

ANCAMIDE[®] 2353**Curing Agent****DESCRIPTION**

Ancamide 2353 curing agent is a high-performance modified polyamide intended for use with epoxy resins in two part ambient cure coatings. Special features of this product include fast dry, good cure at low temperatures and good resistance to solvents.

TYPICAL PROPERTIES

Property	Value	Unit	Method
Appearance	Slightly Turbid Amber Liquid		
Colour	9	Gardner	ASTM D 1544-80
Viscosity @ 77°F	3,000	cP	ASTM D 445-83, Brookfield, RVTD, Spindle 4
Amine Value	330	mg KOH/g	Perchloric Acid Titration
Specific Gravity @ 77°F	1.01		ASTM D 1475-85
Density	8.45	lb/gal	ASTM D 1475-85
Flash Point	>200	°F	
Equivalent Wt/{H}	114		
Recommended use Level			
(EEW=190)	60	PHR	
(EEW=500)	23	PHR	

ADVANTAGES

- Fast dry time
- Good cure at 5°C
- High solvent resistance
- Good corrosion resistance
- High gloss finish
- Excellent development of hardness
- Zero induction time
- Good adhesion to damp concrete
- Moderate viscosity

APPLICATIONS

- High-solids marine and maintenance coatings
- Concrete primers, coatings and bonding agents
- Adhesives

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 Ancamide 2353 curing agent.

TYPICAL CURE SCHEDULE

2-7 days at ambient temperature.

TYPICAL HANDLING PROPERTIES *

Property	Value	Unit	Method
Mixed Viscosity	5,800	cP	ASTM D 445-83, Brookfield, RVTD, Spindle 4
Gel Time (150g mix)	65	min	Techne GT-4 Gelation Timer
Thin Film Set Time @ 77°F	4.5	h	BK Drying Recorder
Thin Film Set Time @ 40°F	20	h	BK Drying Recorder
Peak Exotherm (100 g mass)	300	°F	ASTM D 2471-71
Peak Exotherm Time	65	min	ASTM D 2471-71

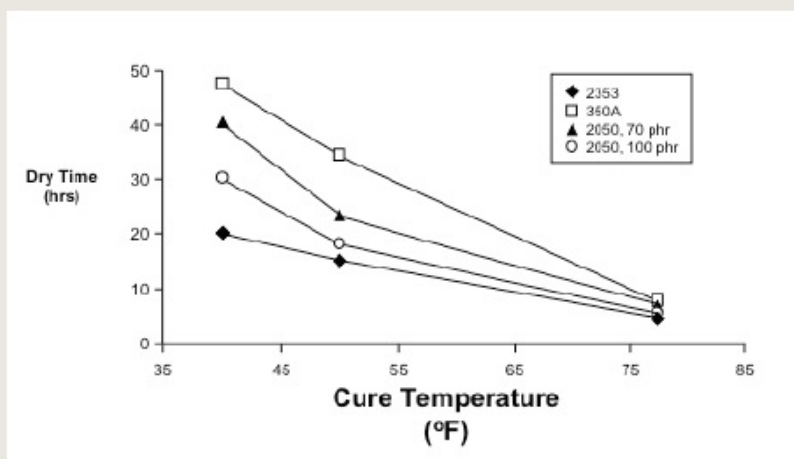
TYPICAL PERFORMANCE PROPERTIES

Property	Value	Unit	Method
Glass Transition Temp	131	°F	ASTM D3418-82
Compressive Strength @ Yield	14,300	psi	ASTM D 695-85
Compressive Modulus	388	thousand psi	ASTM D 695-85
Tensile Strength	9,800	psi	ASTM D 638-86
Tensile Modulus	403	thousand psi	ASTM D 638-86
Tensile Elongation	6.7	%	ASTM D 638-86
Flexural Strength	16,300	psi	ASTM D 790-86
Flexural Modulus	516	thousand psi	ASTM D 790-86
Hardness	80	Shore D	ASTM D 2240-86
Adhesion to Damp Concrete			
7 DAY CURE @ 72°F	300	psi	ASTM D 4547
7 DAY CURE @ 40°F	250	psi	ASTM D 4547

SUPPLEMENTARY DATA

FAST DRY TIME: As shown in Figure 1, the thin film dry time of Ancamide 2353 curing agent with liquid epoxy resin is significantly faster than Ancamide 2050 and Ancamide 350A (a conventional polyamide) curing agents. In dry time tests at room temperature, the thin film set time was reduced to 4.5 hours from 7 hours and 11 hours, respectively. At 40°F, the thin film set time was reduced from 46 hours for Ancamide 350A and 30-40 hours for Ancamide 2050, depending on use level, to 20 hours for Ancamide 2353. Ancamide 2353-based coatings can be recoated after overnight cure at 40°F. Tables 9, 10, 11 and 12 contain preliminary formulations based on Ancamide 2353 curing agent for an anti-corrosive primer, an aluminized mastic and two white gloss enamels (one low-VOC formulation with liquid resin and one fast-dry formulation with solid resin). The dry-to-touch times for these formulations were all under 4.5 hours, with the primer formulation being only 1 hour.

FIGURE 1: COMPARATIVE DRY TIMES

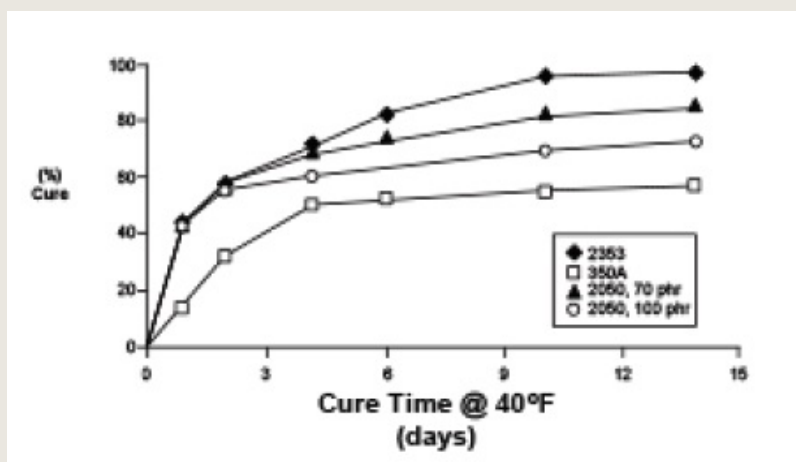


NOTE: Set to Touch times measured by BK dry time recorder

LOW TEMPERATURE PERFORMANCE: Ancamide 2353 curing agent is designed to cure at temperatures as low as 40°F when used with liquid epoxy resins. It produces hard, high-gloss coatings which are highly resistant to amine blush even when cured at low temperature and high humidity.

Figure 2 compares the cure development of Ancamide 2353, Ancamide 2050 and Ancamide 350A curing agents at 40°F. Both Ancamide 2353 and Ancamide 2050 curing agents have a faster and more complete cure than the conventional polyamide, even when the conventional polyamide is accelerated with Ancamine K54 curative. The superior cure is most evident in the first 3 days of cure at 40°F, when rapid property development is needed most. Although Ancamide 2353 and Ancamide 2050 curing agents both show very good cure rate and degree of cure at 40°F, Ancamide 2353 possesses the best balance of degree of cure and glass transition temperature, which is necessary for good coating performance.

FIGURE 2: 40°F CURE TIMES



NOTE: % Cure was measured by DSC.

CORROSION RESISTANCE: Formulations developed for an aluminized epoxy mastic and an inhibitive metal primer based on Ancamide 2353 are detailed in Tables 9 and 10. These formulations were evaluated for salt spray resistance after 1000 hours of exposure, and the results are shown in Table 1. Both formulations showed very good performance.

TABLE 1: SALT SPRAY RESISTANCE – ANCAMIDE 2353

	General Corrosion	Scribe Corrosion	Field Blistering	Blister Size
Aluminium Mastic	10	6-7	8	8
Red Primer	10	8-9	8-9	7-8

NOTE: 5% salt spray, cabinet temperature 95°F — ASTM B-117, film thickness 2.5 mils. Rating: 10 = Best, 0 = Worst.

ADHESION

STEEL SUBSTRATE: The Ancamide 2353-based primer and aluminum mastic formulations were evaluated per ASTM D-4541, Pull-Off Adhesion Test, for adhesion to heavy, hotrolled steel. Panels were blasted to an SSPC-SP 5 white metal quality with a mil profile of 3.0 mils. Greater than 450 psi was required for each formulation to cause failure, and all failures occurred in the adhesive. No cohesive failure in the coatings or adhesive failure at any interface was observed. Both formulations showed good results.

CONCRETE: Ancamide 2353 curing agent was tested for adhesion to damp concrete using dolly pull-off tests in accordance with ASTM D-4541. Samples were prepared by immersing blocks of ASTM C109 cement mortar in water for 24 hours. The blocks were then removed from the water, the excess water was wiped from the surface, and formulated epoxy was applied immediately. As shown in Table 3, Ancamide 2353 curing agent provides excellent adhesion to damp concrete even when used in conjunction with a diluted epoxy resin at 40°F. By comparison, Ancamide 350A curing agent exhibits poor adhesion to concrete when cured at low temperatures or when used with diluted epoxy resin. Ancamide K54 curing agent is ineffective at improving the adhesion of Ancamide 350A to damp concrete.

HANDLING PROPERTIES: Table 4 compares the handling properties of Ancamide 2353, Ancamide 2050 and Ancamide 350A curing agents. Ancamide 2353 has the lowest viscosity and zero induction time, resulting in easier handling than a conventional polyamide such as Ancamide 350A. Equivalent loading compared with Ancamide 350A allows Ancamide 2353 curing agent to be substituted into existing formulations with minimal modifications.

TABLE 2: HUMIDITY EXPOSURE – ANCAMIDE 2353

	General Corrosion	Blistering Degree	Blister Size
Aluminium Mastic	10	10	10
Red Primer	10	10	10

NOTE: Continuous 100% Humidity Exposure — ASTM D-2247, cabinet temperature 122°F, film thickness 2.5 mils. Rating: 10 = Best, 0 = Worst



TABLE 3: ADHESION TO DAMP CONCRETE

Curing Agent	Epoxy Resin	Tensile Pull Off (psi) 72°F Cure	Failure Mode	Tensile Pull Off (psi) 40°F Cure	Failure Mode
Ancamide 2353	DGEBA#*	300	Surface	250	Surface
	90% DGEBA*	290	Mortar	Mortar	Mortar
	10% Epodil® 748*				
Ancamide 350A	DGEBA*	210	Cohesive	60	Cohesive
	90% DGEBA*	60	Cohesive	50	Cohesive
	10% Epodil 748				
95% Ancamide 350A	DGEBA*	200	Cohesive	60	Cohesive
5% Ancamine K54	90% DGEBA*	40	Cohesive	40	Cohesive
	10% Epodil 748*				

DGEBA: Diglycidyl Ether of Bisphenol A (EEW=190)

Epodil 748: C₁₂₋₁₄ Alkyl Glycidyl Ether

Surface Failure: Bond failure in the upper 10% of the mortar specimen

Mortar Failure: Bond failure in the lower 90% of the mortar specimen

Cohesive Failure: Bond failure in the epoxy bond line

TABLE 4: HANDLING PROPERTIES

Handling Properties	Ancamide 2353	Ancamide 350A	Ancamide 2050
Viscosity (cP)	3,000	11,000	4,000
Mixed Viscosity* (cP)	5,800	12,000	6,400
Pot Life (min)*	60	200	100
Tack Free (h @ 72°F)*	4.5	11	7
Tack Free (h @ 40°F)*	20	46	40

* Curing agents were mixed with liquid DGEBA epoxy (EEW= 1 90) @ 60 phr for Ancamide 2353 and Ancamide 350A and 70 phr for Ancamide 2050

FILM PROPERTIES: Table 5 shows that the direct and reverse impact resistance levels for Ancamide 2353 are comparable to Ancamide 350A curing agent. Gloss is superior, while VOC content in a formulated paint can be at least maintained at the same level. Table 11 shows a white gloss enamel preliminary formulation based on liquid epoxy resin and Ancamide 2353 where the VOC has been reduced to 1.6 lb/gal.



TABLE 5: FILM PROPERTIES

Film Properties	Ancamide 2353	Ancamide 350A
VOC (LB/GAL)	2.3	2.3
Direct Impact (in/lb)	192	208
Reverse Impact (in/lb)	10	12
Gloss, 60°	100	90

NOTE: Pigmented formulations based on solid epoxy resin (EEW=325) were mixed with each curing agent, applied to cold rolled steel panels (S) (5 mil DFT) and cured for 7 days @ 72°F before testing.

Table 6 compares the hardness development of Ancamide 2353 and Ancamide 2050 curing agents with liquid bis-A resin at ambient temperature. Also shown are film appearance results under various conditions for both curing agents. Ancamide 2353-based films harden much more rapidly than those based on Ancamide 2050, and the Ancamide 2353-based films develop greater ultimate hardness.

TABLE 6: HARDNESS DEVELOPMENT AND FILM APPEARANCE

Hardness Development (pendulum)	Ancamide 2353	Ancamide 2050
1 day	98	5
7 days	137	60
14 days	140	112
Reverse Impact (cm.kg)		
1 day, 25°C, 50% RH	clear, tack free	clear, tack free
1 day, 10°C, 90% RH	slight haze, tacky	haze, tacky
1 day, 5°C, 80% RH	clear, tacky	clear, very tacky
7 days, 10°C, 90% RH	slight haze, tacky	haze, tack free
7 days, 5°C, 80% RH	clear, tacky	clear, tacky

NOTE: Clear formulations with liquid epoxy resin (EEW=190)

Film appearance also favors Ancamide 2353 in low temperature/high humidity conditions. Both curing agents give clear, tack-free film appearance at ambient temperature and moderate humidity.



PHYSICAL PROPERTIES: Table 7 shows the superior physical properties of Ancamide 2353 curing agent compared with Ancamide 350A. The high tensile strength, flexural strength and Shore D hardness show that Ancamide 2353 curing agent produces harder, tougher, more resilient epoxy formulations than the conventional polyamide.

TABLE 7: PHYSICAL PROPERTIES

Physical Properties	Ancamide 2353	Ancamide 350A
Tensile Strength (psi)	9,770	5,700
Flexural Strength (psi)	16,300	13,900
Compressive Strength (psi)	14,270	13,100
Shore D Hardness	80	75

NOTE: Curing agents were mixed with liquid epoxy (EEW-190) at 60 phr and cured for 7 days at 72°F before testing.

CHEMICAL RESISTANCE: Comparative chemical resistance levels for Ancamide 2353 and Ancamide 350A curing agents are shown in Table 8. Ancamide 2353 curing agent imparts significantly higher chemical resistance than Ancamide 350A curing agent, particularly to toluene.

The conventional polyamide is destroyed after 3 days' immersion in toluene, while Ancamide 2353 curing agent is virtually unaffected after 28 days' immersion in toluene. Ancamide 2353-based systems have higher resistance to ethanol, 10% acetic acid and 70% sulfuric acid, particularly as the immersion time increases. Resistance to 50% NaOH is comparable to the conventional polyamide.

TABLE 8: COMPARATIVE CHEMICAL RESISTANCE **

Reagent	Immersion Time (days)	Weight Gain (%)	
		Ancamide 2353	Ancamide 350A
	1	0.0	13.7
Toluene	3	0.1	26.3
	7	0.3	Destroyed
	28	1.8	Destroyed
	1	1.7	3.3
Ethanol	3	3.0	4.7
	7	4.4	6.1
	28	8.5	10.4
	1	5.6	7.6
10% HAc	3	9.7	13.9
	7	14.1	20.7
	28	25.1	36.8
	1	0.2	0.3
70% H₂SO₄	3	0.4	0.7
	7	0.7	1.6
	28	2.4	10.3
	1	0	0
50% NaOH	3	0	0
	7	0	0
	28	0	0

NOTE: Curing agents were mixed with liquid epoxy resin (EEW=190) at 60 phr and cured for 7 days at 72°F before Immersion.

** ASTM D 543-84

ANCAMIDE 2353 STARTING FORMULATIONS

TABLE 9: ANTICORROSIVE PRIMER PRELIMINARY FORMULATION

A-Component		lb	gal
Liquid DGEBA Epoxy	Dow, Resolution	233.7	24.093
MPA-1078	Rheox	4.0	0.541
Mix well, then add at high speed:			
TiPure R900	DuPont	25.0	0.751
10 Wollastekup AS	NYCO	370.0	15.289
Disperse To 5 Hegman And 125°F. Reduce Speed And Add:			
Xylene	Ashland	45.0	6.207
Total A component		677.7	46.860
B-Component			
Ancamide 2353	Evonik	125.54	15.212
MPA-1078	Rheox	4.0	0.541
Beetle 216-8	Cyanamid	15.0	1.724
Mix well at high speed, then add:			
Red Iron Oxide J-3100	Mineral Pigments	60.0	1.4411
Beaverwhite 325	Cyprus	96.7	4.204
Phosplus J-0866	Mineral Tech	141.4	5.065
Disperse to 5 Hegman and 125°F. Reduce speed and add:			
Diacetone Alcohol	Union Carbide	31.3	3.997
Super High Flash Naptha		106.8	14.691
Total B component		583.74	46.877

TECHNICAL DATA

Volume Solids	71.8%	VOC	2.1 lb/gal
PVC	39.7%	Mixing Ratio	1.1 by Volume
CPVC	54.6%	Pot Life, h	3
PVC/CPVC	.725	Dry to Touch, h	1
		Dry Through, h	6
Weight/gallon, Part A	14.45		
Weight/gallon, Part B	12.45		
Weight/gallon	13.45		



TABLE 10: ALUMINUM MASTIC PRELIMINARY FORMULATION

A-Component		lb	gal
Liquid DGEBA Epoxy		307.0	31.7
MPA-1078	Rheox	8.0	1.0
10 Wollastekup AS	NYCO	250.0	10.3
Disperse to 6 Hegman and 130°F.			
Epodil L	Evonik	35.0	4.0
High Flash Naptha		120.0	16.5
Beetle 216-8	Cytec	25.0	2.8
Lansford L243	Silberline	125.0	10.2
Diacetone Alcohol		24.0	3.0
Cabosil TS 720	Cabot	10.0	0.4
Total A component		904.0	80.0
B-Component			
Ancamide 2353	Evonik	169.0	20.0

TECHNICAL DATA

Volume Solids	71.9%	VOC	< 2.5 lb/gal
PVC	20.0%	Mixing Ratio	4.1 by Volume
CPVC	47.1%	Pot Life, h	5
PVC/CPVC	.426	Dry to Touch, h	3
		Dry Through, h	7
Weight/gallon,, Part A	11.29		
Weight/gallon, Part B	8.45		
Weight/gallon,	10.73		



TABLE 11: LOW-VOC WHITE GLOSS ENAMEL

A-Component		lb	gal
Grind Base			
Liquid DGEBA Epoxy	Dow, Resolution	352.76	36.43
Nuosperse 657	Hüls America	3.88	0.46
Byk 307	BYK Chemie	1.76	0.25
PM Solvent		48.68	6.32
TiPure R-960	DuPont	388.04	11.92
Let Down			
High Flash Naptha		67.73	9.22
Methyl Propyl Ketone		14.11	2.09
Total A component		876.97	66.70
B-Component			
Ancamide 2353	Evonik	212.03	23.96
n-Butanol		63.14	9.34
Total B component		275.17	33.30

TECHNICAL DATA

Part A Viscosity	73 KU	Pot Life, h	2
Part B Viscosity	64 KU	60° Gloss	102
Mixed Viscosity	70 KU	Dry Times	5
		- Set to Touch, h	7
		- Dust Free, h	Overnight
		- hard-dry, h	
PVC	17%	Volume Solids	70%
VOC @ 70 KU	< 2.2 lb/gal		
Mixing Ratio	2.1 by Volume		
Induction Time	0		

TABLE 12: FAST-DRYING WHITE GLOSS ENAMEL

A-Component		lb	gal
Grind Base			
DER 66OX80	Dow	472.55	51.47
Nuosperse 657	Hüls America	3.54	0.42
Beetie 216-8	Cytec	2.84	0.34
PM Solvent		47.26	6.20
TiPure R-960	DuPont	307.16	9.44
Let Down			
High Flash Naptha		73.72	10.03
Methyl Propyl Ketone		14.18	2.10
Total A component		921.25	80.00
B-Component			
Ancamide 2353	Evonik	131.44	14.86
n-Butanol		34.75	5.14
Total B component		166.22	20.00

TECHNICAL DATA

Part A Viscosity	86 KU	Pot Life, h	3
Part B Viscosity	64 KU	60° Gloss	104
Mixed Viscosity	80 KU	Dry Times:	50
		- Set to Touch, h	75
		- Dust Free, h	Overnight
		- hard-dry, h	
PVC	15.2%	Volume Solids	62.2%
VOC @ 70 KU	< 2.8 lb/gal		
Mixing Ratio	4.1 by Volume		
Induction Time	0		

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