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(54) COATING COMPOSITION COMPRISING AMINO FUNCTIONAL ACRYLIC RESIN AND A FLUOROCARBON POLYMER

BESCHICHTUNGSMITTELZUSAMMENSETZUNG ENTHALTEND AMINFUNKTIONELLES ACRYLHARZ UND FLUORHARZ

COMPOSITION DE REVETEMENT COMPRENANT UNE RESINE ACRYLIQUE A FONCTION AMINO ET UN POLYMERE FLUOROCARBONE

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Description

BACKGROUND OF THE INVENTION

1. Field of the Invention

[0001] The present invention relates to coating compositions based on non-aqueous dispersions of solid fluoropolymer particles in an organic solution of acrylic polymers.

[0002] The coatings, referred to as "organosols," may be clear or pigmented (opaque) coatings, which may be applied to a variety of substrates. In particular, the present invention is directed to coating compositions that have a high solids content and relatively few ingredients. The coating compositions are easily manufactured and may be applied using a number of art recognized techniques.

2. Description of the Prior Art

[0003] Fluoropolymer dispersion coatings are known in the art and are disclosed in, for example, Canadian Patent No. 756,165 to Koblitz et al., U.S. Patent No. 4,314,004 to Stoneberg, and European Patent No. EP 0 960 918 to Lin et al.

[0004] Fluoropolymer dispersion coatings are known to exhibit outdoor durability, chemical resistance, and acceptable mechanical properties. The performance features of fluoropolymer dispersion coatings have led to their extensive use, for example, in the exterior building panel market. Fluoropolymer dispersion coatings are typically applied by spray and roll coating or coil coating of flat sheet stock techniques. The coating film is formed by thermal fusion of the fluoropolymer particles in admixture with an acrylic resin.

[0005] Historically, fluoropolymer dispersion coatings exhibit a relatively high viscosity at relatively low volume solids content. Consequently, as much as 65 percent organic solvent by volume may be required to reduce the viscosity in order to facilitate application of the fluoropolymer dispersion coatings to a substrate.

[0006] The high level of volatile organic compounds (VOCs) of fluoropolymer dispersion coatings generally requires that the solvent vapors emitted by the wet film be captured and,conveyed to a gas-fired incinerator or thermal oxidizer to destroy the VOCs. For example, the large amount of VOCs produced by coil coating flat metal sheet stock can limit the line speed of the coating application, or result in blistering of the film at higher film thicknesses. The incineration of the VOCs can also produce higher amounts of nitrogen oxide pollutants, particularly for fossil fuel-fired combustion processes.

[0007] U.S. patent No. 6,017,639 to Higginbotham et al. discloses a high solids thermoset fluorocarbon coating. However, the composition disclosed by Higginbotham et al. relies on expensive fluorinated surfactants or "hyperdispersants" as an essential element of the coating. The coating composition is relatively complex and includes a relatively long list of ingredients. U.S. Patent No. 4,786,546 to Vassiliou discloses a composite containing a substrate, a primer layer, and a top coat layer, the primer includes an amine containing acrylic copolymer and polyvinyl fluoride.

[0008] International Application No. WO 01/00739 to Zupancic et al. discloses a high solids thermoset fluorocarbon coating, which includes a "cross-linkable" acrylic resin. An additional required ingredient in the coating composition of Zupancic et al. is a cross-linking agent for the acrylic resin. The resulting film, although flexible and solvent resistant, provides only a modest degree of film hardness, as exemplified by the reported pencil rating of "F." JP 63-051479 discloses a coating composition that includes a solvent soluble fluoroolefinic polymer and an acrylic polymer containing nitrogen and phosphorous. JP 07-070508 discloses a coating composition that includes a methacrylate, a fluoropolymer, and a solvent.

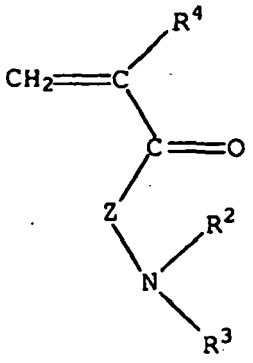
[0009] There is a clear and well defined need for a higher solids, lower VOC content liquid fluoropolymer coating composition, which would allow for higher line speed application, reduced blistering tendency of the applied coating, and a reduced impact on the environment from VOCs. Furthermore, it would be considered by those skilled in the art to be an advance and particularly economically advantageous development if such a coating composition could be achieved by the blending of relatively few ingredients while providing a simple formulation that would be easily manufactured and readily reproducible.

SUMMARY OF THE INVENTION

[0010] The present invention is directed to a simple, high solids fluoropolymer coating composition having excellent solvent resistance, hardness, and flexibility properties. The present high solids fluoropolymer coating composition does not require or include costly hyperdispersants or additional cross-linking agents.

[0011] More particularly, the fluoropolymer coating composition of the present invention includes an aminoalkyl (meth) acrylate containing acrylic polymer, a fluorocarbon polymer, and a solvent, wherein the fluorocarbon polymer is in the form of solid dispersible particles of from 0.1 to 5.0 μm.

[0012] The acrylic polymer includes one or more (meth)acrylate monomers and one or more aminoalkyl (meth)acrylate monomers described by the structure:



where Z is a divalent linking group; R^2 and R^3 are independently selected from H or C_1-C_6 linear or branched aliphatic; and R^4 is H or CH_3.

[0013] The present invention is also directed to methods of coating a substrate using the present fluoropolymer coating composition. The methods include coil coating, spray coating, and extrusion coating the present fluoropolymer coating composition to a substrate as defined in claims 18-20.

[0014] The present invention is further directed to substrates coated with the present fluoropolymer coating composition using any of the above-mentioned methods.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

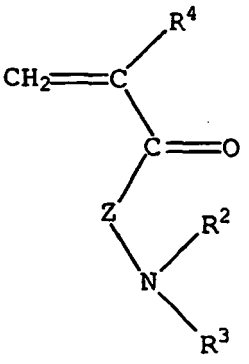
[0015] Other than in the operating examples, or where otherwise indicated, all numbers or expressions referring to quantities of ingredients, reaction conditions, etc. used in the specification and claims are to be understood as modified in all instances by the term "about."

[0016] The terms (meth)acrylic and (meth)acrylate are meant to include both acrylic and methacrylic acid derivatives, such as the corresponding alkyl esters often referred to as acrylates and (meth)acrylates, which the term (meth)acrylate is meant to encompass.

[0017] The fluoropolymer coating composition of the present invention includes a fluorocarbon polymer, an aminoalkyl (meth)acrylate containing acrylic polymer, and a solvent. The aminoalkyl (meth)acrylate containing acrylic polymer may be a thermoplastic resin. In an embodiment of the present invention, the fluorocarbon polymer is present as a dispersed phase and a solution including the acrylic polymer in the solvent is present as a continuous phase.

[0018] The acrylic polymer includes one or more (meth)acrylate monomers and one or more aminoalkyl (meth)acrylate monomers described by the structure I:

(I)



where Z is a divalent linking group; R^2 and R^3 are independently selected from H or C_1-C_6 linear or branched aliphatic; and R^4 is H or CH_3.

[0019] The divalent linking group Z may be described as an ester having the structure -O-R^1- or an amide having the structure -N(R^5)-R^1-, where R^5 is H or C_1-C_6 linear or branched aliphatic, and R^1 may be C_1-C_{20} linear or branched

aliphatic, aryl, alkylaryl, ethoxylated alkyl, ethoxylated aryl, ethoxylated alkylaryl, propoxylated alkyl, propoxylated aryl, and propoxylated alkylaryl.

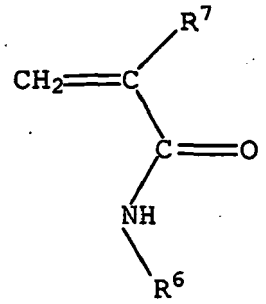
[0020] In an embodiment of the present invention, the aminoalkyl(meth)acrylate monomer may be an N-t-butyl, aminoalkyl (meth)acrylate. A non-limiting example of a suitable aminoalkyl(meth)acrylate monomer is t-butylaminoethyl methacrylate.

[0021] Any suitable (meth)acrylate monomer may be used when preparing the aminoalkyl (meth)acrylate containing acrylic polymer of the present invention. Examples of suitable (meth)acrylates include, but are not limited to, methyl (meth)acrylate, n-butyl(meth)acrylate, t-butyl(meth)acrylate, and ethyl(meth)acrylate.

[0022] In an embodiment of the present invention, the acrylic polymer contains 90 to 99.99 percent by weight, preferably 92 to 99.9 percent by weight, more preferably 95 to 99.9 percent by weight, and most preferably 98 to 99.9 percent by weight (meth)acrylic monomers based on the total weight of acrylic polymer. The acrylic polymer contains 0.01 to 10 percent by weight, preferably 0.1 to 8 percent by weight, more preferably 0.1 to 5 percent by weight, and most preferably 0.1 to 2 percent by weight aminoalkyl (meth)acrylate monomers based on the total weight of acrylic polymer. The inclusion of the aminoalkyl (meth)acrylate monomer provides for improved fluorocarbon dispersions. The dispersions contain minimal large particles and have good Hegman grind values, typically not exceeding 5 or 6. When the level of the aminoalkyl (meth)acrylate monomers is too high, the coating may develop a yellow colored tint.

[0023] The aminoalkyl (meth)acrylate containing acrylic polymer of the present invention may also contain one or more additional monomers having the structure II:

(II)



where R^7 is H or CH_3 and R^6 is $-CH_2-OH$ or $-CH_2-O-R^{10}$, where R^{10} is C_1-C_6 linear or branched aliphatic. Examples of the additional monomers include, but are not limited to, N-butoxymethylol acrylamide, N-butoxymethylol methacrylamide, N-methylol acrylamide and N-methylol methacrylamide. The additional monomer provides the opportunity for the aminoalkyl (meth)acrylate containing acrylic polymer to be self-condensing. Therefore, in this embodiment, a separate crosslinking agent is not required in the present fluoropolymer coating composition.

[0024] In an embodiment of the present invention, the acrylic polymer may contain at least 70 percent by weight, preferably at least 73 percent by weight, more preferably at least 75 percent by weight, and most preferably at least 78 percent by weight and no more than 99.99 percent by weight, preferably no more than 99.9 percent by weight, more preferably no more than 99 percent by weight, and most preferably no more than 98 percent by weight (meth)acrylic monomers based on the total weight of acrylic polymer. The acrylic polymer may contain at least 0.01 percent by weight, preferably 0.1 percent by weight, more preferably 0.2 percent by weight, and most preferably at least 0.5 percent by weight and no more than 10 percent by weight, preferably no more than 8 percent by weight, more preferably no more than 5 percent by weight, and most preferably no more than 2 percent by weight aminoalkyl (meth)acrylate monomers based on the total weight of acrylic polymer. The acrylic polymer may optionally contain the additional monomers described above. When the acrylic polymer contains such additional monomers, they will be present at a level of at least 1 percent by weight, preferably at least 2 percent by weight, more preferably at least 3 percent by weight, and most preferably at least 5 percent by weight and no more than 20 percent by weight, preferably no more than 18 percent by weight, more preferably no more than 15 percent by weight, and most preferably no more than 13 percent by weight aminoalkyl (meth)acrylate monomers based on the total weight of acrylic polymer. Any combination of the above-cited ranges may be used for each monomer in the present acrylic polymer.

[0025] When the additional monomers are utilized, they provide a self-condensing property to the acrylic polymer. As such, when the level of additional monomers is too low, the final coating will have low solvent resistance. When the level of additional monomers is too high, the final coating may be brittle and/or prone to cracking. These coating defects are detrimental in that they may lead to poor coating aesthetics and/or corrosion of the substrate.

[0026] The weight-average molecular weight of the aminoalkyl (meth)acrylate containing acrylic polymer of the present invention will typically be less than 25,000 and be at least 250, as determined by gel permeation chromatography using polystyrene standards. The weight-average molecular weight of the aminoalkyl (meth)acrylate containing acrylic polymer

of the present invention may be from 2,000 to 22,000, preferably from 5,000 to 20,000, more preferably from 7,000 to 20,000, and most preferably from 10,000 to 20,000 as determined by gel permeation chromatography using polystyrene standards.

[0027] The aminoalkyl (meth)acrylate containing acrylic polymer will typically constitute from 1 to 70 percent by weight, preferably from 10 to 60 percent by weight, more preferably from 20 to 55 percent by weight, and most preferably from 30 to 50 percent by weight of the resin solids portion of the fluoropolymer coating composition of the present invention.

[0028] The fluoropolymer coating composition of the present invention will typically include a solvent. Any suitable solvent may be used, so long as it is able to form a solution with the aminoalkyl (meth)acrylate containing acrylic polymer. The solution should be capable of providing a suitable continuous phase for the present high solids fluoropolymer coating composition. Suitable solvents include, but are not limited to, aliphatic hydrocarbons, aromatic hydrocarbons, ketones, esters, glycols, ethers, ether-esters, glycol ethers, glycol ether-esters, alcohols, ether-alcohols, phthalate plasticizers, and suitable mixtures thereof. Phthalate plasticizers include phthalates esters such as di-ethylhexyl phthalate, di-isononyl phthalate, diisodecyl phthalate, and dioctyl phthalate.

[0029] The fluorocarbon polymer in the present fluoropolymer coating composition may be any suitable fluorocarbon polymer for such coating compositions. Examples of suitable fluorocarbon polymers include, but are not limited to, poly (vinylidene fluoride), poly(vinyl fluoride), poly(chlorotrifluoroethylene), poly(tetrafluoroethylene), and poly(trifluoroethylene). The fluorocarbon polymer will typically have a weight average molecular weight of from 100,000 to 500,000 as determined by gel permeation chromatography using polystyrene standards.

[0030] According to the present invention, the fluorocarbon polymer is in the form of solid dispersible particles. The particle size of the dispersible fluorocarbon polymer particles is from 0.1 to 5.0 microns, preferably from 0.2 to 4.0 microns, and more preferably from 0.5 to 3.5 microns. When the particle size of the dispersible fluorocarbon polymer particles is too small, the viscosity of the fluoropolymer coating composition may become too high, resulting in a difficult to apply coating. When the particle size of the dispersible fluorocarbon polymer particles is too large, the particles may settle, resulting in a fluoropolymer coating composition with poor storage stability and/or a short shelf life.

[0031] Suitable fluorocarbon polymers are available commercially, for example, those fluorocarbon polymers sold under the trade name KYNAR® by Atofina Chemicals, Inc., Philadelphia, Pennsylvania and those fluorocarbon polymers sold under the trade name Hylar® PVDF by Ausimont, an affiliate of the Montedison group, Milan, Italy.

[0032] The fluoropolymer coating composition may include the fluorocarbon polymer at from 30 to 99 percent, preferably from 40 to 90 percent by weight, more preferably from 45 to 85 percent by weight, and most preferably from 50 to 70 percent by weight based on the weight of the resin solids portion of the coating composition.

[0033] In an embodiment of the present invention, the fluoropolymer coating composition will include from 50 to 75 percent by weight, preferably from 55 to 70 percent by weight, and most preferably from 60 to 65 percent by weight resin solids based on the total weight of the fluoropolymer coating composition. The resin solids include, but are not limited to, the aminoalkyl (meth)acrylate containing acrylic polymer and the fluorocarbon polymer. The solvent will be present at from 25 to 50 percent by weight, preferably from 30 to 45 percent by weight, and most preferably from 35 to 40 percent by weight based on the total weight of the fluoropolymer coating composition.

[0034] The present high solids fluoropolymer coating compositions may be an unpigmented or clear coating, or they may be pigmented with a variety of materials to provide opaque coating films. When pigments are utilized in the high solids fluoropolymer coating compositions, they are typically incorporated as a second dispersed phase. Suitable pigments that may be used in the present high solids fluoropolymer coating composition include, but are not limited to, the inorganic metal oxides, organic compounds, metal flake and mica pigments for "metallic" effect colors, extender or filler pigments, and corrosion-inhibitive pigment types, such as chromates, silicas, silicates, phosphates, and molybdates. Organic compounds include, but are not limited to, diarylide m-xylidide, toluidine red, monoazo naphthol, quinacridone, pthalocyanine blue, indanthrone blue, phthalocyanine green, dinitraniline orange and dioxazine carbazole. Extender or filler pigments include kaolin, talc, calcium carbonate, diatomaceous earth, synthetic calcium silicates, perlite, cellulose fibers, ground silica, calcined clays, microspheres, fumed silica, treated fumed silicas, titanium dioxide, wet ground micas, synthetic fibers, snobrite clay, bentonite clay, micronized micas, attapulgite clays, and alumina trihydrate.

[0035] Other types of art recognized additives may be employed to control rheology, pigment dispersion, and settling, as well as flow or leveling. Occasionally, it may be advantageous to include UV absorbers and stabilizers for some pigmentations. Particularly useful UV stabilizers include those sold under the trade name TINUVIN by Ciba Specialty Chemicals, Basel, Switzerland.

[0036] The present invention is also directed to a method of coil coating a metal substrate and the coil coated substrate. In the present coil coating method, a coil coating apparatus is used to apply the high solids fluoropolymer coating composition of the present invention. The high solids fluoropolymer coating composition is applied such that the wet film thickness is 25.4μm to 254μm (1 to 10 mils). The coating is then cured at a temperature of from 200°C to 300°C for 10 to 50 seconds to form a cured dry film with a film thickness of 12.7 to 152.4 μm (0.5 to 6 mils).

[0037] The present invention is further directed to a method of spray coating a substrate and the spray coated substrate. In the present spray coating method, a spray coating apparatus is used to apply the high solids fluoropolymer coating

composition of the present invention. The high solids fluoropolymer coating composition is applied such that the wet film thickness is 1 to 4 mils. The coating is cured at a temperature of 200°C to 300°C for 5 to 20 minutes to form a cured dry film with a film thickness of 7.62 to 50.8 μm (0.3 to 2 mils).

[0038] Another embodiment of the present invention is directed to a method of extrusion coating a substrate and the extrusion coated substrate. In the present extrusion coating method, an extrusion coating apparatus is used to apply the high solids fluoropolymer coating composition of the present invention. The high solids fluoropolymer coating composition is applied such that the wet film thickness is 25.4 to 152.4 μm (1 to 6 mils). The coating is cured at a temperature of 200°C to 500°C for 10 seconds to 20 minutes to form a cured dry film with a film thickness of 2.62 to 101.6 μm (0.3 to 4 mils).

[0039] The high solids fluoropolymer coating composition may be applied using art recognized methods of brush coating and/or dip coating.

[0040] The high solids fluoropolymer coating composition of the present invention is particularly useful for coating metal substrates or plastic substrates. Particular end uses where coated substrates of the present invention may be found include, but are not limited to, building panels, roofing panels, automotive body parts and aluminum extrusions.

[0041] The present invention is more particularly described in the following examples, which are intended to be illustrative only, since numerous modifications and variations therein will be apparent to those skilled in the art. Unless otherwise specified, all parts and percentages are by weight.

Example 1

[0042] This example demonstrates the preparation of an aminoalkyl (meth)acrylate containing acrylic polymer of the present invention. The polymer was prepared using the charges in Table 1.

TABLE 1

CHARGE	MATERIAL NAME	WEIGHT
1	Toluene	1564.1
2	Toluene	146.87
	t-Amyl Peroctoate	59.23
	Lupersol 575, Atofina Chemicals, Inc., Philadelphia, Pa.	
3	Methyl Methacrylate	1240.4
	N-butoxy methacrylamide	251.6
	t-butylaminoethyl methacrylate	13.9
4	Toluene	23.13
	t-Amyl Peroctoate	4.18
5	Toluene	23.13
	t-Amyl Peroctoate	4.18
6	Toluene	343.5
	bis-(1-octyloxy-2,2,6,6-tetramethyl-4-piperidinyl) sebacate Tinuvin 123, Ciba Specialty Chemicals, Basel, Switzerland	13.9
	TOTAL WEIGHT	3688.1

[0043] Charge 1 was added to a laboratory reactor fitted with a condenser, thermometer, and stirring mechanism and heated to 110°C, at which temperature a mild reflux was maintained. Charges 2 and 3 were fed to the reactor over a

two-hour period while maintaining a mild reflux condition. The solution was maintained at reflux for an additional one-hour after the feed was completed. Charge 4 was fed to the reactor over a 5-minute period and the solution was maintained at reflux for an additional one hour. Charge 5 was fed to the reactor over a 5-minute period, and the solution was maintained at reflux for an additional one hour. Charge 6 was then added to the reactor, and the solution was cooled to ambient temperature.

[0044] The resulting solution had a total solids content of 41.7 percent. The solution had a Brookfield viscosity of 133.6 cps (spindle no. 2, 100 rpm, 21.9°C). The resulting polymer had a number average molecular weight (Mn) of 3,702, a weight average molecular weight of 10,078 (Mw) and a polydispersity index (Mw/Mn) of 2.7 as measured by gel permeation chromatography using polystyrene standards.

Example 2

[0045] This example demonstrates the preparation of an aminoalkyl (meth)acrylate containing acrylic polymer of the present invention. The polymer was prepared using the charges in Table 2.

TABLE 2

CHARGE	MATERIAL NAME	WEIGHT
1	Toluene	1000.9
2	Toluene	146.87
	t-Amyl Peroctoate	52.26
	Lupersol 575, Atofina Chemicals, Inc., Philadelphia, Pa.	
3	Methyl Methacrylate	975.6
	Ethyl Acrylate	404.2
	t-butylaminoethyl methacrylate	13.9
4	Toluene	23.13
	t-Amyl Peroctoate	4.18
5	Toluene	23.13
	t-Amyl Peroctoate	4.18
6	Toluene	343.5
	bis-(1-octyloxy-2,2,6,6-tetramethyl-4-piperidinyl) sebacate Tinuvin 123, Ciba Specialty Chemicals, Basel, Switzerland	13.9
	TOTAL WEIGHT	3688.1

[0046] Charge 1 was added to a laboratory reactor fitted with a condenser, thermometer, and stirring mechanism and heated to 110°C, at which temperature a mild reflux was maintained. Charge 2 was added over a five-minute period. Five minutes after charge 2 was added, charge 3 was fed to the reactor over a two-hour period while maintaining a mild reflux condition. The solution was maintained at reflux for an additional one hour after the feed was completed. Charge 4 was fed to the reactor over a 5-minute period and the solution was maintained at reflux for an additional one hour. Charge 5 was fed to the reactor over a 5-minute period and the solution was maintained at reflux for an additional one hour. Charge 6 was then added to the reactor, and the solution was cooled to ambient temperature.

[0047] The resulting solution had a total solids content of 41.8 percent. The solution had a Brookfield viscosity of 71.8 cps (spindle no. 1, 50 rpm, 23.6°C). The resulting polymer had a number average molecular weight (Mn) of 4,570, a weight average molecular weight of 12,032 (Mw), and a polydispersity index (Mw/Mn) of 2.6 as measured by gel per-

meation chromatography using polystyrene standards.

Examples 3-5

[0048] This example compares fluoropolymer coating compositions prepared using the aminoalkyl (meth)acrylate containing acrylic polymers of Examples 1 and 2 with a commercially available acrylic polymer that does not contain an aminoalkyl (meth)acrylate monomer. The coating compositions were prepared using the ingredients in Table 3.

TABLE 3

Ingredient	Supplier	Example 3	Example 4	Example 5
Charge 1				
Acrylic Polymer	Example 1	13.37		
Acrylic Polymer	Example 2		12.91	
Paraloid B44S Acrylic Resin	Rohm & Haas			10.99
BUTYL CELLOSOLVE	Union Carbide	4.12	4	3.25
Dimethyl Phthalate	Eastman	2.58	2.49	2.03
Titanium Dioxide R-960	DuPont	13.6	13.17	10.73
Shepherd Black #1	Shepherd	2.72	2.63	2.15
Shepherd Yellow #29	Shepherd	0.45	0.44	0.36
RED IRON OXIDE R1599	Elementis	0.07	0.07	0.05
Charge 2				
Acrylic Polymer	Example 1	12.68		
Acrylic Polymer	Example 2		12.25	
Paraloid B44S Acrylic Resin	Rohm-Haas			10.43
CYASTAT SN	Cytec	0.04	0.04	0.03
Isophorone	BP	14.1	13.67	11.13
Polyvinylidene fluoride	ATOFINA	30.64	29.69	24.17
Bentone SD-1 clay	Elementis	0.09	0.09	0.07
MACN acrylic resin	PPG	5	4.85	3.95
2-Ethyl hexyl acrylate homopolymer	PPG	0.35	0.34	0.27
Isopropyl alcohol	BP	0.19	0.19	0.16
Isophorone	BP		3.17	20.23
Total Weight		100	100	100

The composition of MACN acrylic resin is described in Table 4.

TABLE 4

Monomers	Amount
Ethyl Acrylate	36.821
Methacrylic acid	2.676
Methyl methacrylate	21.179
Methacrylonitrile	17.31
Solvents	

(continued)

Monomers	Amount
N-butyl alcohol	39.6
2-butoxyethanol	21.26
Acetone CP	0.6
Isopar K odorless Mineral Spirits	0.6
Xylene	2.41
Aromatic Solvent-150 type	35.53
percent Wt. Solids	44.67

[0049] Charge 1 was added to a sand mill and milled until a Hegman grind reading of 7+ was reached. The milled pigment dispersion was then added to a Cowels mixer and mixed until a Hegman grind reading of 5.5 was achieved for the slurry. The total solids and viscosity using a No. 4 Zahn cup for each slurry was 60.8 percent (43.0 volume percent) and 44 seconds for Example 3, 58.9 percent (41.1 volume percent), 23 seconds for Example 4 and 48.0 percent (30.8 volume percent), and 43 seconds for Example 5. The data demonstrates the higher solids (lower VOC) property of the present fluoropolymer coating compositions when compared to a conventional fluoropolymer coating composition using an acrylic polymer that does not contain an aminoalkyl (meth)acrylate monomer.

[0050] The coating compositions of Examples 3-5 were applied, with a wet film wire-wound rod applicator to galvalume stainless steel. A primer, 1PMY5650 available commercially from PPG Industries, was applied with a dry film thickness of 0.2 mils. The coating compositions of Examples 3-5 were then applied with a peak metal temperature of 240°C (465°F) and a dwell time of 30 seconds. The topcoat dry film thickness was 20.32 μm (0.8 mils) for each example. Table 5 shows properties of the coated substrates.

TABLE 5

Property	Example 3	Example 4	Example 5
60° Gloss	35.5	45.8	44.4
E.T. Pencil	2H	H	2H
Double Rub MEK	100+	100+	100+
Flexibility	1T	1T	0T
T-Bend - No Pick Flexibility T-Bend - No Crack	3T	4T	2T

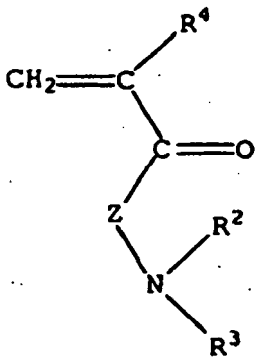
[0051] The data demonstrates that the high solids fluoropolymer coating compositions of the present invention have excellent solvent resistance, hardness, and flexibility properties.

[0052] The invention has been described with reference to the preferred embodiments. Obvious modifications and alterations will occur to others upon reading and understanding the preceding detailed description. It is intended that the invention be construed as including all such modifications and alterations insofar as they come within the scope of appended claims or the equivalents thereof.

Claims

1. A coating composition comprising:

a) a polymer comprising one or more (meth)acrylate monomers and one or more aminoalkyl(meth)acrylate monomers described by the structure:



where Z is a divalent linking group; R^2 and R^3 are independently selected from H or a C_1-C_6 linear or branched aliphatic group, and R^4 is H or CH_3;
b) a fluorocarbon polymer; and
c) a solvent;

wherein the fluorocarbon polymer is in the form of solid dispersible particles having a particle size of from 0.1 to 5.0 microns.

2. The coating composition of claim 1, wherein Z is selected from -O-R^1- and -N(R^5)-R^1-, wherein R^5 is H or a C_1-C_6 linear or branched aliphatic group, and R^1 is selected from the group consisting of C_1-C_{20} linear or branched aliphatic groups, aryl, alkylaryl, ethoxylated alkyl, ethoxylated aryl, ethoxylated alkylaryl, propoxylated alkyl, propoxylated aryl, and propoxylated alkylaryl.

3. The coating composition of the preceding claims, wherein the polymer (a) is a thermoplastic resin.

4. The coating composition of the preceding claims, wherein the polymer (a) comprises 1 percent to 70 percent by weight of the resin solids portion of the coating composition.

5. The coating composition of the preceding claims, wherein the weight-average molecular weight of the polymer (a) is less than 25,000, as determined by gel permeation chromatography using polystyrene standards.

6. The coating composition of claim 5, wherein the weight-average molecular weight of the polymer (a) is from 7,000 to 20,000, as determined by gel permeation chromatography using polystyrene standards.

7. The coating composition of the preceding claims, wherein the fluorocarbon polymer is one or more selected from the group consisting of poly(vinylidene fluoride), poly(vinyl fluoride), poly(chlorotrifluoroethylene), poly(tetrafluoroethylene), and poly(trifluoroethylene).

8. The coating composition of the preceding claims, wherein the weight average molecular weight of the fluorocarbon polymer as determined by gel permeation chromatography using polystyrene standards is from 100,000 to 500,000.

9. The coating composition of the preceding claims, wherein the polymer of (a) and the solvent (c) constitute a continuous phase and the fluorocarbon polymer constitutes a dispersed phase.

10. The coating composition of the preceding claims, wherein the fluorocarbon polymer comprises 30 to 99 percent by weight of the resin solids portion of the coating composition.

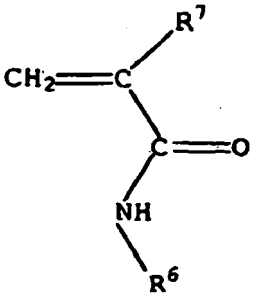
11. The coating composition of the preceding claims, wherein the solvent component is selected from the group consisting of aliphatic hydrocarbons, aromatic hydrocarbons, ketones, esters, glycols, ethers, ether-esters, glycol ethers, glycol ether-esters, alcohols, ether-alcohols, phthalate plasticizers, and mixtures thereof.

12. The coating composition of the preceding claims, wherein the (meth)acrylate monomers are one or more selected from the group consisting of methyl(meth)acrylate, n-butyl(meth)acrylate, t-butyl(meth)acrylate, n-propyl(meth)acrylate, cyclohexyl(meth)acrylate and ethyl(moth)acrylate.

13. The coating composition of claim 2, wherein the aminoalkyl(meth)acrylate monomer is an N-t-butyl aminoalkyl (meth) acrylate.

14. The coating composition of claim 2, wherein the aminoalkyl(meth)acrylate monomer is t-butylaminoethyl methacrylate.

15. The coating composition of the preceding claims, wherein the polymer (a) comprises one or more additional monomers having the structure:



wherein R^7 is H or CH_3 and R^6 is $-CH_2-OH$ or $-CH_2-O-R^{10}$, where R^{10} is a C_1-C_6 linear or branched aliphatic group.

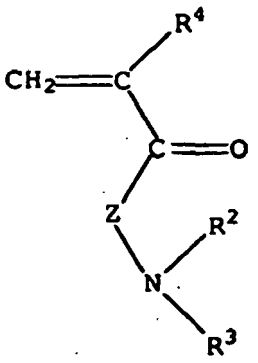
16. The coating composition of claim 15, wherein the additional monomers include one or more selected from the group consisting of N-butoxymethyl acrylamide, N-butoxymethyl methacrylamide, N-methylol acrylamide, and N-methylol methacrylamide.

17. The coating composition according to any of claims 1-3, comprising:

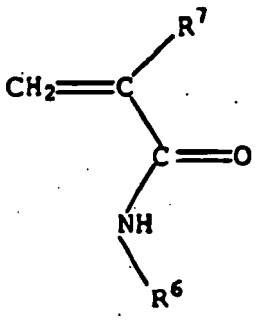
(a) a continuous phase comprising:

(i) 1 percent to 70 percent by weight based on resin solids of a polymer comprising the polymerized composition of:

(A) 70 to 99.99 percent by weight, based on the weight of the polymer of one or more monomers selected from the group consisting of methyl(meth)acrylate, n-butyl(meth)acrylate, t-butyl(meth)acrylate, and ethyl(meth)acrylate;
(B) 0.01 to 10 percent by weight, based on the weight of the polymer of one or more aminoalkyl(meth) acrylate monomers described by the structure:



where Z is a divalent linking group; R^2 and R^3 are independently selected from H or a C_1-C_6 linear or branched aliphatic group; and R^4 is H or CH_3; and
(C) 0 to 20 percent by weight, based on the weight of the polymer of one or more additional monomers having the structure:



wherein R^7 is H or CH_3 and R^6 is CH_2-OH or -CH_2-O-R^{10} where R^{10} is a C_1-C_6 linear or branched aliphatic group, wherein the sum of the amounts of (A), (B) and (C) is 100 percent and wherein the weight-average molecular weight of the thermoplastic resin is from 7, 000 to 20,000, as determined by gel permeation chromatography using polystyrene standards,
(ii) a solvent selected from the group consisting of aliphatic hydrocarbons, aromatic hydrocarbons, ketones, esters, glycols, ethers, ether-esters, glycol ethers, glycol ether-esters, alcohols, ether-alcohols, phthalate plasticizers and mixtures thereof; and

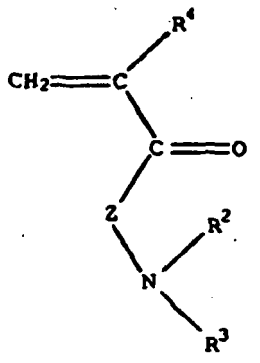
(b) 30 to 99 percent by weight based on resin solids of a dispersed phase comprising solid dispersible particles, ranging in particle size from 0.1 to 5.0 microns, of one or more fluorocarbon polymers selected from the group consisting of poly(vinylidene fluoride), poly(vinyl fluoride), poly(chlorotrifluoroethylene), poly(tetrafluoroethylene), and poly(trifluoroethylene).

18. A method of coil coating to a metal substrate using a coil coating apparatus comprising:

A) applying a coating composition such that the wet film thickness is 25.4 to 254 μm (1 to 10 mils), wherein the coating composition comprises:

(i) a continuous phase comprising:

(a) 1 to 70 percent by weight based on total resin solids of a polymer comprising one or more (meth) acrylate monomers and one or more aminoalkyl(meth) acrylate monomers described by the structure:



where Z is a divalent linking group; R^2 and R^3 are independently selected from H or a C_1-C_6 linear or branched aliphatic group; and R^4 is H or CH_3; and
(b) 25 - 50 percent by weight of a solvent based on the total weight of the coating composition;

(ii) 30 to 99 percent by weight based on total resin solids of a dispersed phase comprising solid dispersible particles of a fluorocarbon polymer, the particle size of the dispersible fluorocarbon polymer particles being 0.1 to 5.0 microns;

wherein the total resin solids are 50 - 75 percent by weight based on the total weight of the coating composition;

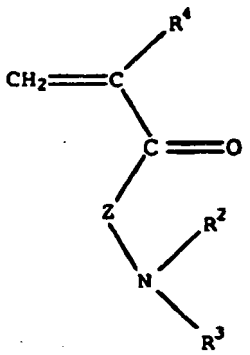
and
B) curing at a temperature of 200°C to 300°C for 10 to 50 seconds to form a cured dry film with a film thickness of 12.7 - 152.4 μm (0.5 to 6 mils).

19. A method of extrusion coating a substrate using an extrusion coating apparatus comprising:

A) applying a coating composition such that the wet film thickness is 25.4 to 152.4 μm (1 to 6 mils), wherein the coating composition comprises:

(i) a continuous phase comprising:

(a) 1 to 70 percent by weight based on total resin solids of a polymer comprising one or more (meth) acrylate monomers and one or more aminoalkyl(meth)acrylate monomers described by the structure:



where Z is a divalent linking group; R^2 and R^3 are independently selected from H or a C_1-C_6 linear or branched aliphatic group; and R^4 is H or CH_3, and
(b) 25 - 50 percent by weight of a solvent based on the total weight of the coating composition;

(ii) 30 to 99 percent by weight based on total resin solids of a dispersed phase comprising solid dispersible particles of a fluorocarbon polymer, the particle size of the dispersible fluorocarbon polymer particles being 0.1 to 5.0 microns;

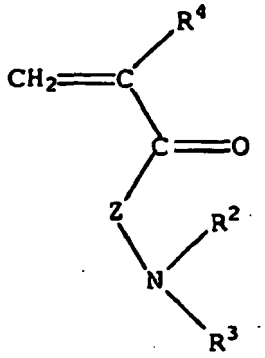
wherein the total resin solids are 50 - 75 percent by weight based on the total weight of the coating composition; and
B) curing at a temperature of 200°C to 300°C for 10 seconds to 20 minutes to form a cured dry film with a film thickness of 7.6 - 101.6 μm (0.3 to 4 mils).

20. A method of spray coating a substrate using a spray coating apparatus comprising:

A) applying a coating composition such that the wet film thickness is 25.4 - 101.6 μm (1 to 4 mils), wherein the coating composition comprises:

(i) a continuous phase comprising:

(a) 1 to 70 percent by weight based on total resin solids of a polymer comprising one or more (meth) acrylate monomers and one or more aminoalkyl(meth) acrylate monomers described by the structure:



where Z is a divalent linking group; R^2 and R^3 are independently selected from H or a C_1-C_6 linear or branched aliphatic group; and R^4 is H or CH_3; and
(b) 25 - 50 percent by weight of a solvent based on the total weight of the coating composition; and

(ii) 30 to 99 percent by weight based on total resin solids of a dispersed phase comprising solid dispersible particles of a fluorocarbon polymer having a particle size of from 0.1 to 5 microns;

wherein the total resin solids are 50 - 75 percent by weight based on the total weight of the coating composition, and
B) curing at a temperature of 200°C to 300°C for 5 to 20 minutes to form a cured dry film with a film thickness of 7.6 to 50.8 μm (0.3 to 2 mils).

21. The method of any of claims 18-20, wherein the polymer comprises 10 percent to 60 percent by weight of the resin solids portion of the coating composition.

22. The method of any of claims 18-20, wherein the fluorocarbon polymer comprises 40 to 90 percent by weight of the resin solids portion of the coating composition.

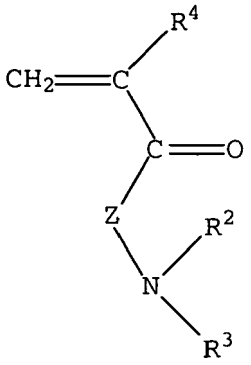
23. The method of any of claims 18-20, wherein the coating composition is defined in any of claims 2, 3, 5-8, and 11-16.

24. A coated substrate obtainable by a method according to any of claims 18-23.

Patentansprüche

1. Beschichtungszusammensetzung, enthaltend:

a) ein Polymer, das ein oder mehrere (Meth)acrylatmonomere und ein oder mehrere Aminoalkyl(meth)acrylatmonomere, die durch die Formel:



beschrieben werden, enthält, worin Z eine zweibindige Verbindungsgruppe ist, R^2 und R^3 unabhängig voneinander ausgewählt sind aus H oder einer linearen oder verzweigten aliphatischen C_1- bis C_6-Gruppe und R^4 gleich H oder CH_3 ist,
b) ein Fluorkohlenstoffpolymer und
c) ein Lösungsmittel,

wobei das Fluorkohlenstoffpolymer in Form von festen dispergierbaren Teilchen mit einer Teilchengröße von 0,1 bis 5,0 μm vorliegt.

2. Beschichtungszusammensetzung nach Anspruch 1, worin Z ausgewählt ist aus -O-R^1- und -N(R^5)-R^1-, worin R^5 gleich H oder eine lineare oder verzweigte aliphatische C_1- bis C_6-Gruppe ist und R^1 ausgewählt ist aus der Gruppe bestehend aus linearen oder verzweigten aliphatischen C_1- bis C_{20}-Gruppen, Aryl, Alkylaryl, ethoxyliertem Alkyl, ethoxyliertem Aryl, ethoxyliertem Alkylaryl, propoxyliertem Alkyl, propoxyliertem Aryl und propoxyliertem Alkylaryl.

3. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin das Polymer (a) ein thermoplastisches Harz ist.

4. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin das Polymer (a) 1 bis 70 Gew.-% des Harzfeststoffanteils der Beschichtungszusammensetzung ausmacht.

5. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin das gewichtsmittlere Molekulargewicht des Polymers (a) kleiner als 25.000, bestimmt durch Gelpermeationschromatographie unter Verwendung eines Polystyrolstandards, ist.

6. Beschichtungszusammensetzung nach Anspruch 5, worin das gewichtsmittlere Molekulargewicht des Polymers (a) 7.000 bis 20.000, bestimmt durch Gelpermeationschromatographie unter Verwendung eines Polystyrolstandards, beträgt.

7. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin das Fluorkohlenstoffpolymer eines oder mehrere ist, die ausgewählt sind aus der Gruppe bestehend aus Poly (vinylidenfluorid), Poly(vinylfluorid), Poly(chlortrifluorethylen), Poly(tetrafluorethylen) und Poly(trifluorethylen).

8. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin das gewichtsmittlere Molekulargewicht des Fluorkohlenstoffpolymers, bestimmt durch Gelpermeationschromatographie unter Verwendung eines Polystyrolstandards, 100.000 bis 500.000 beträgt.

9. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin das Polymer (a) und das Lösungsmittel (c) eine kontinuierliche Phase bilden und das Fluorkohlenstoffpolymer eine disperse Phase bildet.

10. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin das Fluorkohlenstoffpolymer 30 bis 99 Gew.-% des Harzfeststoffanteils der Beschichtungszusammensetzung ausmacht.

11. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin die Lösungsmittelkomponente ausgewählt ist aus der Gruppe bestehend aus aliphatischen Kohlenwasserstoffen, aromatischen Kohlenwasserstoffen, Ketonen, Estern, Glykolen, Ethern, Etherestern, Glykolethern, Glykoletherestern, Alkoholen, Etheralkoholen, Phthalatweichmachern und Mischungen davon.

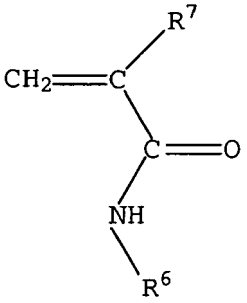
12. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin die (Meth)acrylatmonomere eines oder mehrere sind, die ausgewählt sind aus der Gruppe bestehend aus Methyl(meth)acrylat, n-Butyl(meth)acrylat, tert.-Butyl(meth)acrylat, n-Propyl(meth)acrylat, Cyclohexyl(meth)acrylat und Ethyl(meth)acrylat.

13. Beschichtungszusammensetzung nach Anspruch 2, worin das Aminoalkyl(meth)acrylatmonomer ein N-tert.-Butylaminoalkyl(meth)acrylat ist.

14. Beschichtungszusammensetzung nach Anspruch 2, worin das Aminoalkyl(meth)acrylatmonomer tert.-Butylaminoe-

thylmethacrylat ist.

15. Beschichtungszusammensetzung nach den vorstehenden Ansprüchen, worin das Polymer (a) ein oder mehrere zusätzliche Monomere mit der Struktur:



enthält, worin R^7 gleich H oder CH_3 ist und R^6 gleich $-CH_2-OH$ oder $-CH_2-O-R^{10}$ ist, worin R^{10} eine lineare oder verzweigte aliphatische C_1- bis C_6-Gruppe ist.

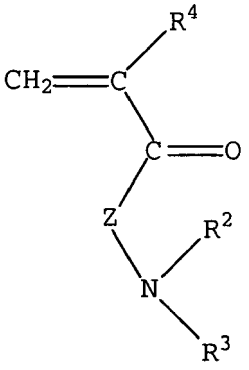
16. Beschichtungszusammensetzung nach Anspruch 15, worin die zusätzlichen Monomere eines oder mehrere, ausgewählt aus der Gruppe bestehend aus N-Butoxymethylacrylamid, N-Butoxymethylmethacrylamid, N-Methylolacrylamid und N-Methylolmethacrylamid, beinhalten.

17. Beschichtungszusammensetzung nach einem der Ansprüche 1-3, enthaltend:

(a) eine kontinuierliche Phase, enthaltend:

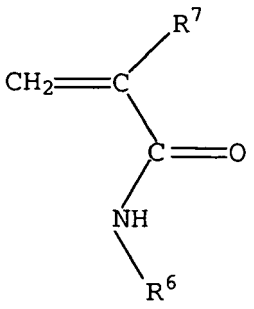
(i) 1 bis 70 Gew.-%, bezogen auf Harzfeststoffe, eines Polymers, das die polymerisierte Zusammensetzung von:

(A) 70 bis 99,99 Gew.-%, bezogen auf das Gewicht des Polymers, eines oder mehrerer Monomere, ausgewählt aus der Gruppe bestehend aus Methyl(meth)acrylat, n-Butyl(meth)acrylat, tert.-Butyl(meth) acrylat und Ethyl(meth)acrylat,
(B) 0,01 bis 10 Gew.-%, bezogen auf das Gewicht des Polymers, eines oder mehrerer Aminoalkyl (meth)-acrylatmonomere, beschrieben durch die Struktur:



worin Z eine zweibindige Verbindungsgruppe ist, R^2 und R^3 unabhängig voneinander ausgewählt sind aus H oder einer linearen oder verzweigten aliphatischen C_1- bis C_6-Gruppe und R^4 gleich H oder CH_3 ist, und
(C) 0 bis 20 Gew.-%, bezogen auf das Gewicht des Polymers, eines oder mehrerer zusätzlicher Mo-

nomere mit der Struktur:



worin R^7 gleich H oder CH_3 ist und R^6 gleich $-CH_2-OH$ oder $-CH_2-O-R^{10}$ ist, worin R^{10} eine lineare oder verzweigte aliphatische C_1- bis C_6-Gruppe ist, enthält,
wobei die Summe der Mengen von (A), (B) und (C) gleich 100% ist und wobei das gewichtsmittlere Molekulargewicht des thermoplastischen Harzes 7.000 bis 20.000 beträgt, bestimmt durch Gelpermeationschromatographie unter Verwendung eines Polystyrolstandards,
(ii) ein Lösungsmittel, das ausgewählt ist aus der Gruppe bestehend aus aliphatischen Kohlenwasserstoffen, aromatischen Kohlenwasserstoffen, Ketonen, Estern, Glykolen, Ethern, Etherestern, Glykolethern, Glykoletherestern, Alkoholen, Etheralkoholen, Phthalatweichmachern und Mischungen davon, und

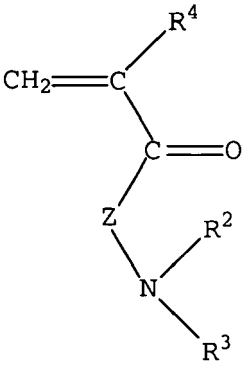
(b) 30 bis 99 Gew.-%, bezogen auf die Harzfeststoffe, einer dispergierten Phase, die feste dispergierbare Teilchen enthält mit einer Teilchengröße im Bereich von 0,1 bis 5,0 μm eines oder mehrerer Fluorkohlenstoffpolymere, ausgewählt aus der Gruppe bestehend aus Poly(vinylidenfluorid), Poly(vinylfluorid), Poly(chlortrifluorethylen), Poly(tetrafluorethylen) und Poly(trifluorethylen).

18. Verfahren zur Coil-Beschichtung eines Metallsubstrats unter Verwendung einer Coil-Beschichtungsvorrichtung, umfassend:

A) Aufbringen einer Beschichtungszusammensetzung, so dass die Nassfilmdicke 25,4 bis 254 μm (1 bis 10 mil) beträgt, wobei die Beschichtungszusammensetzung enthält:

(i) eine kontinuierliche Phase, enthaltend:

(a) 1 bis 70 Gew.-%, bezogen auf die Gesamtharzfeststoffe, eines Polymers, das ein oder mehrere (Meth)acrylatmonomere und ein oder mehrere Aminoalkyl(meth)acrylatmonomere, beschrieben durch die Struktur:



enthält, worin Z eine zweibindige Verbindungsgruppe ist, R^2 und R^3 unabhängig voneinander ausge-

wählt sind aus H oder einer linearen oder verzweigten aliphatischen C_1- bis C_6-Gruppe und R^4 gleich H oder CH_3 ist, und
(b) 25 bis 50 Gew.-% eines Lösungsmittels, bezogen auf das Gesamtgewicht der Beschichtungszusammensetzung,

(ii) 30 bis 99 Gew.-%, bezogen auf die Gesamtharzfeststoffe, einer dispergierten Phase, die feste dispergierbare Teilchen eines Fluorkohlenstoffpolymers enthält, wobei die Teilchengröße der dispergierbaren Fluorkohlenstoffpolymerteilchen 0,1 bis 5,0 μm beträgt,

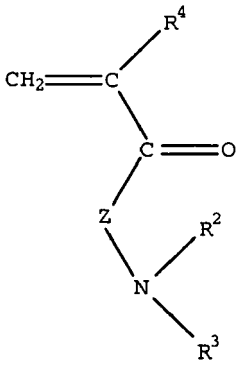
worin die Gesamtharzfeststoffe 50 - 75 Gew.-%, bezogen auf das Gesamtgewicht, der Beschichtungszusammensetzung ausmachen, und
B) Härten bei einer Temperatur von 200°C bis 300°C für 10 bis 50 s, um einen gehärteten trockenen Film mit einer Filmdicke von 12,7 bis 152,4 μm (0,5 to 6 mil) zu bilden.

19. Verfahren zur Extrusionsbeschichtung eines Substrats unter Verwendung einer Extrusionsbeschichtungsvorrichtung, umfassend:

A) Aufbringen einer Beschichtungszusammensetzung, so dass die Nassfilmdicke 25,4 bis 152,4 μm (1 bis 6 mil) beträgt, wobei die Beschichtungszusammensetzung enthält:

(i) eine kontinuierliche Phase, enthaltend:

(a) 1 bis 70 Gew.-%, bezogen auf die Gesamtharzfeststoffe, eines Polymers, das ein oder mehrere (Meth)acrylatmonomere und ein oder mehrere Aminoalkyl(meth)acrylatmonomere, beschrieben durch die Struktur:



enthält, worin Z eine zweibindige Verbindungsgruppe ist, R^2 und R^3 unabhängig voneinander ausgewählt sind aus H oder einer linearen oder verzweigten aliphatischen C_1- bis C_6- Gruppe und R^4 gleich H oder CH_3 ist, und
(b) 25 bis 50 Gew.-% eines Lösungsmittels, bezogen auf das Gesamtgewicht der Beschichtungszusammensetzung,

(ii) 30 bis 99 Gew.-%, bezogen auf die Gesamtharzfeststoffe, einer dispergierten Phase, die feste dispergierbare Teilchen eines Fluorkohlenstoffpolymers enthält, wobei die Teilchengröße der dispergierbaren Fluorkohlenstoffpolymerteilchen 0,1 bis 5,0 μm beträgt,

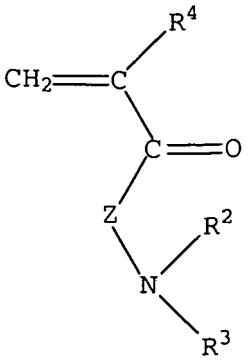
wobei die Gesamtharzfeststoffe 50 - 75 Gew.-%, bezogen auf das Gesamtgewicht, der Beschichtungszusammensetzung ausmachen, und
B) Härten bei einer Temperatur von 200°C bis 300°C für 10 s bis 20 min, um einen gehärteten trockenen Film mit einer Filmdicke von 7,6 bis 101,6 μm (0,3 bis 4 mil) zu bilden.

20. Verfahren zur Sprühbeschichtung eines Substrats unter Verwendung einer Sprühbeschichtungsvorrichtung, umfassend:

A) Aufbringen einer Beschichtungszusammensetzung, so dass die Nassfilmdicke 25,4 bis 101,6 μm (1 bis 4 mil) beträgt, wobei die Beschichtungszusammensetzung enthält:

(i) eine kontinuierliche Phase, enthaltend:

(a) 1 bis 70 Gew.-%, bezogen auf die Gesamtharzfeststoffe, eines Polymers, das ein oder mehrere (Meth)acrylatmonomere und ein oder mehrere Aminoalkyl(meth)acrylatmonomere, beschrieben durch die Struktur:



enthält, worin Z eine zweibindige Verbindungsgruppe ist, R^2 und R^3 jeweils unabhängig voneinander ausgewählt sind aus H oder einer C_1- bis C_6- linearen oder verzweigten aliphatischen Gruppe und R^4 gleich H oder CH_3 ist, und
(b) 25 bis 50 Gew.-% eines Lösungsmittels, bezogen auf das Gesamtgewicht der Beschichtungszusammensetzung, und

(ii) 30 bis 99 Gew.-%, bezogen auf die Gesamtharzfeststoffe, einer dispergierten Phase, die feste dispergierbare Teilchen eines Fluorkohlenstoffpolymers mit einer Teilchengröße von 0,1 bis 5,0 μm enthält,

wobei die Gesamtharzfeststoffe 50 - 75 Gew.-%, bezogen auf das Gesamtgewicht, der Beschichtungszusammensetzung ausmachen, und
B) Härten bei einer Temperatur von 200°C bis 300°C für 5 bis 20 min, um einen gehärteten trockenen Film mit einer Filmdicke von 7,6 bis 50,8 μm (0,3 bis 2 mil) zu bilden.

21. Verfahren nach einem der Ansprüche 18-20, wobei das Polymer 10 bis 60 Gew.-% des Harzfeststoffanteils der Beschichtungszusammensetzung ausmacht.

22. Verfahren nach einem der Ansprüche 18-20, wobei das Fluorkohlenstoffpolymer 40 bis 90 Gew.-% des Harzfeststoffanteils der Beschichtungszusammensetzung ausmacht.

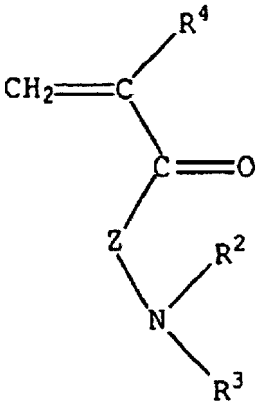
23. Verfahren nach einem der Ansprüche 18-20, wobei die Beschichtungszusammensetzung wie in einem der Ansprüche 2, 3, 5-8 und 11-16 definiert ist.

24. Beschichtetes Substrat, erhältlich nach einem Verfahren gemäß einem der Ansprüche 18-23.

Revendications

1. Composition de revêtement comprenant :

a) un polymère comprenant un ou plusieurs monomères de (méth)acrylate et un ou plusieurs monomères de (méth)acrylate d'aminoalkyle décrit par la structure :



où Z est un groupe liant divalent ; R^2 et R^3 sont indépendamment choisis parmi H ou un groupe aliphatique en C_1 à C_6 linéaire ou ramifié ; et R^4 est H ou CH_3 ;
b) un polymère de fluorocarbone ; et
c) un solvant ;

dans laquelle le polymère de fluorocarbone se présente sous la forme de particules solides dispersibles possédant une taille de particule allant de 0,1 à 5,0 microns.

2. Composition de revêtement selon la revendication 1, dans laquelle Z est choisi parmi -O-R^1- et -N(R^5)-R^1-, dans laquelle R^5 est H ou un groupe aliphatique en C_1 à C_6 linéaire ou ramifié, et R^1 est choisi dans le groupe constitué par des groupes aliphatiques en C_1 à C_{20} linéaires ou ramifiés, un aryle, un alkylaryle, un alkyle éthoxylé, un aryle éthoxylé, un alkylaryle éthoxylé, un alkyle propoxylé, un aryle propoxylé et un alkylaryle propoxylé.

3. Composition de revêtement selon les revendications précédentes, dans laquelle le polymère (a) est une résine thermoplastique.

4. Composition de revêtement selon les revendications précédentes, dans laquelle le polymère (a) comprend 1 pour cent à 70 pour cent en poids de la partie de résine solide de la composition de revêtement.

5. Composition de revêtement selon les revendications précédentes, dans laquelle le poids moléculaire moyen en poids du polymère (a) est inférieur à 25 000, tel que déterminé par chromatographie par perméation de gel en utilisant un polystyrène comme étalon.

6. Composition de revêtement selon la revendication 5, dans laquelle le poids moléculaire moyen en poids du polymère (a) va de 7 000 à 20 000, tel que déterminé par chromatographie par perméation de gel en utilisant un polystyrène comme étalon.

7. Composition de revêtement selon les revendications précédentes, dans laquelle le polymère de fluorocarbone est un ou plusieurs choisis dans le groupe constitué par le poly(fluorure de vinylidène), le poly(fluorure de vinyle), le poly(chlorotrifluoro-éthylène), le poly(tétrafluoroéthylène) et le poly(trifluoroéthylène).

8. Composition de revêtement selon les revendications précédentes, dans laquelle le poids moléculaire moyen en poids du polymère de fluorocarbone, tel que déterminé par chromatographie par perméation de gel en utilisant un polystyrène comme étalon, va de 100 000 à 500 000.

9. Composition de revêtement selon les revendications précédentes, dans laquelle le polymère de (a) et le solvant (c) constituent une phase continue et le polymère de fluorocarbone constitue une phase dispersée.

10. Composition de revêtement selon les revendications précédentes, dans laquelle le polymère de fluorocarbone comprend 30 à 99 pour cent en poids de la partie de résine solide de la composition de revêtement.

11. Composition de revêtement selon les revendications précédentes, dans laquelle le composant solvant est choisi

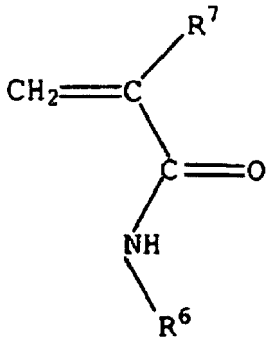
dans le groupe constitué par des hydrocarbures aliphatiques, des hydrocarbures aromatiques, des cétones, des esters, des glycols, des éthers, des éther-esters, des éthers de glycol, des éther-esters de glycol, des alcools, des éther-alcools, des plastifiants à base de phtalate et leurs mélanges.

12. Composition de revêtement selon les revendications précédentes, dans laquelle les monomères de (méth)acrylate sont un ou plusieurs choisis dans le groupe constitué par le (méth)acrylate de méthyle, le (méth)acrylate de n-butyle, le (méth)acrylate de t-butyle, le (méth)acrylate de n-propyle, le (méth)acrylate de cyclohexyle et le (méth)acrylate d'éthyle.

13. Composition de revêtement selon la revendication 2, dans laquelle le monomère de (méth)acrylate d'aminoalkyle est un (méth)acrylate de N-t-butylaminoalkyle.

14. Composition de revêtement selon la revendication 2, dans laquelle le monomère de (méth)acrylate d'aminoalkyle est le méthacrylate de t-butylaminoéthyle.

15. Composition de revêtement selon les revendications précédentes, dans laquelle le polymère (a) comprend un ou plusieurs monomères supplémentaires ayant la structure :



dans laquelle R^7 est H ou CH_3 et R^6 est $-CH_2-OH$ ou $-CH_2-O-R^{10}$, où R^{10} est un groupe aliphatique en C_1 à C_6 linéaire ou ramifié.

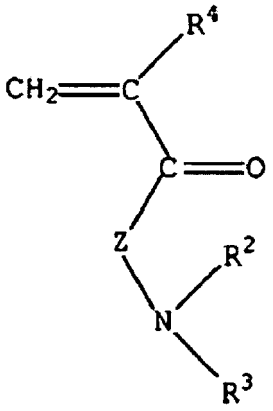
16. Composition de revêtement selon la revendication 15, dans laquelle les monomères supplémentaires comprennent un ou plusieurs choisis dans le groupe constitué par le N-butoxyméthyl acrylamide, le N-butoxyméthyl méthacrylamide, le N-méthylol acrylamide et le N-méthylol méthacrylamide.

17. Composition de revêtement selon l'une quelconque des revendications 1 à 3, comprenant :

(a) une phase continue comprenant :

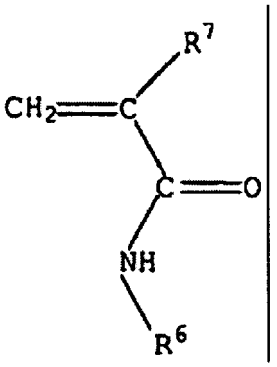
(i) 1 pour cent à 70 pour cent en poids sur la base de la résine solide d'un polymère comprenant la composition polymérisée de :

(A) 70 à 99,99 pour cent en poids, sur la base du poids du polymère d'un ou de plusieurs monomères choisis dans le groupe constitué par le (méth)acrylate de méthyle, le (méth)acrylate de n-butyle, le (méth)acrylate de t-butyle et le (méth)acrylate d'éthyle ;
(B) 0,01 à 10 pour cent en poids, sur la base du poids du polymère d'un ou de plusieurs monomères de (méth)acrylate d'aminoalkyle décrit par la structure :



où Z est un groupe liant divalent ; R^2 et R^3 sont indépendamment choisis parmi H ou un groupe aliphatique en C_1 à C_6 linéaire ou ramifié ; et R^4 est H ou CH_3 ; et

(C) 0 à 20 pour cent en poids, sur la base du poids du polymère d'un ou de plusieurs monomères supplémentaires ayant la structure :



dans laquelle R^7 est H ou CH_3 et R^6 est CH_2-OH ou -CH_2-O-R^{10}, où R^{10} est un groupe aliphatique en C_1 à C_6 linéaire ou ramifié ; dans laquelle la somme des quantités de (A), (B) et (C) est de 100 pour cent et dans laquelle le poids moléculaire moyen en poids de la résine thermoplastique va de 7 000 à 20 000, tel que déterminé par chromatographie par perméation de gel en utilisant un polystyrène comme étalon ;

(ii) un solvant choisi dans le groupe constitué par des hydrocarbures aliphatiques, des hydrocarbures aromatiques, des cétones, des esters, des glycols, des éthers, des éther-esters, des éthers de glycol, des éther-esters de glycol, des alcools, des éther-alcools, des plastifiants à base de phtalate et leurs mélanges ; et

(b) 30 à 99 pour cent en poids, sur la base de la résine solide d'une phase dispersée comprenant des particules solides dispersibles dont la taille de particule va de 0,1 à 5,0 microns, d'un ou de plusieurs polymères de fluorocarbone choisis dans le groupe constitué par le poly(fluorure de vinylidène), le poly(fluorure de vinyle), le poly(chlorotrifluoro-éthylène), le poly(tétrafluoroéthylène) et le poly(trifluoroéthylène).

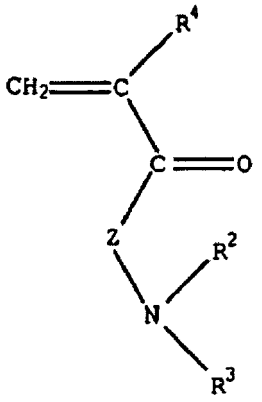
18. Procédé de laquage en continu d'un substrat métallique utilisant un appareil de laquage en continu, comprenant :

A) l'application d'une composition de revêtement de manière à ce que l'épaisseur du film humide aille de 25,4 à 254 μm (1 à 10 mils), dans lequel la composition de revêtement comprend :

(i) une phase continue comprenant :

(a) 1 pour cent à 70 pour cent en poids sur la base de la résine solide d'un polymère comprenant un

ou plusieurs monomères de (méth)acrylate et un ou plusieurs monomères de (méth)acrylate d'aminoalkyle décrit par la structure :



où Z est un groupe liant divalent ; R^2 et R^3 sont indépendamment choisis parmi H ou un groupe aliphatique en C_1 à C_6 linéaire ou ramifié ; et R^4 est H ou CH_3 ; et
(b) 25 à 50 pour cent en poids d'un solvant sur la base du poids total de la composition de revêtement ;

(ii) 30 à 99 pour cent en poids, sur la base de la résine solide d'une phase dispersée comprenant des particules solides dispersibles d'un polymère de fluorocarbone, la taille de particule des particules du polymère de fluorocarbone dispersible allant de 0,1 à 5,0 microns ;

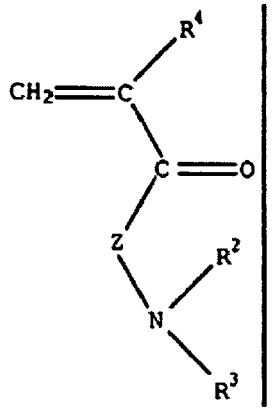
dans laquelle la résine solide totale va de 50 à 75 pour cent en poids sur la base du poids total de la composition de revêtement ; et
B) le durcissement à une température de 200 °C à 300 °C pendant 10 à 50 secondes pour former un film sec durci ayant une épaisseur de film de 12,7 à 152,4 μm (0,5 à 6 mils).

19. Procédé de revêtement par extrusion d'un substrat utilisant un appareil de revêtement par extrusion, comprenant :

A) l'application d'une composition de revêtement de manière à ce que l'épaisseur du film humide aille de 25,4 à 152,4 μm (1 à 6 mils), dans lequel la composition de revêtement comprend :

(i) une phase continue comprenant :

(a) 1 pour cent à 70 pour cent en poids sur la base de la résine solide totale d'un polymère comprenant un ou plusieurs monomères de (méth)acrylate et un ou plusieurs monomères de (méth)acrylate d'aminoalkyle décrit par la structure :



où Z est un groupe liant divalent ; R^2 et R^3 sont indépendamment choisis parmi H ou un groupe aliphatique en C_1 à C_6 linéaire ou ramifié ; et R^4 est H ou CH_3 ; et
(b) 25 à 50 pour cent en poids d'un solvant sur la base du poids total de la composition de revêtement ;

(ii) 30 à 99 pour cent en poids, sur la base de la résine solide totale d'une phase dispersée comprenant des particules solides dispersibles d'un polymère de fluorocarbone, la taille de particule des particules du polymère de fluorocarbone dispersible allant de 0,1 à 5,0 microns ;

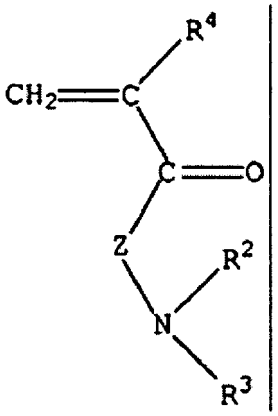
dans laquelle la résine solide totale va de 50 à 75 pour cent en poids sur la base du poids total de la composition de revêtement ; et
B) le durcissement à une température de 200 °C à 300 °C pendant 10 secondes à 20 minutes pour former un film sec durci ayant une épaisseur de film de 7,6 à 101,6 μm (0,3 à 4 mils).

20. Procédé de revêtement par pulvérisation d'un substrat utilisant un appareil de revêtement par pulvérisation, comprenant :

A) l'application d'une composition de revêtement de manière à ce que l'épaisseur du film humide aille de 25,4 à 101,6 μm (1 à 4 mils), dans lequel la composition de revêtement comprend :

(i) une phase continue comprenant :

(a) 1 pour cent à 70 pour cent en poids sur la base de la résine solide totale d'un polymère comprenant un ou plusieurs monomères de (méth)acrylate et un ou plusieurs monomères de (méth)acrylate d'aminoalkyle décrit par la structure :



où Z est un groupe liant divalent ; R^2 et R^3 sont indépendamment choisis parmi H ou un groupe aliphatique en C_1 à C_6 linéaire ou ramifié ; et R^4 est H ou CH_3 ; et
(b) 25 à 50 pour cent en poids d'un solvant sur la base du poids total de la composition de revêtement ; et

(ii) 30 à 99 pour cent en poids, sur la base de la résine solide totale d'une phase dispersée comprenant des particules solides dispersibles d'un polymère de fluorocarbone ayant une taille de particule allant de 0,1 à 5,0 microns ;

dans laquelle la résine solide totale va de 50 à 75 pour cent en poids sur la base du poids total de la composition de revêtement ; et
B) le durcissement à une température de 200 °C à 300 °C pendant 5 à 20 minutes pour former un film sec durci ayant une épaisseur de film de 7,6 à 50,8 μm (0,3 à 2 mils).

21. Procédé selon l'une quelconque des revendications 18 à 20, dans lequel le polymère comprend 10 pour cent à 60 pour cent en poids de la partie de résine solide de la composition de revêtement.

22. Procédé selon l'une quelconque des revendications 18 à 20, dans lequel le polymère de fluorocarbone comprend

40 à 90 pour cent en poids de la partie de résine solide de la composition de revêtement.

23. Procédé selon l'une quelconque des revendications 18 à 20, dans lequel la composition de revêtement est définie dans l'une quelconque des revendications 2, 3, 5 à 8 et 11 à 16.

24. Substrat revêtu pouvant être obtenu par un procédé selon l'une quelconque des revendications 18 à 23.

REFERENCES CITED IN THE DESCRIPTION

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