PARALOID™ Thermosetting Acrylic Resins

For Conventional Solids and High Solids Coatings

Description

Thermosetting PARALOID resins can be classified in two groups according to their crosslinking mechanism: hydroxyl-functional which normally are crosslinked with nitrogen resins, and carboxyl-functional which normally are crosslinked with epoxy resins. These resins combine the same wide range of properties of the thermoplastic grades with the excellent solvent resistance, flexibility, impact resistance and high hardness of a crosslinked system.

Individual Grades Of PARALOID Thermosetting Acrylic Resins

Hydroxyl-Functional Resins

PARALOID AT-746

PARALOID AT-746 is a thermosetting acrylic polymer supplied at 50% solids in xylene. When crosslinked with a nitrogen resin it cures at standard baking temperatures to an extremely hard, glossy film which possesses superior resistance to soap, detergents, and staining. By virtue of its high degree of crosslinking, it develops excellent solvent resistance, print resistance, and resistance to deformation at elevated temperatures. Gloss retention and color retention are also excellent.

PARALOID AT-746 exhibits a wide range of compatibility with other film formers and plasticizers, a factor that provides considerable formulating latitude.

The use of PARALOID AT-746 allows the formulator to select the melamine resin type and level that will deliver the desired balance of properties.

PARALOID AT-63

PARALOID AT-63 is a thermosetting acrylic resin that is crosslinked with a nitrogen resin to produce baking coatings that are fast-curing and possess medium hardness, good adhesion, excellent flexibility, good overbake resistance, high gloss, and exterior durability. It is supplied at 50% solids in xylene.

PARALOID WR-97

PARALOID WR-97 is a thermosetting acrylic resin that is both water and solvent reducible. It has excellent compatibility with a wide variety of urea and melamine crosslinking resins, thermosetting acrylic emulsions, and aqueous colloidal dispersions. It is used for general purpose sprayable high-gloss industrial finishes and as a universal pigment dispersion medium.

PARALOID WR-97 resin is supplied at 70% solids in a mixture of isopropanol and butyl Cellosolve™.

High-Solids Hydroxyl-Functional Resins

PARALOID AT-400/PARALOID AT-410

PARALOID AT-400 and PARALOID AT-410 are thermosetting acrylic resins supplied in methyl n-amyl ketone. They react with aminoplasts to provide coatings that cure at low temperature (250°F) without the use of an external catalyst, and have an excellent balance of hardness, gloss, flexibility, and resistance properties.

The higher application solids allow the user to spray coatings without the sag problems associated with many high solids polyesters.

Enamels based on PARALOID AT-410 resin have higher gloss with better stain and solvent resistance than those based on PARALOID AT-400. However, PARALOID AT-400 based enamels have good exterior durability while PARALOID AT-410 ones do not.

Addition of PARALOID AT-400 and PARALOID AT-410 will also improve the performance of polyester polyol crosslinked systems.

Carboxyl-Functional Resins

PARALOID AT-76

PARALOID AT-76 is a thermosetting acrylic intermediate designed to crosslink with epoxy resins to give an outstanding balance of fabrication, dry heat, and processing resistance for metal-decorating applications. It provides excellent color high gloss, and retention of performance properties after high-temperature overbakes.

PARALOID AT-76 resin is supplied at 41% solids in a mixture of Aromatic 150 and butyl Cellosolve.

PARALOID AT-81/PARALOID AT-147

PARALOID AT-81 is a thermosetting acrylic intermediate designed to be crosslinked with epoxy resins. It is supplied at 55% solids in a mixture of Aromatic 150 and butyl Cellosolve. This solvent system makes PARALOID AT-81 resin suitable for roll coat applications and for metal-decorating finishes.

PARALOID AT-147 is similar to PARALOID AT-81 but it is supplied in butyl Cellosolve alone.

PARALOID AT-81 is generally used in combination with PARALOID AT-85, a softer acrylic resin intermediate.

PARALOID AT-85/PARALOID AT-148

PARALOID AT-85 is a thermosetting acrylic intermediate designed to be crosslinked with epoxy resins for producing metal-decorating finishes. It is softer than PARALOID AT-81 resin and it is also supplied at 55% solids in Aromatic 150 and butyl Cellosolve.

PARALOID AT-148 is similar to PARALOID AT-85 but supplied in butyl Cellosolve alone.

PARALOID AT-9LO

PARALOID AT-9LO is a thermosetting acrylic resin designed to crosslink with epoxy resins. It gives an outstanding balance of fabrication, dry heat, and processing resistance for metal-decorating applications. It provides excellent color, low odor, and high gloss, and retains performance properties even after high-temperature overbakes.

PARALOID AT-9LO is supplied at 43% solids in a mixture of Aromatic 150 and butyl Cellosolve.

FDA Clearance

PARALOID AT-81, PARALOID AT-85, and PARALOID AT-9LO have clearance under FDA Food Additive Regulation 21 CFR175.300 (Resinous and Polymeric Coatings) for use as a modifier for epoxy resins.

Table 1
Typical Physical Properties of PARALOID Thermosetting Resins
These properties are typical but do not constitute specifications.

PARALOID Resins	% Solids	Solvent[a] Ratio	Viscosity[b] cP at 25°C	Pensky-Martens Closed Cup Flash Point, °F	Lbs. per U.S. Gallon	Functionality	Crosslinking Resin
PARALOID AT-746	50	Xylene	3200 to 8700	81[d]	8.2	Hydroxyl	Nitrogen
PARALOID AT-63	50	Xylene	1500 to 3000	76	8.0	Hydroxyl	Nitrogen
PARALOID WR-97	70	IP/BC (83/17)	10000 to 17500	62	8.4	Hydroxyl	Nitrogen
PARALOID AT-400	75	MAK	3000 to 9000	121[d]	8.5	Hydroxyl	Nitrogen
PARALOID AT-410	73	MAK	2000 to 6000	113[d]	8.4	Hydroxyl	Nitrogen
PARALOID AT-76	41	A-150/BC (75/25)	2500 to 4500	134	8.1	Carboxyl	Epoxy
PARALOID AT-81	55.5	A-150/BC (87.5/12.5)	8000 to 16000	152[c]	8.4	Carboxyl	Epoxy
PARALOID AT-147	55	BC	4000 to 8000	138[d]	8.5	Carboxyl	Epoxy
PARALOID AT-85	55.5	A-150/BC (87.5/12.5)	3500 to 7000	150[c]	8.6	Carboxyl	Epoxy
PARALOID AT-148	55	BC	1600 to 3200	138[d]	8.3	Carboxyl	Epoxy
PARALOID AT-9LO	45	A-150/BC (83/17)	3400 to 6800	137	8.1	Carboxyl	Epoxy

[a]A-150 = Aromatic 150; BC = butyl Cellosolve; IP = isopropanol; MAK = methyl n-amyl ketone.
[b]Corrected to mid-range solids.
[c]Tag closed cup.
[d]SETA closed cup.

Table 2
Application of Thermosetting Acrylic Resins

PARALOID Resins		AT-746	AT-63	WR-97	AT-400	AT-410	AT-76	AT-81	AT-85	AT-147	AT-148	AT-9LO
Coil Coatings	Interior	X	X					X	X	X	X	
	Exterior		X									
Metal Decorating	Base Coat							X	X	X	X	X
	Overprint							X	X	X	X	X
	Can Liner							X	X	X	X	X
	Drum and Pail							X	X	X	X	X
	Closures						X	X	X	X	X	X
Low Temperature Conversion			X		X	X						
Appliance Finishing	Major Appliances							X	X	X	X	X
	Light Appliances	X	X	X	X	X	X	X	X	X	X	X
	Hospital	X				X		X	X	X	X	X
	Equipment	X				X		X	X	X	X	X
	Lab Equipment							X	X	X	X	X
Product Finishing	Aluminum Extrusions											
	Business Equipment											
	General Metal	X	X	X	X	X	X					
	Metal Furniture	X	X			X						
	Metal Cabinets	X	X			X						
Transportation	Auto Parts	X	X	X	X	X						
	Auto Refinishing		X									

Table 3
Desired Properties

	Hydroxyl						Carboxyl		
PARALOID Resin Properties	**AT-746**	**AT-63**	**WR-97**	**AT-400**	**AT-410**	**AT-76**	**AT-81 AT-147**	**AT-85 AT-148**	**AT-9LO**
Adhesion	X	X	X	X	X	X	X	X	X
Flexibility		X		X		X			X
Fast Cure		X		X	X				
Low-Temperature Cure		X		X	X				
Exterior Durability		X		X					
Resistance Properties	X				X	X	X	X	X
Hardness	X				X				
Gloss	X	X	X	X	X	X	X	X	X
Color Retention	X						X	X	X
Low Odor							X	X	X

Table 4
Compatibility of Selected PARALOID Thermosetting Resins

Baked Films 30 min./300°F	Hydroxyl Functional				Carboxyl Functional											
PARALOID Grade	**AT-746**		**AT-63**		**AT-76**		**AT-81**		**AT-85**		**AT-9LO**		**AT-147**		**AT-148**	
Intercompatibility																
Ratio:	**3/1[a]**	**1/3**	**3/1**	**1/3**	**3/1**	**1/3**	**3/1**	**1/3**	**3/1**	**1/3**	**3/1**	**1/3**	**3/1**	**1/3**	**3/1**	**1/3**
PARALOID AT-63	C	C	-	-	H	H	C	C	I	I	C	C	C	C	I	I
PARALOID AT-9LO	C	C	C	C	I	I	C	C	H	C	-	-	C	C	H	C
PARALOID AT-76	C	C	H	H	-	-	H	C	I	I	I	I	H	C	I	I
PARALOID AT-81	C	C	C	C	C	H	-	-	C	C	C	C	-	-	C	C
PARALOID AT-85	H	H	I	I	I	I	C	C	-	-	C	H	C	C	-	-
With Nitrogen Resins																
Nitrogen resin:	**7/3**	**6/4**	**7/3**	**6/4**												
Cymel 303	I	C	C	C												
Cymel 325	H	I	C	C												
Cymel 1168	I	I	C	C												
Resimine 745	I	I	C	C												
Resimine 741	C	C	C	C												
Resimine 755	C	C	C	C												

C = compatible I = incompatible H = Slightly hazy

[a]First number designates column; second number designates row.

Table 5
Solvent Tolerance of Selected PARALOID Thermosetting Resins

	Carboxyl-Functional ml of solvent added to 10g of resin to produce a haze		
Solvent	**PARALOID AT-81**	**PARALOID AT-85**	**PARALOID AT-9LO**
Xylene	∞	∞	∞
Aromatic 100	77	∞	∞
Aromatic 150	151	25	∞
VM&P Naptha	52	42	48
Mineral Thinner	∞	∞	28
PM Acetate	∞	∞	∞
n-Butanol	116	∞	32
Diacetone Alcohol	∞	∞	∞
MIBK	∞	∞	∞

Formulating

Hydroxyl-Functional Resins

PARALOID AT-746

White baking formulations, based on PARALOID AT-746 using selected melamines, are given in Table 6. A comparison of the application properties of these formulations is given in Table 7.

Clear film properties, based on PARALOID AT-746 using various compatible melamines, are indicated in Table 8.

Table 6
White Baking Enamels Based on PARALOID AT-746

	Cymel 325		Resimine 750	
Materials	**Pounds**	**Gallons**	**Pounds**	**Gallons**
Sand Mill Grind:				
Titanium Dioxide	250.0	7.18	250.0	7.18
PARALOID AT-746	100.0	12.20	100.0	12.20
Xylene/PM acetate	150.0	20.18	150.0	20.18
Mix With:				
PARALOID AT-746	358.0	43.66	357.0	43.53
Melamine	95.5	10.27	96.5	10.40
Raybo 3	0.5	0.07	0.5	0.07
	954.0	93.56	954.0	93.56
Formulation Constants:				
Weight per Gallon	10.2 lbs	10.2 lbs		
Total Solids	58.2%	58.3%		
Pigment	45.0%	45.0%		
Vehicle	55.0%	55.0%		
PARALOID AT-746	75.0%	74.8%		
Melamine Resin	25.0%	25.2%		

Table 7
Application Properties of White Baking Enamel Based on PARALOID AT-746

Substrate: Bonderite 1000
Bake Schedule: 30 Minutes at 300°F
Film Thickness: 1.4 mil Dry

Property	Cymel 325	Resimene 750
Spray solids, %	46.2	46.2
Spray viscosity, sec. (#4 Ford Cup)	20	20
Hardness		
Tukon (KHN)	23.8	22.8
Pencil (initial)	5H	5H
Pencil (after 60 min. in PM acetate)	5H	5H
Knife adhesion, Bonderite steel	Good	Good
Gloss, 20°/60°	82/92	76/92
Color, K value (low values better)		
Original (toned)	6.8	6.8
Overbake, 16 hrs. at 350°F)	8.7	9.1
Print resistance		
2 psi/30 min. at 180°F	No print	No print
Flexibility, 1/2-inch mandrel		
0 to 10; 10 = best	7	7
Stain resistance - spot tests		
Mustard - 30 min.	No stain	No stain
Ink - 30 min.	No stain	No stain

Table 8
Clear Film Properties of PARALOID AT-76

The solutions were cast on glass with a 10 mil filmograph, baked at 300°F/30 minutes.
Acrylic resin/melamine ratio = 75/25

Melamine	Tukon Hardness (KHN)	Pencil Hardness Initial/ After 30 Min. in PM Acetate
Cymel 325	17.2	3H/2H
Cymel 370	17.2	2H/2H
Cymel 243-3	15.2	2H/2H
Cymel 248-8	15.5	2H/H
Resimene 881	15.6	2H/H
Resimene 750	15.9	2H/2H
Resimene 741	15.7	2H/2H

PARALOID AT-63

Formulation AT-63-1 in Table 9 is a white gloss enamel based on PARALOID AT-63 resin.

The application properties of AT-63-1 are given in Table 10.

Table 9
Formulation AT-63-1
White Gloss Enamel Based on PARALOID AT-63 Resin

Materials		Parts by Weight
Sand Mill Grind		
Rutile titanium dioxide (Ti-Pure R-902)		50.0
PARALOID AT-63 (50%)		20.0
Xylene	}	12.0
n-Butanol	} Premix	6.0
Aromatic 100	}	12.0
Grind for 15 minutes, then let down as follows:		
PARALOID AT-63 (50%)		100.0
Cymel 370 (88%)		17.0
Xylene	}	30.0
n-Butanol	} Premix	17.0
Aromatic 100	}	15.0
Raybo 3		0.05
		279.05
Formulation Constants:		
Total solids		45%
Pigment		40%
Vehicle		60%
PARALOID AT-63		80%
Melamine		20%

Table 10
Application Properties of White Gloss Enamel
Based on PARALOID AT-63 Resin

Bake Schedule: 30 Minutes at 300°F, No Catalyst
Film Thickness: 1.5 mil on Bonderite 1000

Property	Formulation AT-63-1
Hardness	
Tukon (KHN)	12.0
Pencil	2H
Print resistance	
2 psi/1 hr at 180°F	Very light
Impact resistance, inch-lbs	
Reverse	2
Direct	40
Flexibility, 1/8-in. mandrel	
0 to 10; 10 = best	10
Stain resistance	
Mustard, 30 min.	No stain
Ink, 30 min.	No stain
Color, K value	5.5
Gloss	
20°	86
60°	95
Overbake, 30 min. at 400°F	
Gloss, 20°/60°	78/94
Color, K value	6.7
Xylene resistance, 15 min. (pencil hardness)	3B
Tide resistance, 1% solution at 165°F	
24 hrs.	OK
48 hrs.	Few #9 blisters
100 hrs.	Few #8 blisters
200 hrs.	Med. #4 blisters

PARALOID WR-97

Formulation WR-97-1 (Table 11) is a white, high-gloss baking enamel for general industrial finishes. The performance properties of this sprayable formulation are given in Table 12.

Table 11
Formulation WR-97-1
White High-Gloss Baking Finish (Melamine Crosslinker)

Materials	Pounds	Gallons
Ball Mill Grind (16 hours)		
Preblend:		
PARALOID WR-97	47.78	5.76
DMAE	1.47	0.20
Water	17.67	2.12
Add:		
Ti-Pure R-902	177.57	5.33
Water	100.38	12.05
Letdown:		
PARALOID WR-97	205.79	24.80
Cymel 303	45.34	4.53
Catalyst 4040	1.00	0.13
DMAE	6.69	0.89
Water	368.37	44.19
	972.06	100.00
Formulation Constants:		
PVC	17.1%	
Pigment/binder	45/55	
Volume solids	31.2	
Weight per gallon	9.7 lbs	
Weight solids	41.1	
PARALOID WR-97/Cymel 303	80/20	

Table 12
Performance Properties of Formulation WR-97-1
Film Thickness: ~1.2 mil dry on Bonderite 1000

Bake Schedule:			
Temperature °F	300	350	350
Time, min.	30	10	20
Properties			
Hardness (KHN)	8.1	9.0	10.4
Mandrel flexibility, 1/4"			
0 to 10; 10 = best	8	8	7
Impact resistance, in-lbs			
direct	85	75	65
reverse	15	3	7
Print resistance			
2 psi; 1hr. at 180°F.	Excellent	Excellent	Excellent
Gloss			
20°	86	85	83
20° overbake*	83	79	83
60°	97	97	97
60° overbake*	97	95	96
Color, K value			
initial	4.8	5.6	5.6
overbake*	5.9	5.2	6.6
Staining, 30 min.			
mustard	none	none	none
ink	none	none	none
lipstick	trace	none	none
Solvent resistance, 30 min.			
initial hardness	2H	2H	2H
xylene	B	2B	HB

*Overbake conditions are 16 hours at 400°F (204°C)

High-Solids Hydroxyl-Functional Resins

PARALOID AT-400/PARALOID AT-410

PARALOID AT-400 and PARALOID AT-410 can be formulated in a manner similar to that used for conventional thermosetting acrylic solution resins. A polymeric melamine such as Cymel 325 should be used to achieve uncatalyzed cures at 250°F. Where maximum solids are desired a monomeric melamine such as Cymel 303 should be used, but the formulation will require an external catalyst.

Polyester Modification

In addition, PARALOID AT-400 and PARALOID AT-410 may be used to upgrade the performance of polyester polyols in melamine crosslinked systems.

Typical starting point formulations based on these products for conventional spray applications are presented in Tables 13 and 14. The small amounts of solvent required to reduce to spray viscosity help to keep the cost competitive with conventional enamels.

Stability

Enamels based on PARALOID AT-400 and PARALOID AT-410 resins exhibit excellent viscosity stability. Film properties of aged enamels formulated with Cymel 325 or Cymel 303 have been found to be comparable to those of freshly prepared samples.

Spray Applications

Enamels based on PARALOID AT-400 and PARALOID AT-410 resins exhibit excellent conventional spray properties with outstanding sag and crater resistance. The application solids can be formulated at greater than 50% solids. (Formulations AT-400-1, AT-400-2, AT-410-1 and AT-410-2.) They also exhibit an overspray with lower tack than high solids polyesters to allow for easier cleanup.

Table 13
Conventional Spray White Baking Enamels

	Formulation AT-400-1		Formulation AT-400-2	
Materials	**Pounds**	**Gallons**	**Pounds**	**Gallons**
Sand Mill Grind (15 Minutes):				
Ti-Pure R-902	339.0	9.90	351.0	10.25
PARALOID AT-410 (75% nonvolatiles)	198.9	23.29	205.9	24.11
n-Butanol	98.4	14.65	128.7	19.15
Methyl n-amyl ketone	41.7	6.16	16.4	2.42
Sand - 700 parts by weight				
Total	**678.0**	**54.00**	**702.0**	**55.93**
% Solids	**72.0**		**72.0**	
Storage Enamel:				
Sand Grind	678.0	54.00	702.00	55.93
PARALOID AT-410	215.5	25.23	223.1	26.3
Cymel 325	129.5	13.92	—	—
Cymel 303	—	—	107.3	10.73
Methyl n-amyl ketone	22.8	3.37	22.0	3.25
PM acetate	29.6	3.67	25.7	3.19
Dow 57[a]	0.8	0.11	0.8	0.11
Catalyst 4040 (40% pTSA)	—	—	5.4	0.67
Total	**1076.2**	**100.30**	**1086.3**	**100.01**
Formulation Constants for Storage Enamel:				
Pigment/Binder Ratio	45/55		45/55	
PARALOID AT-400/Melamine (solids ratio)	75/25		75/25	
Enamel Solids, wt. %	70.0		72.0	
Enamel Solids, vol. %	53.5		55.9	
Enamel Viscosity, seconds (No. 4 Ford Cup, 25°C)	77		76	
% Catalyst 4040 on total resin solids	—		1.25	
% Alcohol on total resin solids	30		30	
Application Constants for Spray Enamel[b]:				
Spray Solids, wt. %	66.0		69.0	
Spray Solids, vol. %	49.0		52.4	
Spray Viscosity, seconds (No. 4 Ford Cup, 25°C)	39		40	
VOC, calculated lb/gal	3.54		3.33	

[a]Dow Corning 57 Paint Additive is prediluted to a 10% solution in xylene or other suitable solvent.
[b]Reduce enamel from storage viscosity to 35-40 seconds (No. 4 Ford Cup) spray viscosity with methyl n-amyl ketone/PM acetate (85/15).

Table 14
Conventional Spray White Baking Enamels

Materials	Formulation AT-410-1 Pounds	Formulation AT-410-1 Gallons	Formulation AT-410-2 Pounds	Formulation AT-410-2 Gallons
Sand Mill Grind (15 Minutes):				
Ti-Pure R-902	339.0	9.90	351.0	10.25
PARALOID AT-410 (73% nonvolatiles)	204.3	24.33	211.5	25.19
n-Butanol	98.4	14.65	128.7	19.15
Methyl n-amyl ketone	36.3	5.36	10.8	1.59
Sand - 700 parts by weight				
Total	**678.0**	**54.24**	**702.0**	**56.18**
% Solids	**72.0**		**72.0**	
Storage Enamel:				
Sand Grind	678.0	54.24	702.00	56.18
PARALOID AT-410	221.4	26.36	229.2	27.30
Cymel 325	129.5	13.92	—	—
Cymel 303	—	—	107.3	10.73
Methyl n-amyl ketone	16.9	2.50	15.9	2.35
PM acetate	29.6	3.67	25.7	3.19
Dow 57[a]	0.8	0.11	0.8	0.11
Catalyst 4040 (40% pTSA)	—	—	5.4	0.67
Total	**1076.2**	**100.80**	**1086.3**	**100.53**
Formulation Constants for Storage Enamel:				
Pigment/Binder Ratio	45/55		45/55	
PARALOID AT-400/Melamine (solids ratio)	75/25		75/25	
% Alcohol on total resin solids	30		30	
% Catalyst 4040 on total resin solids	—		1.25	
Enamel Solids, wt. %	70.0		72.0	
Enamel Solids, vol. %	53.8		56.1	
Enamel Viscosity, seconds (No. 4 Ford Cup, 25°C)	66		73	
Application Constants for Spray Enamel[b]:				
Spray Solids, wt. %	67.0		69.0	
Spray Solids, vol. %	50.3		52.6	
Spray Viscosity, seconds (No. 4 Ford Cup, 25°C)	38		38	
VOC, calculated lb/gal	3.44		3.27	

[a]Dow Corning 57 Paint Additive is prediluted to a 10% solution in xylene or other suitable solvent.
[b]Reduce enamel from storage viscosity to 35-40 seconds (No. 4 Ford Cup) spray viscosity with methyl n-amyl ketone/PM acetate (85/15).

Carboxyl-Functional Resins

PARALOID AT-76

For metal-decorating coatings with excellent colon high gloss, deep draw, and good overbake characteristics, two PARALOID AT-76-based white formulations (Table 15) and one clear overprint formulation (Table 16) are given (Formulations AT-76-1, AT-76-2, and AT-76-3, respectively).

The performance properties of AT-76-1 and AT-76-2 are shown in Table 17, while the application properties of AT-76-1 and AT-76-2 with a clear overprint (AT-76-3) are shown in Table 18.

Table 15
Base White Formulations for Metal Decoration
Based on PARALOID AT-76 Resin

Materials	Formulation AT-76-1 Pounds	Formulation AT-76-2 Pounds
Grind:		
Rutile titanium dioxide	200.0	200.0
PARALOID AT-76 (41%)	92.6	92.6
Aromatic 150	34.0	34.0
PM acetate	66.0	66.0
Mix With:		
PARALOID AT-76 (41%)	351.2	365.9
Epon 1001 (50% in PM acetate)	36.0	24.0
PM acetate	144.0	144.0
Aromatic 150	69.3	69.3
	993.1	995.8
Formulation Constants:		
Adjust viscosity to desired storage or application viscosity		
Total solids	40.2%	40.2%
Pigment	50%	50%
Vehicle	50%	50%
PARALOID AT-76	91%	94%
Epon 1001	9%	6%

Table 16
Formulation AT-76-3
Clear Overprint Based on PARALOID AT-76 Resin

Materials	Pounds
PARALOID AT-76 (41%)	208.5
Epon 1001 (50% in PM acetate)	30.0
Pine oil	45.0
Butyl Cellosolve	136.0
Formulation Constants	
Adjust viscosity to desired storage or spray viscosity	
Solids	24.0%
Binder	
PARALOID AT-76	85%
Epon 1001	15%

Table 17
Application Properties of Metal-Decorating Systems Based on PARALOID AT-76 Resin

	AT-76-1		AT-76-2	
Property	**10'/375°F**	**10'/400°F**	**10'/375°F**	**10'/400°F**
Flow and leveling (1 = best)	1	—	1	—
Gloss, 60°	92	—	92	—
Color (visual)	White	White	White	White
Fabrication				
Erichsen rating, mm	0.55	0.50	0.60	0.60
Knurl fractures, screw caps	0	3	0	3
Dry heat, screw caps (10 min, at 400°F)	OK	OK	OK	OK
Steam processing, screw caps	OK	OK	OK	OK
(15 lbs steam for 1 hr.)		trace failure		
Hot stacking (30 psi - 16 hrs. at 120°F)				
Face-to-face	V. light	OK	Light	OK-trace
Face-to-back	V. light	OK	V. light	OK
With Size Coat*				
Flow and leveling (1 = best)	1	—	1	—
Gloss, 60°	92	—	92	—
Color (visual)	White	White	White	White
Fabrication				
Erichsen rating, mm	0.60	0.50	0.65	0.60
Knurl fractures, screw caps	0	3	0	3
Dry heat, screw caps (10 min, at 400°F)	OK	OK	OK	OK
Steam processing, screw caps	OK	OK	OK	OK
(15 lbs steam for 1 hr.)				
Hot stacking (30 psi - 16 hrs. at 120°F)				
Face-to-face	V. light	OK	Light	OK-trace
Face-to-back	V. light	OK	V. light	OK

*Size Coat - Eponol 55-L-32/Methylon 75202 (90/10) with 1.5% H_3PO_4 added as 50% solution in n-butanol; baked 10 minutes at 390°F.

Table 18
Application Properties of Base White Metal-Decorating Formulations AT-76-1 and AT-76-2 With Clear Overprint Formulation AT-76-3

Overprint Bake Schedule = 10 Minutes at 375°F				
Base White Foundation:	**AT-76-1**		**AT-76-2**	
Base White Bake Schedule:	**10'/375°F**	**10'/400°F**	**10'/375°F**	**10'/400°F**
Flow and leveling (1 = best)	2	—	2	—
Gloss, 60°	100	—	100	—
Mar resistance	Fair	—	Fair	—
Color (visual)	White	White	White	White
Fabrication				
Erichsen rating, mm	0.60	0.55	0.65	0.60
Knurl fractures, screw caps	0	0	0	0
Dry heat, screw caps (10 min, at 400°F)	OK	Trace failure	OK	OK
Steam processing, screw caps	OK	OK	OK	OK
(15 lbs steam for 1 hr.)		trace failure		
Hot stacking (30 psi - 16 hrs. at 120°F)				
Face-to-face	V. light	V. light	V. light	V. light
Face-to-back	V. light	V. light	V. light	V. light

PARALOID AT-81 and PARALOID AT-85

PARALOID AT-81 is generally used in combination with PARALOID AT-85, a softer acrylic resin intermediate. Both are used in combination with an epoxy resin for metal decorating. The degree of crosslinking can be varied by selecting the appropriate acrylic/epoxy resin ratio to obtain the desired balance of flexibility and resistance properties.

Formulation AT-85-1 is a white baking enamel using PARALOID AT-85 resin as the sole acrylic binder. This system gives a tough metal-decorating coating with the highest hot stacking resistance, impact resistance, and resistance to water softening (see Table 19).

Formulation AT-85-2, another white baking enamel based on PARALOID AT-85 resin, has a higher acrylic to epoxy resin ratio and offers more resistance to severe fabrication and dry heat (see Table 19).

Formulation A-85-3 utilizes both PARALOID AT-85 and PARALOID AT-81 resins and provides a balanced formulation with resistance to severe fabrication and dry heat at the slight expense of hot stacking resistance, water softening resistance, and hardness (see Table 20).

Application properties are found in Table 21 for Formulations AT-85-1, AT-85-2 and AT-85-3.

Table 19
White Baking Enamels for Metal Decoration
Based on PARALOID AT-85 Resin

Materials	Formulation AT-85-1 Pounds	Formulation AT-85-2 Pounds
Sand Mill Grind:		
Rutile titanium dioxide	357.0	357.0
PARALOID AT-85 (55%)	136.4	136.4
Aromatic 150	126.0	126.0
PM acetate	42.0	42.0
Mix With:		
PARALOID AT-85 (55%)	208.7	287.3
Araldite 6060 (50% in PM acetate)	204.4	116.5
Raybo 3	0.5	0.5
	1075.0	1065.7
Formulation Constants:		
Adjust viscosity to desired storage or application viscosity		
Total solids	60.3%	60.8%
Pigment	55%	55%
Vehicle	45%	45%
PARALOID AT-85	65%	80%
Araldite 6060	35%	20%

Table 20
Formulation At-85-3
White Baking Enamel for Metal Decorating
Based on PARALOID AT-81 and PARALOID AT-85 Resins

Materials	Pounds
Sand Mill Grind:	
Rutile titanium dioxide	340.0
PARALOID AT-85 (55%)	132.0
Aromatic 150	135.0
PM acetate	45.0
Mix With:	
PARALOID AT-85 (55%)	90.5
PARALOID AT-81 (55%)	222.5
Epon 1001 (50% in PM acetate)	66.8
Aromatic 150	38.0
PM acetate	13.0
Raybo 3	0.5
	1083.3
Formulation Constants	
Adjust viscosity to desired storage or spray viscosity	
Total solids	57.1%
Pigment	55%
Vehicle	45%
PARALOID AT-85	44
PARALOID AT-81	44
Epon 1001	12

Table 21
Application Properties for White Baking Enamels
Based on PARALOID AT-81 and PARALOID AT-85 Resins

Bake Schedule: 10 Minutes at 400°F

Property	AT-85-1	AT-85-2	AT-85-3
Gloss, 60°	77	74	83
Color	1	1	1
Flow	1	1	1
Hot slip	1	1	1
Hot stacking			
Face-to-face	No sticking	Sl. sticking	Sl. sticking
Face-to-back	No sticking	No sticking	No sticking
Wedge-bend, cm.	4.6	3.6	5.8
Pencil hardness	H	H	F
Enamel stability	Excellent	Excellent	Excellent

PARALOID AT-9LO

As a starting point for the evaluation of PARALOID AT-9LO, Formulation AT-9LO-1 is given in Table 22. Properties of this formulation on sized and on unsized tinplate are given in Table 23.

Table 22
Formulation AT-9LO-1
White Baking Enamel

Materials	Pounds
Sand Mill Grind:	
Rutile titanium dioxide	200.0
PARALOID AT-9LO (43%)	84.4
Aromatic 150	34.4
PM acetate	66.0
Mix With:	
PARALOID AT-9LO (43% solids)	326.7
Epon 1001 (50% in PM acetate)	30.0
PM acetate	144.0
Aromatic 150	69.3
	954.8
Formulation Constants	
Adjust viscosity to desired storage or spray viscosity	
Total solids	41.8%
Pigment	50%
Binder	50%
PARALOID AT-9LO	92.5%
Epon 1001	7.5%

Table 23
Performance Properties of Formulation AT-9LO-1

Regular Baked Base White - 10 Minutes at 375°F		
Size Coat	—	Yes*
Base white	Formulation 1	Formulation 1
PARALOID AT-9LO	92.5	92.5
Epon 1001	7.5	7.5
Flow and leveling (1 = best)	1	1
Gloss, 60°	92	92
Color (visual)	White	White
Fabrication		
Erichsen rating, mm	0.55	0.60
Knurl fractures, screw caps	0	0
Dry heat (10 min. at 400°F), screw caps	OK	OK
Steam processing (15 lbs steam, 1 hr.)		
screw caps	OK	OK
Hot stacking (30 psi, 120°F, 16 hrs.)		
Face-to-face	Very light	Very light
Face-to-back	Very light	Very light
Regular Baked Panels Overbaked for an Additional 10 Minutes at 400°F		
Size coat	—	Yes*
Base white	Formulation 1	Formulation 1
PARALOID AT-9LO	92.5	92.5
Epon 1001	7.5	7.5
Color (Visual)	White	White
Fabrication		
Erichsen rating, mm	0.50	0.50
Knurl fractures, screw caps	3	2
Dry heat (10 min. at 400°F), screw caps	OK-trace failure	OK
Steam processing (15 lbs steam, 1 hr.)		
screw caps	OK-trace failure	OK
Hot stacking (30 psi, 120°F, 16 hrs.)		
Face-to-face	OK	OK
Face-to-back	OK	OK
*Based on Eponol 55-L-32		

Raw Material Supplier List

Ingredient	Supplier
Araldite 6060	Ciba Products Co., Summit, NJ
Aromatic 100 Aromatic 150	Exxon Corp., Houston, TX
butyl Cellosolve	Union Carbide Corp., Danbury, CT
Catalyst 4040	Cytec Industries, Inc., Morristown, NJ
Cymel 243-4 Cymel 248-8 Cymel 303 Cymel 325 Cymel 370 Cymel 1168	Cytec Industries, Inc., Morristown, NJ
Dow 57	Dow Chemical Co., Midland, MI
Epon 1001	Shell Chemical Co., Houston, TX
Eponol 55-L-32	Shell Chemical Co., Houston, TX
pTSA catalyst	Cytec Industries, Inc., Morristown, NJ
Raybo 3	Raybo Chemical Co., Huntingdon, WV
Resimene 741 Resimene 745 Resimene 750 Resimene 755 Resimene 881	Solutia, St. Louis, MO
Ti-Pure R-902	E.I. duPont de Nemours & Co., Wilmington, DE
Titanox RA	NL Chemicals, Inc., Hightstown, NJ

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