Claims

1. A multi-stage polymer comprising, based on the total weight of the multi-stage polymer, from 1 wt.% to 99 wt.% of a first stage polymer, and from 1 wt.% to 99 wt.% of a second stage polymer,

wherein the first stage polymer comprises, as polymerization units, based on the total weight of the first stage polymer:

(a) from 0.1 wt.% to 50 wt.%, of a nonionic macromonomer, characterized by the following formula: $H_2C=C(R)CO_2(CH_2CH_2O)_n(CH(R')CH_2O)_mR"$, wherein R is H or CH_3, R' is C_1-C_2 alkyl; R" is C_8-C_{30} alkyl, C_8-C_{16} alkylphenyl or C_{13}-C_{36} aralkylphenyl; n is an integral number from 6 to 100 and m is an integral number from 0 to 50, provided that n≥m and m+n is from 6 to 100;

(b) from 30 wt.% to 70 wt.%, of an α,β-ethylenically unsaturated carboxylic acid monomer; and

(c) from 30 wt.% to 70 wt.%, of an α,β-ethylenically unsaturated nonionic monomer;

wherein the first stage polymer has a weight average molecular weight of at least 50,000 Daltons; and

the second stage polymer comprises, as polymerization units, based on the total weight of the second stage polymer:

(e) from 10 wt.% to 70 wt.%, of an α,β-ethylenically unsaturated carboxylic acid monomer; and

(f) from 30 wt.% to 90 wt.%, of a nonionic α,β-ethylenically unsaturated monomer;

wherein the second stage polymer has a weight average molecular weight of from 500 to 20,000 Daltons, and the second stage polymer contains a substantial absence of the nonionic macromonomer.

2. The multi-stage polymer according to claim 1, wherein the first stage polymer further comprises, as polymerization units, based on the total weight of the first stage polymer, from 0.01 wt.% to 5 wt.%, a polyethyenically unsaturated crosslinking monomer.

3. The multi-stage polymer according to claim 1, wherein the second stage polymer contains an absence of the nonionic macromonomer.

4. The multi-stage polymer according to claim 1, wherein the α,β-ethylenically unsaturated carboxylic acid monomer is acrylic acid, methacrylic acid or a combination thereof.

5. The multi-stage polymer according to claim 1, wherein the α,β-ethylenically unsaturated nonionic monomer is ethyl acrylate, methyl methacrylate, 2-hydroxybutyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, vinyl acetate or acrylonitrile or a combination thereof.

6. A method for preparing a multi-stage polymer which comprises the steps:

i) contacting under emulsion polymerization conditions a first monomer composition comprising:

(a) from 0.1 wt.% to 50 wt.%, of a nonionic macromonomer, characterized by the following formula: $H_2C=C(R)CO_2(CH_2CH_2O)_n(CH(R')CH_2O)_mR''$, wherein R is H or CH_3, R' is C_1-C_2 alkyl; R" is C_8-C_{30} alkyl, C_8-C_{16} alkylphenyl or C_{13}-C_{36} aralkylphenyl; n is an integral number from 6 to 100 and m is an integral number from 0 to 50, provided that n≥m and m+n is from 6 to 100;

(b) from 30 wt.% to 70 wt.%, of an α,β-ethylenically unsaturated carboxylic acid monomer; and

(c) from 30 wt.% to 70 wt.%, of an α,β-ethylenically unsaturated nonionic monomer; to obtain a first stage polymer having a weight average molecular weight of at least 50,000 Daltons; and

ii) contacting under emulsion polymerization the first stage polymer with a second monomer composition comprising, based on the weight of the second monomer composition:

(e) from 10 wt.% to 70 wt.%, of an α,β-ethylenically unsaturated carboxylic acid monomer; and

(f) from 30 wt.% to 90 wt.%, of an α,β-ethylenically unsaturated nonionic monomer; to obtain a second stage polymer having a weight average molecular weight of from 500 to 20,000 Daltons, and the second stage polymer contains a substantial absence of the nonionic macromonomer.

7. The method for preparing a multi-stage polymer according to claim 6, wherein the first monomer composition further comprises, based on the total weight of the first polymer composition, from 0.01 wt.% to 5 wt.%, a polyethyenically unsaturated crosslinking monomer.

8. The method for preparing a multi-stage polymer according to claim 6, wherein the second monomer composition contains an absence of the nonionic macromonomer.

9. The method for preparing a multi-stage polymer according to claim 6, wherein the α,β-ethylenically unsaturated carboxylic acid monomer is acrylic acid or methacrylic acid or a combination thereof.

10. The method for preparing a multi-stage polymer according to claim 6, wherein the α,β-ethylenically unsaturated nonionic monomer is ethyl acrylate, methyl methacrylate, 2-hydroxybutyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, vinyl acetate or acrylonitrile or a combination thereof.

11. A coating composition comprising from 0.1% to 2%, by weight based on the total weight of the coating composition, of the multi-stage polymer according to claim 1, a pigment, an extender, and a binder.

CLAIMS

1. A multi-stage polymer comprising, based on the total weight of the multi-stage polymer, from 1 wt. % to 99 wt. % of a first stage polymer, and from 1 wt. % to 99 wt. % of a second stage polymer,

wherein the first stage polymer comprises, as polymerization units, based on the total weight of the first stage polymer:

(a) from 2 wt. % to 20 wt. %, of a nonionic macromonomer, characterized by the following formula: $H_2C{=}C(R)CO_2(CH_2CH_2O)_n(CH(R')CH_2O)_mR''$, wherein R is H or CH_3, R′ is C_1-C_2 alkyl; R″ is C_8-C_{30} alkyl, C_8-C_{16} alkylphenyl or C_{13}-C_{36} aralkylphenyl; n is an integral number from 6 to 100 and m is an integral number from 0 to 50, provided that $n \geqq m$ and m+n is from 6 to 100;

(b) from 35 wt. % to 60 wt. %, of an α,β-ethylenically unsaturated carboxylic acid monomer; and

(c) from 35 wt. % to 60 wt. %, of an α,β-ethylenically unsaturated nonionic monomer;

wherein the first stage polymer has a weight average molecular weight of at least 50,000 Daltons; and

the second stage polymer comprises, as polymerization units, based on the total weight of the second stage polymer:

(e) from 10 wt. % to 70 wt. %, of an α,β-ethylenically unsaturated carboxylic acid monomer; and

(f) from 30 wt. % to 90 wt. %, of a nonionic α,β-ethylenically unsaturated monomer;

wherein the second stage polymer has a weight average molecular weight of from 500 to 20,000 Daltons, and the second stage polymer contains a substantial absence of the nonionic macromonomer.

2. The multi-stage polymer according to claim 1, wherein the first stage polymer further comprises, as polymerization units, based on the total weight of the first stage polymer, from 0.01 wt. % to 5 wt. %, a polyethyenically unsaturated crosslinking monomer.

3. The multi-stage polymer according to claim 1, wherein the second stage polymer contains an absence of the nonionic macromonomer.

4. The multi-stage polymer according to claim 1, wherein the α,β-ethylenically unsaturated carboxylic acid monomer is acrylic acid, methacrylic acid or a combination thereof.

5. The multi-stage polymer according to claim 1, wherein the (α,β-ethylenically unsaturated nonionic monomer is ethyl acrylate, methyl methacrylate, 2-hydroxybutyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, vinyl acetate or acrylonitrile or a combination thereof.

6. A method for preparing a multi-stage polymer which comprises the steps:

i) contacting under emulsion polymerization conditions a first monomer composition comprising:

(a) from 2 wt. % to 20 wt. %, of a nonionic macromonomer, characterized by the following formula: $H_2C{=}C(R)CO_2(CH_2CH_2O)_n(CH(R')CH_2O)_mR''$, wherein R is H or CH_3, R′ is C_1-C_2 alkyl; R″ is C_8-C_{30} alkyl, C_8-C_{16} alkylphenyl or C_{13}-C_{36} aralkylphenyl; n is an integral number from 6 to 100 and m is an integral number from 0 to 50, provided that $n \geqq m$ and m+n is from 6 to 100;

(b) from 35 wt. % to 60 wt. %, of an α,β-ethylenically unsaturated carboxylic acid monomer; and

(c) from 35 wt. % to 60 wt. %, of an (α,β-ethylenically unsaturated nonionic monomer; to obtain a first stage polymer having a weight average molecular weight of at least 50,000 Daltons; and

ii) contacting under emulsion polymerization the first stage polymer with a second monomer composition comprising, based on the weight of the second monomer composition:

(e) from 10 wt. % to 70 wt. %, of an α,β-ethylenically unsaturated carboxylic acid monomer; and

(f) from 30 wt. % to 90 wt. %, of an α,β-ethylenically unsaturated nonionic monomer; to obtain a second stage polymer having a weight average molecular weight of from 500 to 20,000 Daltons, and the second stage polymer contains a substantial absence of the nonionic macromonomer.

7. The method for preparing a multi-stage polymer according to claim 6, wherein the first monomer composition further comprises, based on the total weight of the first polymer composition, from 0.01 wt. % to 5 wt. %, a polyethyenically unsaturated crosslinking monomer.

8. The method for preparing a multi-stage polymer according to claim 6, wherein the second monomer composition contains an absence of the nonionic macromonomer.

9. The method for preparing a multi-stage polymer according to claim 6, wherein the α,β-ethylenically unsaturated carboxylic acid monomer is acrylic acid or methacrylic acid or a combination thereof.

10. The method for preparing a multi-stage polymer according to claim 6, wherein the α,β-ethylenically unsaturated nonionic monomer is ethyl acrylate, methyl methacrylate, 2-hydroxybutyl acrylate, 2-hydroxyethyl methacrylate, 2-hydroxypropyl methacrylate, vinyl acetate or acrylonitrile or a combination thereof.

11. A coating composition comprising from 0.1% to 2%, by weight based on the total weight of the coating composition, of the multi-stage polymer according to claim 1, a pigment, an extender, and a binder.