Coated articles in particular are ideally smooth and non-tacky, and they preferably have a coating that does not flake off. There is a need in the art for such articles, and methods of making such articles.

[0004] Coatings have been used in products, such as for enhancing the desirable features of rubber gloves. Previous coatings have been developed, such as those disclosed in U.S. Patent Nos. 4,548,844; 4,575,476; 6,242,042; 6,706,313; 7,179415; 6,772,443; 7,032,251; 6,706,836; 6,743,880; 7,019,067; 6,653,427; 6,828,399; 6,284,856; and 5,993,923, each of which is incorporated in its entirety as if set forth fully herein. All references cited herein are incorporated by reference in their entirety.

SUMMARY

[0005] A novel and useful preparation of a copolymer emulsion is provided. In one embodiment, a method for forming a copolymer emulsion is provided by combining and copolymerizing at least one water soluble monomer and at least one water insoluble monomer, wherein the monomers used in the process are comprised of at least 50% by weight water soluble monomer and at least 10% by weight water insoluble monomer as measured by the total monomer weight.

[0005a] In one aspect of the present disclosure, there is provided a method for the preparation of a copolymer emulsion comprising:

concurrently combining a monomer feed and a pre-emulsion feed to form an emulsion, wherein the monomer feed comprises at least 50% by weight water soluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed, and the pre-emulsion feed comprises at least 10% by weight water insoluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed

wherein the water insoluble monomer of the pre-emulsion feed comprises a mixture of at least two or more different insoluble monomers selected from the group consisting of methyl acrylate, ethyl acrylate, butyl acrylate, propyl acrylate, 2- ethylhexyl acrylate, methyl methacrylate, lauryl methacrylate, 2-ethylhexyl methacrylate, trifluoroethyl methacrylate, isooctyl acrylate, isodecyl acrylate, and dimethylaminoethyl methacrylate.

water insoluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed.

[0006] In another aspect of the present disclosure, there is provided a method for the preparation of a copolymer emulsion comprising:

concurrently combining a monomer feed and a pre-emulsion feed to form an emulsion, wherein the monomer feed comprises at least 50% by weight water soluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed, and the pre-emulsion feed comprises at least 10% by weight water insoluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed, wherein the method further comprises the following steps:

introducing into a reactor and agitating an initial charge comprising a stabilizer, a surfactant, an initiator, and deionized water;

maintaining the reactor contents at a temperature of about 55° C and a pH above about 6.0;

introducing about 6% of the monomer feed and about 6% of the pre-emulsion feed into the reactor and maintaining the temperature and pH in the reactor for about ten minutes;

introducing an activator feed into the reactor at a rate such that the contents of the activator feed will be exhausted concurrently with or after the exhaustion of the monomer feed and the pre-emulsion feed, wherein the activator feed comprises deionized water and sodium hydroxymethanesulfinate;

introducing the monomer feed and the pre-emulsion feed into the reactor at a constant rate over a span of about 4.5 hours;

after the monomer feed, pre-emulsion feed, and activator feed have been fully introduced into the reactor, introducing a feed into the reactor comprising a second initiator and

maintaining the temperature and pH in the reactor for about one hour to complete polymerization.

[0007] In still another embodiment, the method for the preparation of a copolymer emulsion is provided by concurrently combining a monomer feed and a pre-emulsion feed to form a monomer mixture, wherein the monomer feed comprises at least 50% by weight water soluble monomer and wherein the pre-emulsion feed comprises at least 10% water insoluble monomer, with such percentages based on the total monomer weight of the monomer feed and the pre-emulsion feed. The method further requires introducing into a reactor and agitating an initial charge that includes a stabilizer, a surfactant, an initiator, and deionized water and maintaining the reactor contents at about 55° C and at a pH above about 6.0. The method also includes introducing about 6% of the monomer feed and about 6% of the pre-emulsion feed into the reactor and maintaining the temperature and pH for about ten minutes, followed by introducing an activator feed into the reactor. The activator feed, which includes deionized water and sodium hydroxymethanesulfinate, is introduced at a rate such that the contents of the activator feed will be exhausted concurrently with or after the exhaustion of the monomer feed and the pre-emulsion feed. The remaining

CLAIMS

What is claimed is:

1. A method for the preparation of a copolymer emulsion comprising:

concurrently combining a monomer feed and a pre-emulsion feed to form an emulsion, wherein the monomer feed comprises at least 50% by weight water soluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed, and the pre-emulsion feed comprises at least 10% by weight water insoluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed

wherein the water insoluble monomer of the pre-emulsion feed comprises a mixture of at least two or more different insoluble monomers selected from the group consisting of methyl acrylate, ethyl acrylate, butyl acrylate, propyl acrylate, 2- ethylhexyl acrylate, methyl methacrylate, lauryl methacrylate, 2-ethylhexyl methacrylate, trifluoroethyl methacrylate, isooctyl acrylate, isodecyl acrylate, and dimethylaminoethyl methacrylate.

2. The method of claim 1 wherein the water soluble monomer comprises from 50% to 97% of the total monomer weight.

3. The method of claim 1 wherein the water soluble monomer comprises at least 60% of the total monomer weight.

4. The method of claim 1 wherein the water soluble monomer comprises at least 75% of the total monomer weight.

5. The method of claim 1 wherein the water insoluble monomer comprises at least 15% of the total monomer weight.

6. The method of claim 1 wherein the water insoluble monomer comprises at least 25% of the total monomer weight.

7. The method of claim 1, 2, 3, 4, 5, or 6 wherein the water soluble monomer is selected from the group consisting of 2-hydroxyethyl methacrylate and 4-hydroxybutyl acrylate.

8. The method of claim 2, 3, 4, 5, or 6 wherein the water insoluble monomer comprises 2-ethylhexyl acrylate and 2-ethylhexyl methacrylate.

9. The method of claim 2, 3, 4, 5, or 6 wherein the water insoluble monomer comprises 2-ethylhexyl acrylate and lauryl methacrylate.

10. The method of claim 1 wherein the method further comprises introducing a crosslinker into the copolymer emulsion.

11. The method of claim 10 wherein the crosslinker is selected from the group consisting of formaldehydes, melamine formaldehydes, metal salts, aziridines, isocyanates, dichromates.

12. The method of claim 10 wherein the crosslinker comprises a polyfunctional aziridineliquid.

13. The method of claim 10 wherein the crosslinker comprises a carbodiimide compound.

14. The method of claim 10 wherein the crosslinker comprises a melamine formaldehyde.

15. The method of claim 10 wherein the crosslinker comprises a polyamide-epichlorohydrin-type resin.

16. The method of claim 1 wherein the method further comprises introducing an activator to the monomer mixture.

17. The method of claim 1 further comprising introducing a surfactant to the monomer mixture.

18. The method of claim 17 wherein the surfactant is sodium lauryl ether sulfate.

19. The method of claim 1 further comprising introducing an initiator to the monomer mixture.

20. The method of claim 19 wherein the initiator is selected from the group consisting of ammonium persulfate, potassium persulfate, sodium persulfate, hydrogen peroxide, tert-butyl hydroperoxide, azo compounds, sodium persulfate with sodium metabisulfite, hydrogen peroxide with ferrous ion, sulfite ion, bisulfite ion or ascorbic acid, hydroperoxides with sulfoxylates, and tert-butyl hydroperoxide with sodium formaldehyde sulfoxylate.

21. The method of claim 20 wherein the initiator is tert-butyl hydroperoxide.

22. The method of claim 1 wherein the method further comprises introducing a stabilizer during to the monomer mixture.

23. The method of claim 22 wherein the stabilizer is polyvinyl alcohol.

24. The method of claim 1 further comprising introducing a surfactant, an initiator, and a stabilizer to the monomer mixture.

25. The method of claim 24 wherein the surfactant, initiator, and stabilizer are introduced into the monomer mixture by first combining the surfactant, initiator, and stabilizer with the water insoluble monomer.

26. The method of claim 1 wherein the monomer mixture is maintained at a temperature between 50° C and 60° C.

27. The method of claim 1 wherein the temperature of the monomer mixture is maintained at a temperature of 55° C.

28. The method of claim 1 wherein the monomer mixture is maintained at a pH at or above 6.0.

29. The method of claim 1 wherein the wherein the monomer mixture is maintained at a pH between 6.0 and 7.0

30. The method of claim 1 wherein the monomer feed further comprises deionized water and the pre-emulsion feed further comprises deionized water, a surfactant, and a stabilizer.

31. The method of claim 30 wherein the surfactant is sodium lauryl ether sulfate and the stabilizer is polyvinyl alcohol.

32. The method of claim 1, 30, or 31 wherein the water soluble monomer of the monomer feed comprises 2-hyroxyexthyl methacrylate.

33. The method of claim 1, 30, or 31 wherein the water soluble monomer of the monomer feed consists of 2-hyroxyexthyl methacrylate.

34. The method of claim 32 wherein the water soluble monomer comprises 2 - hydroxy ethyl methacrylate having a purity level of about 97%.

35. The method of claim 1, 30 or 31 wherein the water insoluble monomer of the pre-emulsion feed comprises 2-ethylhexyl acrylate.

36. The method of claim 1 wherein the pre-emulsion feed comprises 2-ethylhexyl acrylate and methacrylic acid.

37. The method of claim 36 wherein the methacrylic acid is about 1% to 5% of the total weight of monomers used in the method.

38. The method of claim 36 wherein the methacrylic acid is 3% of the total weight of monomers used in the method.

39. The method of claim 1 wherein the method comprises the further steps of:

introducing into a reactor and agitating an initial charge comprising a stabilizer, a surfactant, an initiator, and deionized water;

maintaining contents in the reactor at a temperature of 55° C and a pH above 6.0;

introducing 6% of the monomer feed and 6% of the pre-emulsion feed into the reactor and maintaining the temperature and pH in the reactor for ten minutes;

introducing an activator feed into the reactor at a rate such that the contents of the activator feed will be exhausted concurrently with or after the exhaustion of the monomer

feed and the pre-emulsion feed, wherein the activator feed comprises deionzied water and sodium hydroxymethanesulfinate;

introducing the monomer feed and the pre-emulsion feed into the reactor at a constant rate over a span of 4.5 hours; and

after the monomer feed, pre-emulsion feed, and activator feed have been fully introduced into the reactor, introducing a feed into the reactor comprising a second initiator and maintaining the temperature and pH in the reactor for one hour to form complete polymerization.

40. The method of claim 39 wherein the monomer feed comprises 2-hyroxyexthyl methacrylate, the surfactant is sodium lauryl ether sulfate, the stabilizer is polyvinyl alcohol, and the initiator is tert-butyl hydroxide.

41. The method of claim 40 wherein the initiator further comprises biocide.

42. The method of claim 40 wherein the pre-emulsion feed comprises the pre-emulsion feed comprises 2-ethylhexyl acrylate and methacrylic acid.

43. The method of claim 40 wherein the pre-emulsion feed comprises the pre-emulsion feed comprises 2-ethylhexyl methacrylate and methacrylic acid.

44. The method of claim 40 wherein the pre-emulsion feed comprises 2-ethylhexyl acrylate, methacrylic acid, and methyl methacrylate.

45. The method of claim 40 further comprising the step of adding a crosslinker to the emulsion.

46. The method of claim 45 wherein the crosslinker is selected from the group consisting of a polyfunctional aziridineliquid, a carbodiimide compound, a titanium acetylacetonate, a polyamide-epichlorohydrin-type resin, and a melamine-formaldehye resin.

47. A method for the preparation of a copolymer emulsion comprising:

concurrently combining a monomer feed and a pre-emulsion feed to form an emulsion, wherein the monomer feed comprises at least 50% by weight water soluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed, and the pre-emulsion feed comprises at least 10% by weight water insoluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed, wherein the method further comprises the following steps:

introducing into a reactor and agitating an initial charge comprising a stabilizer, a surfactant, an initiator, and deionized water;

maintaining the reactor contents at a temperature of about 55° C and a pH above about 6.0;

introducing about 6% of the monomer feed and about 6% of the pre-emulsion feed into the reactor and maintaining the temperature and pH in the reactor for about ten minutes;

introducing an activator feed into the reactor at a rate such that the contents of the activator feed will be exhausted concurrently with or after the exhaustion of the monomer feed and the pre-emulsion feed, wherein the activator feed comprises deionized water and sodium hydroxymethanesulfinate;

introducing the monomer feed and the pre-emulsion feed into the reactor at a constant rate over a span of about 4.5 hours;

after the monomer feed, pre-emulsion feed, and activator feed have been fully introduced into the reactor, introducing a feed into the reactor comprising a second initiator and maintaining the temperature and pH in the reactor for about one hour to complete polymerization.

48. The method of claim 47 wherein the monomer feed comprises 2-hyroxyexthyl methacrylate, the surfactant is sodium lauryl ether sulfate, the stabilizer is polyvinyl alcohol, and the initiator is tert-butyl hydroxide, and the pre-emulsion feed comprises 2-ethylhexyl acrylate and methacrylic acid.

49. The method of claim 47 wherein the monomer feed comprises 2-hyroxyexthyl methacrylate, the surfactant is sodium lauryl ether sulfate, the stabilizer is polyvinyl alcohol, the initiator is tert-butyl hydroxide, and the pre-emulsion feed comprises 2-ethylhexyl acrylate, methacrylic acid, and methyl methacrylate.

50. The method of claim 48 or 49 further comprising the step of adding a crosslinker to the emulsion, wherein the crosslinker is selected from the group consisting of a polyfunctional aziridineliquid, a carbodiimide compound, and a polyamide-epichlorohydrin-type resin.

51. The method of claim 47 further comprising the step of adding a crosslinker to the emulsion, wherein the crosslinker comprises a melamine-formaldehye resin.

52. The method for the preparation of a copolymer emulsion of claim 39 comprising:

concurrently combining a monomer feed and a pre-emulsion feed to form an emulsion, wherein the monomer feed comprises 75% by weight water soluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed, and the pre-emulsion feed comprises at least 3% by weight water insoluble monomer based on the total monomer weight of the monomer feed and the pre-emulsion feed.

53. The method of claim 52 wherein the water soluble monomer is 2-hydroxyethyl methacrylate.

54. The method of claim 52 or 53 wherein the pre-emulsion feed comprises 2-ethylhexyl acrylate, methacrylic acid, and methyl methacrylate.

55. The method of claim 52 wherein the pre-emulsion feed comprises between 9% to 19% by weight 2-ethylhexyl acrylate, between 1.5% to 6% by weight methacrylic acid, and between 3% to 12% by weight methyl methacrylate, wherein said percentages are based on the total monomer weight of the monomer feed and the pre-emulsion feed.

56. The method of claim 52 wherein 2-hydroxyethyl methacrylate comprises about 75% of the total monomer weight, 2-ethylhexyl acrylate comprises about 14% of the total monomer weight, methyl methacrylate comprises about 8% of the total monomer weight, and methacrylic acid comprises about 3% of the total monomer weight, wherein the total monomer weight indicates the total monomer weight of the monomer feed and the pre-emulsion feed.

57. The method of claim 52 wherein 2-hydroxyethyl methacrylate comprises about 75% of the total monomer weight, 2-ethylhexyl acrylate comprises about 19% of the total monomer weight, methyl methacrylate comprises about 3% of the total monomer weight, and methacrylic acid comprises about 3% of the total monomer weight, wherein the total monomer weight indicates the total monomer weight of the monomer feed and the pre-emulsion feed.

58. The method of claim 52 wherein 2-hydroxyethyl methacrylate comprises about 75% of the total monomer weight, 2-ethylhexyl acrylate comprises about 11.75% of the total monomer weight, methyl methacrylate comprises about 11.75% of the total

monomer weight, and methacrylic acid comprises about 1.5% of the total monomer weight, wherein the total monomer weight indicates the total monomer weight of the monomer feed and the pre-emulsion feed.

59. The method of claim 52 wherein 2-hydroxyethyl methacrylate comprises 75% of the total monomer weight, 2-ethylhexyl acrylate comprises 10.3% of the total monomer weight, methyl methacrylate comprises 10.3% of the total monomer weight, and methacrylic acid comprises 4.5% of the total monomer weight, wherein the total monomer weight indicates the total monomer weight of the monomer feed and the pre-emulsion feed.

60. The method of claim 29 wherein 2-hydroxyethyl methacrylate comprises about 75% of the total monomer weight, 2-ethylhexyl acrylate comprises about 9.5% of the total monomer weight, methyl methacrylate comprises about 9.5% of the total monomer weight, and methacrylic acid comprises about 6% of the total monomer weight, wherein the total monomer weight indicates the total monomer weight of the monomer feed and the pre-emulsion feed.

61. The method of any one of claims 52-60 wherein the method comprises the further steps of:

introducing into a reactor and agitating an initial charge comprising a stabilizer, a surfactant, an initiator, and deionized water and heating to a temperature of about 55° C;