

EPOXY CURATIVES & RESINS > ADHESIVES & COMPOSITES

Imicure® HAPI Curing Agent

Description

Imicure HAPI curing agent is an imidazole based product that can be used as a sole curing agent or used as an accelerator for dicyandiamide (DICY) and anhydride cured epoxy systems. It can provide an excellent balance of shelf stability and low temperature reactivity relative to other commercially available imidazoles.

Applications

- One-Component (1K) Adhesives
- Underfill for Electronics
- Composite - Prepreg
- Small Potting Applications

Advantages

- Excellent balance of shelf stability and reactivity
- "Snap" Cure above its activation temperature
- Excellent adhesion properties

Typical Cure Schedule

- Sole Cure: 30 minutes at 130 °C (266 °F)
- Dicy Cure: 30 minutes at 150 °C (302 °F)
- Anhydride Cure: 30 minutes at 160 °C (320 °F)

Storage and Handling

At least 24 months from the date of manufacture in the original sealed container at ambient conditions. The product is hygroscopic and should be stored in tightly closed containers away from excessive heat and humidity.

Refer to the Material Safety data sheet for Imicure HAPI Curing Agent.

Typical Properties	SI	English
Appearance	White Micronized Powder	
Amine Value (mg KOH/g)	220	
Water %	<1.0%	
Particle Size Distribution:	D50 < 9 µm	
	D90 < 20 µm	
Typical Formulation, in Parts		
DGEBA (EEW=190) Epoxy Resin	100 .0	
Amicure® CG1200G	6.0	
Imicure HAPI	2.0	
Fumed Silica	1.0	
Typical Handling Properties		
DSC Activation Temperature, (10 °C/min Scan Rate)	130 °C	266 °F
267 Time to 2X Initial Viscosity @ 25 °C / (104 °F)	40+ Days	
Heat of Reaction (J/g)	409	
Temperature Resistance		
Glass Transition Temperature (DSC second scan)	128°C	262 °F

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Imicure® HAPI Curing Agent

Sole Curing Agent

Imicure HAPI can be used as a sole curing agent in epoxy curing agent systems at various loading levels, but most commonly 1-10PHR. Figure 1 shows an example of reactivity using Imicure HAPI at 10PHR. At 10 PHR Loading, the system exhibits a shelf life of approximately 14 days (defined as time to double initial system viscosity). Figure 2 provides a comparison of Imicure HAPI curing agent and a standard, commercially available Imidazole based product at 5 PHR.

Figure 1: Imicure HAPI can provide "snap" cure profile when used as a sole curing agent (10 PHR) with a shelf life of 14 days

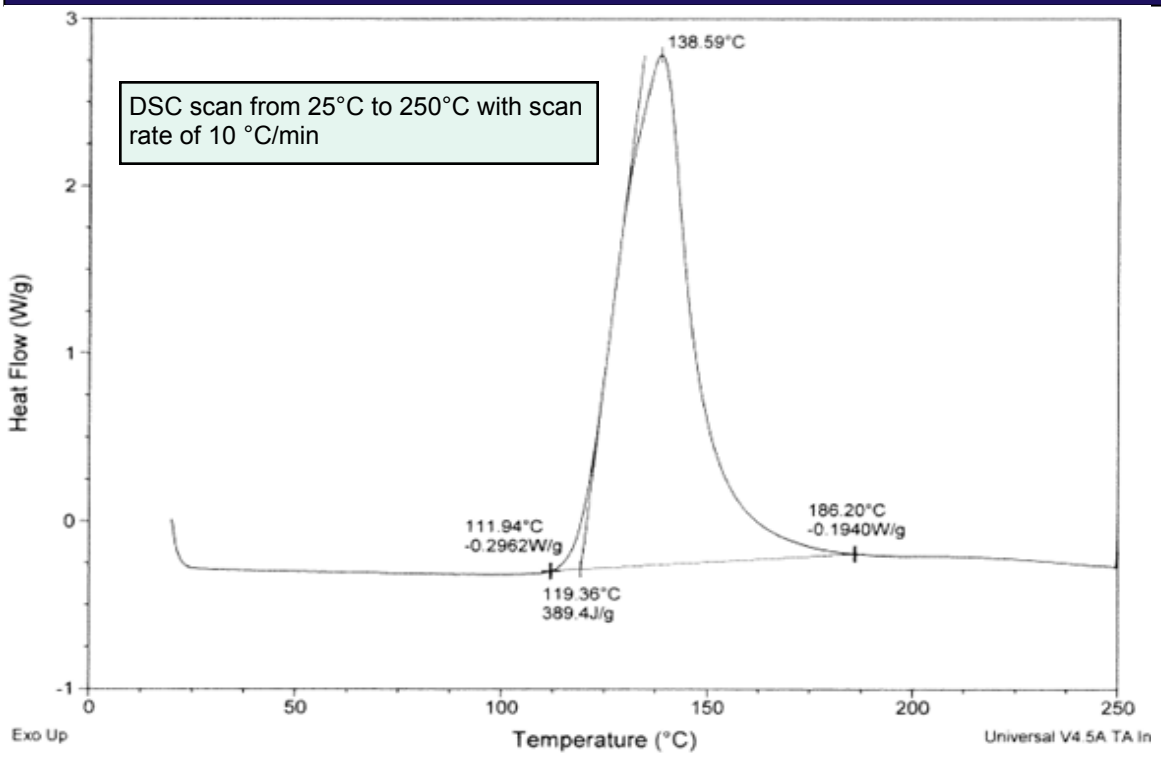

Figure 2: At 5 PHR, Imicure HAPI provides an excellent balance of low temperature reactive while also maintaining superior formulation stability vs. standard imidazoles

Formulation, % by weight		
DGEBA (EEW=190) Epoxy Resin	100	100
Commercial Imidazole	5	0
Imicure HAPI	0	5
Reactivity Profile		
Onset Temperature, in °C	125	118
Peak Temperature, in °C	155	138
Heat of Reaction, J/g	411	369

Viscosity Stability at 25 °C, 5 PHR	**Initial (mPa.s)**	**24 Hours**	**120 hours**	**192 hours**	**288 hours**	**360 hours**	**456 hours**	**504 hours**	**672 hours**	**888 hours**
Commercial Imidazole	17700	19100	19400	24800	34800	72400	388000	■	■	■
Imicure HAPI	**17300**	**19000**	**20000**	**20000**	**21800**	**22800**	**24000**	**25600**	**25600**	**32000**

■ - Gelled

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Acceleration of Anhydride Systems

Six formulations containing three different loadings of Imicure HAPI and Imicure® AMI-2 (control) were evaluated as anhydride cure accelerators for curing agents reactivity, glass transition temperature and viscosity increase at 60 °C. Methyltetrahydrophthalic anhydride (MTHPA) was used as the curing agent with a standard liquid epoxy resin as the control.

As shown in Figure 4, Imicure HAPI based formulations provide significantly longer formulation stability and comparable glass transition temperatures with slightly lower reactivity under the same loading conditions. Since Imicure HAPI curing agent is polymeric in nature (unlike Imicure AMI-2), 1.5 parts of the accelerator is required to achieve reactivity similar to a formulation based on 0.5 PHR of Imicure AMI-2 curing agent.

Figure 4: Imicure HAPI provides superior formulation stability and comparable glass transition temperatures vs. Imicure AMI-2

Formulation	0.5 PHR loading		1.0 PHR loading		1.5 PHR loading	
Epon 828	100	**100**	100	**100**	100	**100**
MTHPA	80	**80**	80	**80**	80	**80**
Imicure AMI-2	0.5	**0**	1	**0**	1.5	**0**
Imicure HAPI	0	**0.5**	0	**1**	0	**1.5**
Reactivity by DSC						
Onset, °C	138	**152**	121	**146**	124	**139**
Peak, °C	178	**190**	153	**178**	152	**173**
Heat Of reaction (J/g)	302	**343**	293	**295**	311	**305**
Tg, °C after initial scan	115	**118**	135	**125**	130	**128**
Viscosity @ 60 °C						
Initial	100	**80**	100	**100**	100	**100**
2 hours	135	**90**	305	**110**	766	**115**
4 hours	310	**105**	2925	**135**	very high	**160**
6 hours	1260	**115**	very high	**170**		**230**
10 hours	very high	**150**		**275**		**695**
18 hours		**270**		**1215**		**very high**
28 hours		**800**		**very high**		
44 hours		**20425**				

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Acceleration of Dicy Systems

Imicure HAPI can also be used to accelerate epoxy systems cured with Dicyandiamide. At 2 PHR loading, an activation temperature of 130 °C can be reached, while also providing significantly more in terms of shelf stability than an imidazole with similar reactivity.

Figure 3: Imicure HAPI curing agent provides an excellent balance of low temperature reactivity while also maintaining superior formulation stability vs. standard imidazoles

Formulation, % by weight	**A**	**B**									
DGEBA (EEW=190) Epoxy Resin	100	100									
Amicure® CG1200G	6	6									
Commercial Imidazole	2	0									
Imicure HAPI	0	2									
Reactivity Profitle											
Onset Temperature, in °C	132	130									
Peak Temperature, in °C	144	149									
Heat of Reaction, J/g	228	490									
Viscosity Stability at 25 °C											
Product	**Initial (mPa.s)**	**24 Hours**	**48 Hours**	**120 hours**	**192 hours**	**288 hours**	**312 hours**	**384 hours**	**552 hours**	**720 hours**	**888 hours**
Commercial Imidazole	14400	15000	13200	15000	16400	620000	■	■	■	■	■
Imicure HAPI	**15200**	**16800**	**16800**	**17600**	**19400**	**19200**	**19200**	**20000**	**21600**	**22800**	**26000**
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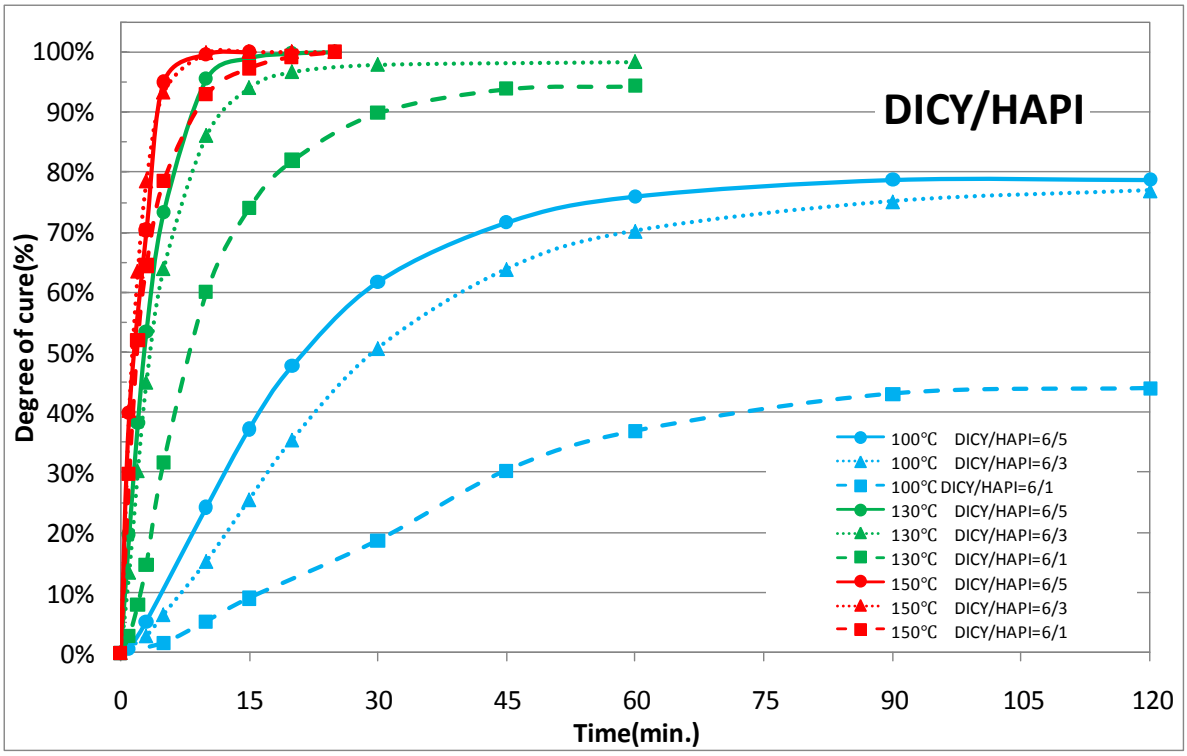
Degree of Cure vs. Loading Level and Temperature

Figure 4 provides more detail on how the degree of cure for systems based on Imicure HAPI can be impacted by the loading level used and bake temperature. Loading levels of 1,3, and 5 PHR were studied in systems contained standard liquid epoxy resin and 6 PHR of micronized Dicyandiamide. These systems were then evaluated at 100 °C, 130 °C, and 150 °C to determine the degree of cure (as a %) vs. time. Imicure HAPI cures very fast at 150 °C, while higher loading is required to reach a reasonable degree of cure (>85%) when the curing temperature is lower. The lowest recommended curing temperature for Imicure HAPI is 120 °C-130 °C, although curing time will be longer than when cured at lower temperatures.

Figure 4: Imicure HAPI Degree of Cure as a function of loading level and bake temperature



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