

# United States Patent [19]

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[54] POLYESTERS FOR POWDER COATING RESINS USING AN INTERMEDIATE HAVING LOW PROCESS VISCOSITY

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[57] **ABSTRACT**

Linear, carboxyl functional polyesters suitable for powder coating compositions which also include polyepoxide cross-linking agents are described.

**15 Claims, No Drawings**

alents of aliphatic diacid to react with the first polyester in accordance with the invention also will vary. Table I shows that over a hydroxyl value of 60 to 100, how the equivalents of diacid will vary to carboxylate the first polyester to an acid value of 25 to about 40 and where the number average molecular weight of the carboxylated polyester ranges from about 2500 to about 4000.

hydroxyl value in the range of about 60 to about 100. As seen in Table II, in general for the first polyester to have a hydroxyl value in the range from about 60 to about 80, from about 0.715 to about 0.658 equivalents of terephthalic or isophthalic acid, over a given equivalent range of polyol such as neopentyl glycol or cyclohexane dimethanol are reacted to form the first polyester.

TABLE II

Ingredient	Equivalents of Terephthalic Acid Required To Provide A Hydroxyl Value of 60 to 100 At A Given Polyol Concentration				
	Hydroxyl Value				
	60	70	80	90	100
Neopentyl glycol (NPG)	.798	.798	.798	.798	.798
Cyclohexane dimethanol (CHDM)	.004	.004	.004	.004	.004
Terephthalic acid (TPA)	.715	.700	.686	.672	.658
Mn (number average) molecular wt.	1726	1496	1320	1181	1068
Acid value	5	5	5	5	5
Resin eq. wt.	935	801	701	623	561

Note as the number average molecular weight of the carboxylated polyester increases to 4000, the acid value of that carboxylated polyester narrows for use in the invention.

To facilitate esterification of the terephthalic or isophthalic acid and diol an esterification catalyst such as butylchlorotin dihydroxide, dibutyl tin oxide or hydrated monobutyl tin oxide is used in an amount of

TABLE I

Mn For Carboxy- lated Poly- ester	Equivalents of Aliphatic Diacid Over Varying Hydroxyl Values					
	AV**	100 (OH)* EQ DA***	90 (OH) AV EQ DA	80 (OH) AV EQ DA	70 (OH) AV EQ DA	60 (OH) AV EQ DV
2500	25	.152	.138	.124	.110	.095
	30	.168	.155	.141	.127	.112
	33	.179	.165	.151	.137	.122
	40	.202	.189	.175	.161	.147
3000	25	.164	.151	.137	.122	.108
	30	.181	.167	.154	.139	.125
	33	.191	.178	.164	.150	.135
	37	.205	35 .184 37 .191	35 .171 37 .178	37 .163	35 .149
3500	25	.173	.160	.146	.131	.117
	30	.190	.176	.163	.148	.134
	32	.197	.183	.169	.155	.141
4000	25	.180	.166	.152	.138	.124
	27	.187	—	—	.145	.130
	28	.190	.176	.163	.148	.134

\*Hydroxyl value of first polyester.

\*\*Acid value of carboxylated polyester.

\*\*\*Equivalent of diacid.

As used herein aliphatic dicarboxylic acid means an open chain without branching, saturated or unsaturated acid or anhydride thereof. Suitable diacids include maleic, succinic, adipic and azelaic acids. The carbon chain length of the value of the first polyester affect the Tg of the cured coating film. As the hydroxyl value of the first polyester increases from 60, the carbon chain length of the aliphatic diacid, should be decreased to maintain the Tg of the coating binder. Fumaric acid also may be used as the aliphatic diacid and indeed, the use of fumaric acid is an important aspect of this invention.

The first polyester is the reaction product of not more than about 53 weight percent, based upon the reaction mixture for the first polyester, of terephthalic or isophthalic acid or mixtures thereof and an amount of neopentyl glycol and/or cyclohexane dimethanol which is effective to provide the first polyester with a

about 0.05-0.35 weight percent of the total reaction charge.

Processing viscosities are kept relatively low to reduce reaction times. The carboxylated polyester resin has an ICI cone and plate viscosity of about 25 to about 60 poise and preferably about 30 to about 50 poise at 200° C. The first polyester has an ICI cone and plate viscosity in the range of about 8 to about 16 poise and preferably from about 10 to about 12 poise at 175° C.

In a preferred embodiment of the invention, the first polyester is made in two steps to keep the processing viscosity of the reaction mixture lower and provide a check to monitor the extent of reaction of terephthalic acid and diol. In this embodiment the diol is reacted with only part of the terephthalic acid or isophthalic acid (from about 50 to about 75 weight percent of the

total terephthalic acid used in the reaction) to form a oligomer. The resulting oligomer then is further reacted with the remaining terephthalic acid to form the first polyester.

After the carboxylated polyester resin is made, it is allowed to cool and solidify. The solidified resin then is crushed or granulated and blended with the polyepoxide along with pigments and other additives to provide a mixture which then may be extruded at from about 80° C. to about 150° C. such as with a PLK 46 Buss Ko-Kneader. The resultant formulated coating composition is cooled, crushed, finely ground and sieved. The resultant formulated powder coating composition may be applied and cured such as by spraying and then baking at from about 160° C. to about 200° C. for about 45 to about 5 minutes.

The following example is provided to illustrate the invention more fully; however, it should not be construed as limiting the scope of the invention, many variations of which are contemplated.

#### EXAMPLE I

One mole of neopentyl glycol (1536.8 g) is reacted with 0.659 mole of terephthalic acid (1615.2 g) with 0.0056 moles CHDMR-100 (12 g), Fascat 4101 (8.0 g) 7.7, an ICI cone and plate viscosity at 100° C. of 25.6 poise. 0.25 moles of terephthalic acid (538.4 g) are added to and reacted with the oligomer for 400 minutes at 220° C. to produce a high molecular weight first polyester with hydroxyl functionality. The first polyester has a hydroxyl value of 70 with an ICI cone and plate melt viscosity of 12.4 poise at 175° C. and an acid value of 9.75.

The first polyester (3243 g) is reacted with 2.85 moles of fumaric acid (330.5 g) at 200° C. for 270 minutes to produce a high molecular weight carboxylated polyester resin having a number average molecular weight of about 3000, and acid value in the range of 30 to 35 and an ICI cone and plate viscosity of 30 to 50 poise at 200° C.

#### EXAMPLE II

The following reactants are reacted as described in Example I to provide a first polyester with a hydroxyl value of about 60.

Reactant	Moles	Wt./Grams
Neopentyl glycol	.37067	38.55
Cyclohexane dimethanol	.02136	3.08
Terephthalic acid	.35141	58.37

The first polyester from the above reaction is reacted with 0.06837 moles (0.1367 equivalent or 6.70 grams) of maleic acid to provide the carboxylated polyester.

#### EXAMPLE III

The following reactants are reacted as described in Example I to provide a first polyester with a hydroxyl value of about 80.

Reactant	Moles	Wt./Grams
Neopentyl glycol	.37433	38.95
Cyclohexane dimethanol	.02656	3.83
Terephthalic acid	.34461	57.24

The first polyester from the above reaction is reacted with 0.1694 equivalents of maleic acid (8.3 g) to provide the carboxylated polyester.

A formulated powder coating is prepared as follows.

The powder coating is made by premixing the powder coating ingredients in a high intensity mixer such as a Welex fen 60 sec @ 1,000 RPM & 60 sec @ 2,000 RPM.

The ingredients then are extruded (melt-mix), Zone (1) @ 80° C., Zone (2) 110° C. with 72% load, 300 RPM on a Werner & Pfleiderer ZSK-30.

The extruded product is cooled, ground and sieved.

The powder coating is evaluated by electrostatic spraying it onto 3" x 9" 24 gauge C.R.S., with a resulting film of 1.5-1.8 mils.

The film is baked for 10 to 15 minutes @ 360° F.

The following ingredients are made into a formulated powdered coating as described above.

Ingredient	Wt. %	Parts Per Hundred
Carboxylated polyester (Example - I)	60.0	100.0
Triglycidyl isocyanurate (TGIC)	4.08	6.8
Flow control agent	0.8	1.33
Anti pin-holing agent (benzoin)	0.5	0.83
Titanium dioxide (pigment)	30.0	50.0
Sparmite barytes (filler)	4.62	7.7
	100.0	

It should be understood that while certain preferred embodiments of the present invention have been illustrated and described, various modifications thereof will become apparent to those skilled in the art. Accordingly, the scope of the present invention should be defined by the appended claims and equivalents thereof.

What is claimed is:

1. A polymeric vehicle suitable for a powder coating composition which polymeric vehicle when cross-linked provides a coating binder with a Tg greater than 50° C., the polymeric vehicle comprises:

from about 82.4 to about 96.6 weight percent based upon the weight of the polymeric vehicle, of a carboxylated polyester resin which has an acid value in a range of from about 25 to about 40 and a number average molecular weight in the range of from about 2500 to about 4500,

from about 3.4 to about 17.6 weight percent based upon the weight of the polymeric vehicle, of a polyepoxide which has an average epoxy functionality of not more than about 4 and an average epoxy equivalent weight in the range of from about 80 to about 300;

the carboxylated polyester resin comprises the carboxylation reaction product of an aliphatic dicarboxylic acid which has 2 to 9 carbon atoms and a first polyester which has a hydroxyl value from about 60 to about 100, the first polyester having an ICI cone and plate viscosity in the range of from about 8 to about 16 poise at about 175° C., the aliphatic dicarboxylic acid and first polyester being in amounts effective for carboxylation of the first polyester to an acid value in the range of from about 25 to about 40; and

the first polyester comprises the esterification reaction product of an aromatic acid selected from the group consisting of terephthalic acid, isophthalic acid and mixtures thereof, and a diol selected from the group consisting of neopentyl glycol, cyclohexane dimethanol and mixtures thereof, the aromatic acid and the diol being in amounts effective for providing the first polyester with a hydroxyl value in the range of from about 60 to about 100.

2. A polymeric vehicle as recited in claim 1 wherein the carboxylated polyester is the reaction product of from about 0.095 to about 0.205 equivalents of the aliphatic diacid and the first polyester comprises the esterification reaction product of the aromatic acid in an amount of not more than about 53 weight percent of the esterification reactants.

3. A polymeric vehicle as recited in claims 1 or 2 wherein the aromatic acid is present in the esterification reaction in an amount of from about 0.715 to about 0.658 equivalents.

4. A polymeric vehicle as recited in claim 1 wherein the diacid in the carboxylation reaction is fumaric acid and the diol in the esterification reaction is neopentyl glycol.

5. A polymeric vehicle as recited in claim 3 wherein the diacid in the carboxylation reaction is fumaric acid and the diol in the esterification reaction is neopentyl glycol.

6. A polymeric vehicle as recited in claim 3 wherein carboxylated polyester resin has an acid value in the range of from about 30 to about 35 and a number average molecular weight of about 3,000.

7. A polymeric vehicle as recited in claim 3 wherein the aromatic acid is terephthalic acid, the first polyester has a hydroxyl value in the range of from about 60 to about 80, the polyepoxide is triglycidyl isocyanurate and the triglycidyl isocyanurate is present in the amount of from about 4.6 to about 7.2 weight percent based upon the weight of the polymeric vehicle.

8. A polymeric vehicle as recited in claim 5 wherein the carboxylated polyester resin has an acid value in the range of from about 30 to about 35 and the first polyester has a hydroxyl value in the range of from about 60 to about 80.

9. A polymeric vehicle as recited in claim 3 wherein the polyepoxide is triglycidyl isocyanurate and the triglycidyl isocyanurate is present in the amount of from about 4.6 to about 7.2 weight percent based upon the weight of the polymeric vehicle.

10. A polymeric vehicle as recited in claims 1 or 2 wherein the aromatic acid is terephthalic acid, the polyepoxide is triglycidyl isocyanurate and the triglycidyl isocyanurate is present in the amount of from about 4.6 to about 7.2 weight percent based upon the weight of the polymeric vehicle.

11. A polymeric vehicle as recited in claim 8 wherein the aromatic acid is terephthalic acid, the polyepoxide is triglycidyl isocyanurate and the triglycidyl isocyanurate is present in the amount of from about 4.6 to about 7.2 weight percent based upon the weight of the polymeric vehicle.

12. A polymeric vehicle as recited in claim 3 wherein the first polyester has an ICI cone and plate viscosity in the range of from about 10 to about 12 poise at about 175° C.

13. A polymeric vehicle as recited in claim 7 wherein the first polyester has an ICI cone and plate viscosity in the range of from about 10 to about 12 poise at about 175° C.

14. A polymeric vehicle as recited in claim 8 wherein the first polyester has an ICI cone and plate viscosity in the range of from about 10 to about 12 poise at about 175° C.

15. A polymeric vehicle as recited in claim 11 wherein the first polyester has an ICI cone and plate viscosity in the range of from about 10 to about 12 poise at about 175° C.

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