</sup>**

Formulation	1	2	3	4
DGE-BPA <sup>a</sup>	100 phr	100 phr	100 phr	100 phr
Imicure EMI-24	1.0	2.0	3.0	5.0
Properties				
Initial Cure @ 70°C, + 4 hr @ 149°C				
Gel Time, min	160	95	45	30
HDT, °C	160	165	162	149
Flexural Strength, psi	5,800	5,900	6,000	9,200
Tensile Strength, psi	3,000	5,000	6,100	8,300
Compressive Strength (Ultimate), psi	24,200	24,200	24,200	26,200

<sup>a</sup> Epoxy resin—diglycidyl ether of bisphenol A.

**Printed Circuit Board Laminates:** The use of Imicure EMI-24 curing agent as a cure accelerator in printed circuit board laminate formulations provides shorter B-stage times, increased crosslinking, higher Tgs, better green strength and reduced solvent requirements when compared with other common accelerators such as 2-methyl imidazole (Imicure AMI-2 curing agent) and benzyl dimethyl amine (Amicure<sup>®</sup> BDMA curing agent).

**TABLE 2: PRINTED CIRCUIT BOARD LAMINATE APPLICATIONS<sup>f</sup>**

Formulation	1	2	3
DGE-BPA <sup>a</sup>	100.00 phr	100.00 phr	100.00 phr
TBBPA <sup>b</sup>	154.3	154.3	154.3
Amicure CG-NA <sup>c</sup>	3.80	2.5	2.5
Methyl Cellosolve	55.0	41.2	41.2
Amicure BDMA <sup>d</sup>	0.47	—	—
H <sub>2</sub> O/K <sub>2</sub> CO <sub>3</sub>	.55/.29	—	—
Imicure AMI-2 <sup>e</sup>	—	0.63	—
Imicure EMI-24 Curing Agent	—	—	0.63
Pre-preg Properties (B-Staged)			
Resin Content	43%	43%	43%
Percent Flow:			
5 min @ 145°C, 300 psi	21.2	N/A	17.0
6 min @ 145°C, 300 psi	18.3	N/A	1.7
Post Cure @ 160°C, 100 psi, Tg, °C	116	120	163

<sup>a</sup> Liquid diglycidyl ether of bisphenol A epoxy resin, pre-catalyzed

<sup>b</sup> Tetrabromo bisphenol A

<sup>c</sup> Dicyandiamide

<sup>d</sup> Benzyl dimethyl amine

<sup>e</sup> 2-Methyl Imidazole

<sup>f</sup> Westinghouse (U.S. Patent 4,452,847 directed to such printed circuit board laminate applications) is the source for data

**Filament Winding Applications:** The high strength/weight ratio imparted by Imicure EMI-24 curing agent improves burst, shear, compressive strength and moduli of filament wound vessels. Its long pot life, high heat distortion temperature and versatility of cure are well-suited to these applications when used as either the sole amine curing agent or as an accelerator for anhydride-cured systems.

**TABLE 3: FILAMENT WINDING FORMULATION<sup>2</sup>**

Formulation	1	2	3	4
DGE-BPA <sup>a</sup>	100 phr	100 phr	100 phr	100 phr
NMA <sup>b</sup>	93	93	93	—
Amicure BDMA <sup>c</sup>	9.6	—	—	—
Ancamine® K54 <sup>d</sup>	—	9.6	—	—
Imicure EMI-24	—	—	1.9	2.0
Properties				
Gel @ 75°C, + 4 hr @ 93°C:				
Gel Time, min	36	24	73	95
HDT, °C	124	128	128	128
Gel @ 75°C, + 4 hr @ 149°C:				
Gel Time, min	36	24	73	95
HDT, °C	149	144	169	165

a Diglycidyl ether of bisphenol A epoxy resin

b NADIC methyl anhydride

c Benzyl dimethyl amine

d Tris (dimethyl amino-methyl) phenol

**Sources:**

(1) Harding, William A., Ethyl Methyl Imidazole (EMI) As An Epoxy Resin Curing Agent, Houdry Process and Chemical Company, Internal Report, #L-839, October 30, 1964, Table 15, page 73 and Figure 6, page 24.

(2) Harding, William A., Ethyl Methyl Imidazole As An Epoxy Resin Curing Agent, Houdry Process and Chemical Company, Internal Report, #L-839, October 30, 1964, Figure 2, page 15; Figure 4, page 19.

**EVONIK CORPORATION**

7201 Hamilton Blvd.

Allentown, PA 18195

1 800 345-3148

Outside U.S. and Canada 1 610 481-6799

**For Technical Information and Support:**

Americas: picus@evonik.com

EMEA: apcse@evonik.com

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