Product information

ANCAMINE® 2337S

Curing Agent

DESCRIPTION

Ancamine 2337S curing agent is a modified aliphatic amine designed for use as a latent curing agent for epoxy resins.

TYPICAL PROPERTIES

Property	Value	Unit
Appearance	Light Yellow Powder	
Melting Point	145-172	°F
Particle Size	90% ≤ 10	micron
Amine Value	260	mg KOH/g
Recommended Use Level (EEW=190)	45	phr

ADVANTAGES

• Very rapid reactivity above 158°F (70°C)
• Rapid green strength development
• Excellent shelf stability in undiluted resin at elevated temperatures
• Can be used as a sole curing agent or as a DICY co-cure accelerator with Ancamine 2014AS and Ancamine 2014FG curing agents
• Good adhesion
• Easy dispersion in liquid resins

APPLICATIONS

• One-component conduction or induction heat-cure adhesives
• Potting
• Coatings
• Hot-melt prepregs

STORAGE 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.

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STORAGE AND HANDLING

Refer to the Safety Data Sheet for Ancamine 2337S curing agent.

TYPICAL CURE SCHEDULE

1) 40 minutes at 212°F (100°C)
2) 30 minutes at 248°F (120°C)

TYPICAL FORMULATION

Liquid DGEBA	100.0
Ancamine 2337S	50.0
Fumed Silica	2.0

TYPICAL HANDLING PROPERTIES*

Property	Value	Unit
Stroke Gel Time		
@ 175 °F (80°C)	2.7	min
@ 250 °F (120°C)	<1	min
DSC Activation Temperature	160	°F
Pot Life [150g mix @ 108°F (42°C)]	>1	month

TYPICAL PERFORMANCE*

Property	Value	Unit
Cure Schedule 2		
Glass Transition Temperature (DSC)	158	°F
Lap Shear Strength (cold rolled steel)	1,670	psi

* Ancamine 2337S curing agent formulated with standard liquid Bisphenol- A based (DGEBA, EEW=190) epoxy resin.

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SUPPLEMENTARY DATA

REACTIVITY

Formulations with epoxy resins and varying levels of Ancamine 2337S curing agent were prepared (Table 1) to study the reactivity by the Stroke cure method and a differential scanning calorimeter (DSC).

As shown in Table 1, at lower temperatures, formulations containing higher levels of modified polyamine were more reactive. At 250°F (120°C), the differences in the reactivity of these formulations are insignificant. At all temperatures, the reactivity of formulations containing Ancamine 2337S curing agent was significantly higher than the formulation containing Ancamine 2014FG curing agent. The DSC reactivity data shows that the heat of reaction increases as a function of the amount of Ancamine 2337S curing agent and begins to level off at 50 phr. The onset and peak temperatures of formulations containing Ancamine 2337S are significantly lower than those of the control formulation, indicating the higher reactivity of Ancamine 2337S curing agent.

TABLE 1: COMPOSITION (% BY WT)

INGREDIENT	I	II	III	IV	V
Liquid DGEBA (EEW=190)	100	100	100	100	100
Ancamine 2337S Curing Agent	30	40	50	60	-
Ancamine 2014FG Curing Agent	-	-	-	-	28
Fumed Silica	1	1	1	1	1
STROKE GEL TIME (MIN)					
@ 175°F (80°C)	4.1	3.7	2.7	2.4	15.0
@ 212°F (100°C)	2.1	1.6	1.4	1.2	7.0
@ 250°F (120°C)	1.0	1.0	<1.0	<1.0	1.5
DSC INITIAL REACTIVITY					
Onset Temperature (°F)	165	162	160	160	230
Peak Temperature (°F)	205	203	203	201	266
Heat of Reaction (J/g)	185	216	270	293	210
Tg (°F)					
after 30 min @ 250°F (120°C) cure	115	130	160	185	160

GLASS TRANSITION TEMPERATURE:

Samples of cured formulations were analyzed for glass transition temperature (Tg) using DSC. The scan rate was 50°F (10°C)/minutes starting at 70°F (20°C). Glass transition temperatures increase with higher levels of Ancamine 2337S curing agent.

SHEAR STRENGTH DEVELOPMENT:

To determine shear strength development, electrogalvanized steel lap coupons were bonded together with a ½" overlap and 10 mil bondline thickness. All bonded coupons were cured in an air circulated oven at 175°F (80°C), 212°F (100°C), 250°F (120°C) and 285°F (140°C). Lap shears were tested at room temperature according to ASTM D1002. Figures 1 and 2 show that shear strength values increased as a function of the increasing level of Ancamine 2337S curing agent, and plateaued at 50 phr for a cure temperature above 212°F (100°C). Also, formulations containing Ancamine 2337S curing agent demonstrated higher shear strength values than the control formulation under all cure conditions. The difference in shear strength values between the formulation containing Ancamine 2337S and the control formulation was more pronounced at lower temperatures, indicating more rapid development of green strength with Ancamine 2337S curing agent.

FIGURE 1: LAP SHEAR STRENGTH VS. CURE CYCLE AT 176°F AND 212°F (80°C AND 100°C)

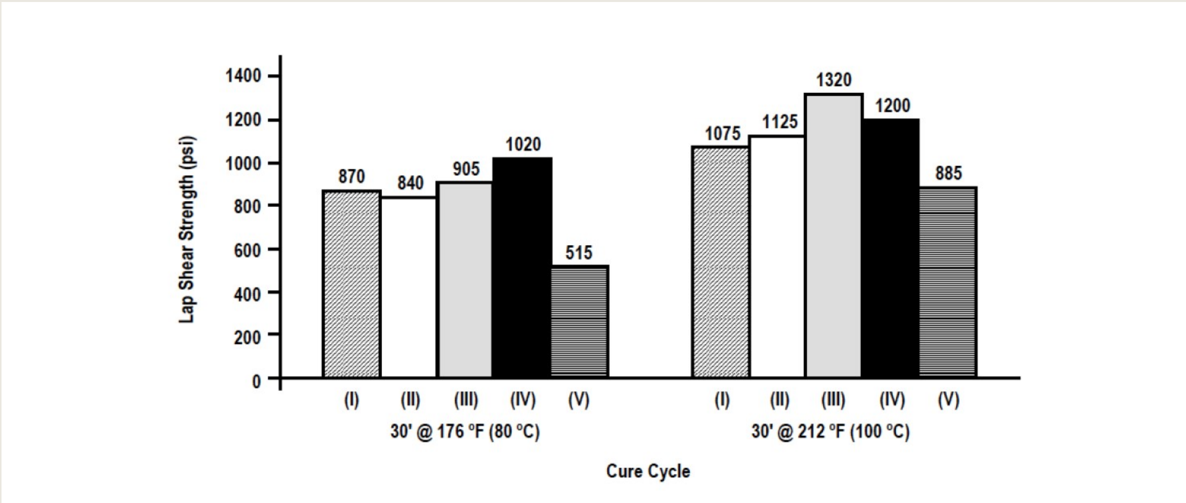
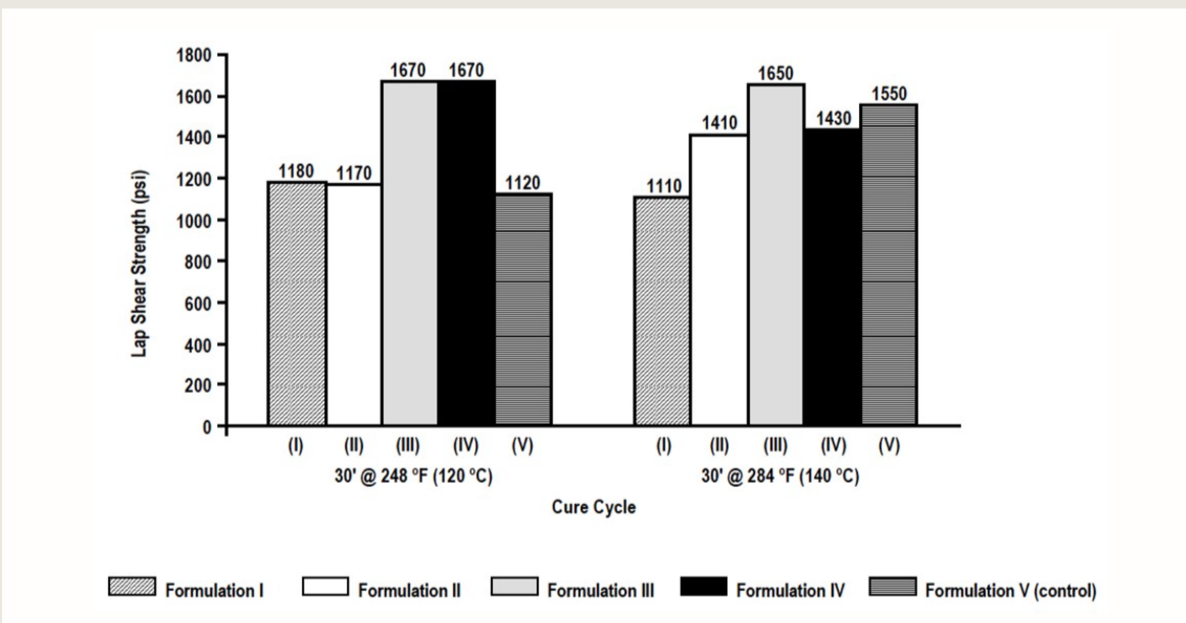


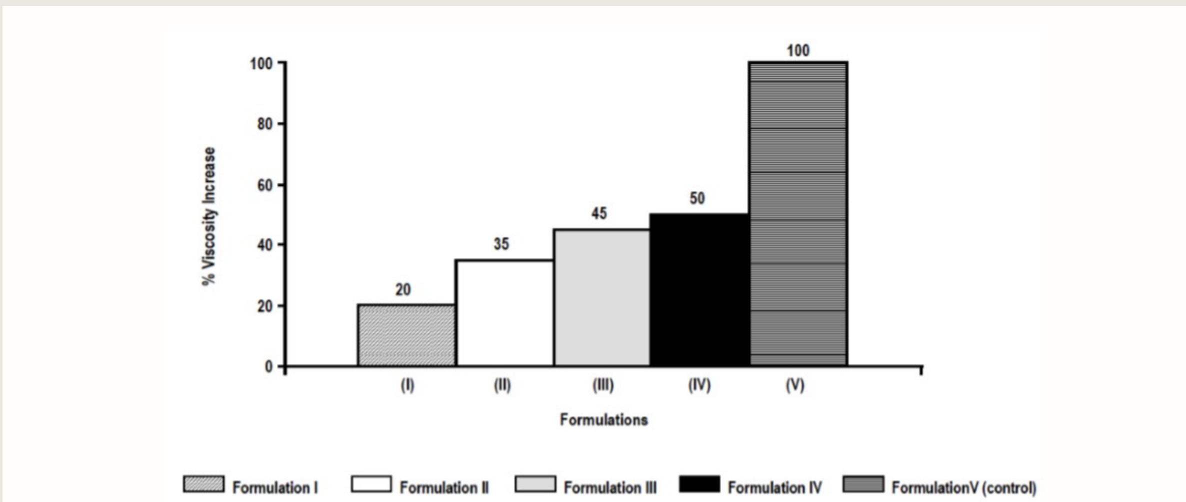
FIGURE 2: LAP SHEAR STRENGTH VS. CURE CYCLE AT 248°F AND 284°F (120°C AND 140°C)



FORMULATION SHELF STABILITY:

Twenty-four hours after mixing and degassing, the viscosity of the formulations was measured at room temperature. Thereafter, the formulations were stored at 110°F (42°C), and their viscosities were measured (after equilibrating to room temperature) every week. Figure 3 indicates that formulations containing Ancamine 2337S curing agent are shelf stable for more than 4 weeks at 110°F (42°C). However, the viscosity of the control formulation containing Ancamine 2014FG curing agent doubled in 4 weeks.

FIGURE 3: % VISCOSITY INCREASE AFTER AGING @ 4 WEEKS



EFFECT OF REACTIVE DILUENTS ON FORMULATION SHELF STABILITY:

The effect of reactive diluents on the shelf stability of formulations containing epoxy resin and Ancamine 2337S curing agent were studied. Results in Table 2 indicate that formulations containing 20 parts of aliphatic glycidyl ether, cresyl glycidyl ether and diglycidyl ether of neopentyl glycol adversely affected the shelf stability at 110°F (42°C). However, the viscosity of the formulation containing 20 phr of Cardura E-10 curing agent remained unchanged aft er 4 weeks.

TABLE 2: COMPOSITION (% BY WT)

Ingredient	I	II	III	IV	V
Liquid DGEBA (EEW=190)	100	80	80	80	80
Aliphatic Glycidyl Ether (Epodil® 748)	-	20	-	-	-
Cresyl Glycidyl Ether (Epodil 742)	-	-	20	-	-
Diglycidyl Ether of Neopentyl Gylcol (Epodil 749)	-	-	-	20	-
Glycidyl Ether (Cardura E-10)	-	-	-	-	20
Ancamine 2337S Curing Agent	40	33	40	43	38
SHELF STABILITY @ 110°F (42°C)					
% Viscosity Increase After 4 wk	40	gelled	gelled	gelled	44

ANCAMINE 2337S AS A CO-CURE ACCELERATOR:

Ancamine 2337S can be used as a co-cure accelerator with Ancamine 2014AS or Ancamine 2014FG curing agents for DICY-based epoxy formulations.

The reactivities of the formulations shown in Table 3 were analyzed by DSC, scanning from 77°F (25°C) to 535°F (280°C) at a ramp rate of 50°F (10°C)/min.

The formulation containing Ancamine 2337S curing agent as a co-cure accelerator demonstrated two separate peaks. The first peak, with lower onset and peak temperatures, represents the reactivity of Ancamine 2337S curing agent with epoxy resin. The second peak resulted from the reaction of Ancamine 2014AS and Amicure CG-1200 dicyandiamide with epoxy resin.

The low temperature reactivity of Ancamine 2337S curing agent allows rapid green strength development, as shown in Table 3. The glass transition temperatures are nearly identical for both formulations.

TABLE 3: COMPOSITION (% BY WT)

Ingredient	I	II
Liquid DGEBA	100	100
Amicure CG-1200 Curing Agent	8	6
Ancamine 2014AS Curing Agent	6	4
Ancamine 2337S Curing Agent	-	10
DSC Initial Reactivity		
Onset Temperature (°F)	268	Peak 1-78 Peak 2-137
Peak Temperature (°F)	300	Peak 1-95 Peak 2-157
Heat of Reaction (J/g)	320	Peak 1-24 Peak 2-228
Green Strength Development		
Lap Shear Strength after 60 min @ 212°F (100°C) (psi)	0	161
GLASS TRANSITION TEMPERATURE (°F)		
after 30 min @ 285°F (140°C)	244	250

COMPARATIVE ANALYSIS WITH COMMERCIAL LATENT CURING AGENTS

REACTIVITY

Reactivity with liquid epoxy resin was evaluated and compared for Ancamine 2337S and three commercial latent curing agents. Formulations (Table 4) were studied for viscosity increase as a function of time at 175°F (80°C) by a Rheometrics Dynamic Analyzer. Each sample was loaded into an environmental chamber preheated to 175°F (80°C). The rate of viscosity increase was significantly greater for the formulation containing Ancamine 2337S than for the formulations containing other commercial curing agents, again indicating rapid green strength development (Figure 4).

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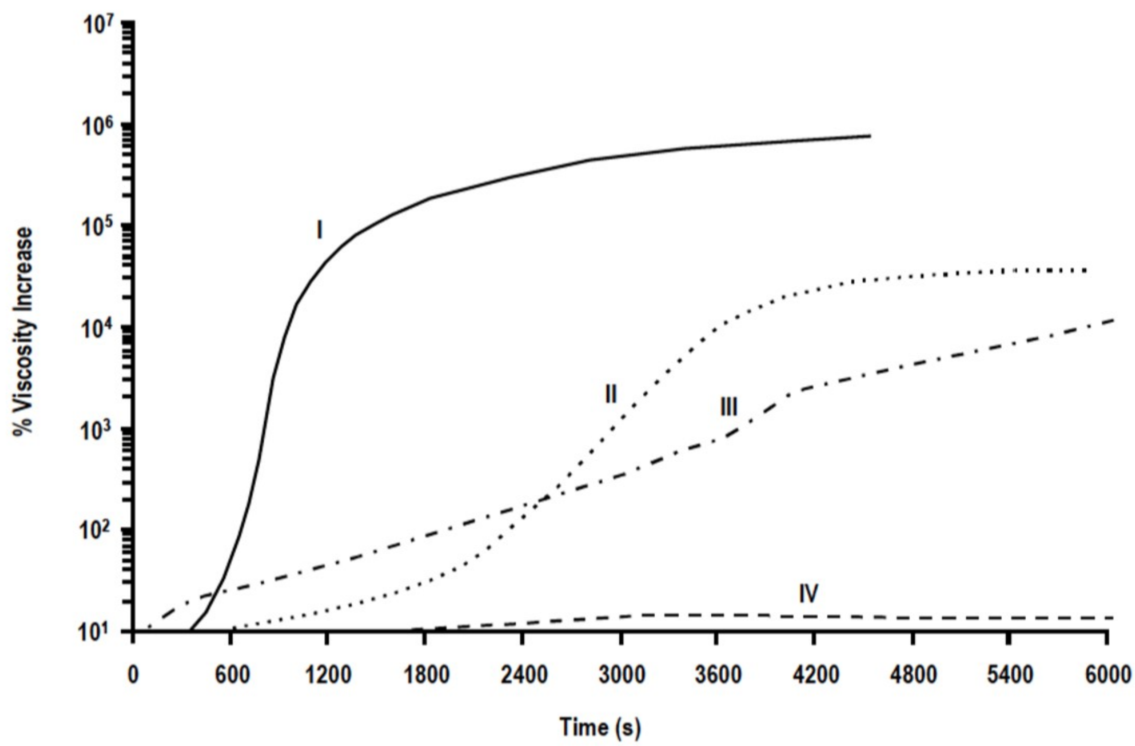
TABLE 4: COMPOSITION (% BY WT)

INGREDIENT	I	II	III	IV
Liquid DGEBA	100	100	100	100
Ancamine 2337S	40	-	-	-
Latent Curing Agent A	-	25	-	-
Ancamine 2014AS	-	-	28	-
Latent Curing Agent B	-	-	-	35

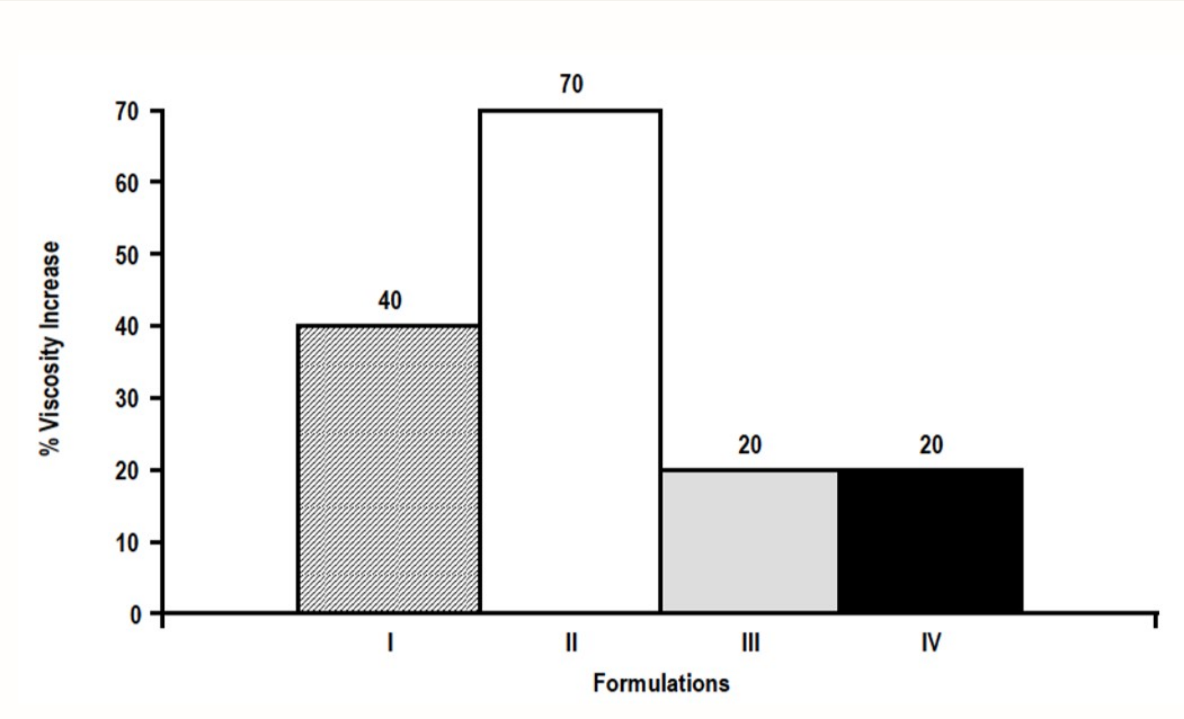
FIGURE 4: VISCOSITY VS. TIME @ 140°F (60°C)



FORMULATION SHELF STABILITY:

The formulations were also evaluated for shelf stability. The formulation containing Ancamine 2337S curing agent demonstrated acceptable shelf stability at 108°F (42°C), despite its excellent low temperature reactivity (Figure 5).

FIGURE 5: % VISCOSITY INCREASE AFTER AGING @ 4 WEEKS



ANCAMINE 2337S IN INDUCTION HEAT-CURE FORMULATIONS

Ancamine 2337S curing agent can be used as a sole curing agent in induction heat-cure epoxy formulations and as a co-cure accelerator with Ancamine 2014AS or Ancamine 2014FG curing agent. The improved low-temperature reactivity of Ancamine 2337S curing agent allows rapid development of green strength and reduced cycle time.

The formulations (Table 5) were studied for shear strength development and environmental resistance.

SHEAR STRENGTH DEVELOPMENT

The induction heat-cured formulations were studied for green strength development by immediately testing bonded lap shears for shear strength. The formulation containing Ancamine 2337S as a co-cure accelerator with Ancamine 2014FG curing agent demonstrated improved reactivity and adequate handling strength.

Lap shears bonded under induction heat were tested for 24 hours and after post-cure. The results are shown in Table 5.

ENVIRONMENTAL RESISTANCE

The adhesive formulations were also tested for environmental resistance. After postcuring, lap shear samples were exposed to two aggressive environmental conditions for 30 days and then tested at ambient temperature. Results in Table 5 indicate little effect on adhesion due to environmental exposure.

TABLE 5: COMPOSITION (% BY WT)

INGREDIENT	I	II	III	IV	V
Liquid DGEBA (EEW=190)	100	100	100	100	100
Ancamine CG-1200 Curing Agent	8	8	-	-	-
Ancamine 2014FG Curing Agent	5	5	-	-	-
Ancamine 2337S	-	10	40	50	60
Iron Oxide	20	20	20	20	20
SHEAR STRENGTH DEVELOPMENT LAP SHEAR STRENGTH (PSI) AFTER					
6 sec (1 sec ramp, 5 sec hold) @ 392°F (200°C)	0	30	-	-	-
4 sec (1 sec ramp, 3 sec hold) @ 347°F (175°C)	0	0	30	40	75
24 hr @ ambient temperature	-	260	485	770	820
Post-cure @ 325°F (163°C) for 30 min	-	1,220	1,040	1,120	1,320
ENVIRONMENTAL RESISTANCE LAP SHEAR STRENGTH (PSI) AFTER					
30 days in water @ 55°C	-	1,130	1,190	947	1,006
30 days in salt spray	-	1,280	775	1,202	1,252

RAW MATERIAL SUPPLIER

Liquid DGEBA
Epon 828 Resin: Shell Chemical Company
DER 331 Resin: Dow Chemical Company
Ancamine 2337S: Evonik Corporation
Ancamine 2014AS: Evonik Corporation
Ancamine 2014FG: Evonik Corporation
Epodil 748: Evonik Corporation
Epodil 742: Evonik Corporation
Epodil 749: Evonik Corporation
Cardura E-10: Shell Chemical Company
Dicyandiamide (Amicure CT-1200): Evonik Corporation
Iron Oxide: Magnox Pulaski, Inc.

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