WHAT IS CLAIMED:

1. A block copolymer comprising at least one PA block and at least one PB block, wherein PA represents a polymer block comprising one or more units of monomer A and PB represents a polymer block comprising one or more units of monomer B, with monomer A being a vinyl, acrylic, diolefin, nitrile, dinitrile, or acrylonitrile monomer, and monomer B being a radically polymerizable plant oil monomer containing one or more triglycerides.

2. The block copolymer of claim 1, wherein the block copolymer has a triblock polymer architecture of PA-PB-PA or PB-PA-PB.

3. The block copolymer of claim 1, wherein the block copolymer has a pentablock polymer architecture of PA-PB-PA-PB-PA or PB-PA-PB-PA-PB.

4. The block copolymer of claim 1, wherein the block copolymer has a $(PA\text{-}PB)_n$ architecture, wherein n is an integer ranging from 2 to 10.

5. The block copolymer of claim 1, wherein the block copolymer has a $(PA\text{-}PB)_n$-PA architecture, wherein n is an integer ranging from 2 to 10.

6. The block copolymer of claim 1, wherein the block copolymer has a PB-$(PA\text{-}PB)_n$ architecture, wherein n is an integer ranging from 2 to 10.

7. The block copolymer of claim 1, wherein the PA block comprises repeating units of monomer A and the PB block comprises repeating units of monomer B.

8. The block copolymer of claim 1, wherein the PA block comprises a polymerized linear-chain or branched-chain A monomer, or radicals thereof.

9. The block copolymer of claim 1, wherein the monomer A is selected from the group consisting of styrene, α-methyl styrene, t-butyl styrene, vinyl xylene, vinyl naphthalene, vinyl pyridine, divinyl benzene, methyl acrylate, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, heptyl (meth)acrylate, hexyl (meth)acrylate, acrylonitrile, adiponitrile, methacrylonitrile, butadiene, isoprene, and mixtures thereof.

10. The block copolymer of claim 9, wherein the monomer A is styrene.

11. The block copolymer of claim 1, wherein the PB block comprises a polymerized linear-chain or branched-chain plant oil, or radicals thereof.

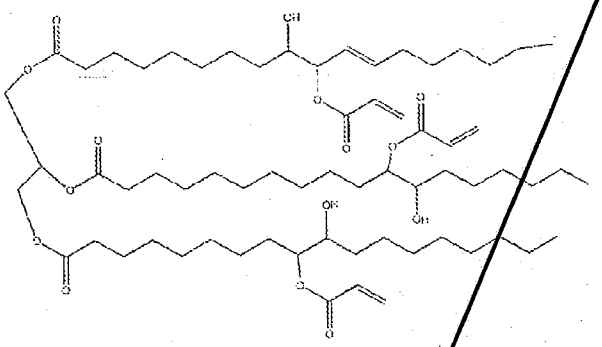
12. The block copolymer of claim 11, wherein the PB block comprises polymerized triglyceride or mixtures thereof.

13. The block copolymer of claim 12, wherein the polymerized triglyceride or mixtures thereof comprises one or more conjugated sites.

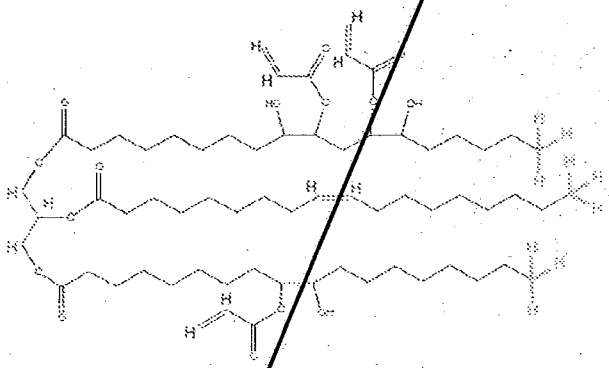
14. The block copolymer of claim 13, wherein the conjugated site is formed by acrylate groups.

15. The block copolymer of claim 12, wherein the triglyceride is acrylated epoxidized triglyceride.

16. The block copolymer of claim 12, wherein the triglyceride is:



, or



17. The block copolymer of claim 1, wherein the PB block is polymerized plant oil which is subsequently partially or fully saturated via catalytic hydrogenation post-polymerization.

18. The block copolymer of claim 1, wherein the plant oil is soybean oil, linseed oil, flax seed oil, or rapeseed oil.

19. The block copolymer of claim 1, wherein the block copolymer has a PA-PB-PA triblock polymer architecture, with the PA block being a linear-chain polystyrene or radicals thereof, and the PB block being a linear-chain or branched-chain polymerized soybean oil or radicals thereof.

20. The block copolymer of claim 19, wherein the soybean oil is acrylated epoxidized soybean oil.

21. The block copolymer of claim 19, wherein the block copolymer has a molecular weight ranging from 7 kDa to 1000 kDa.

22. The block copolymer of claim 19, wherein the PB block has a glass transition temperature (T_g) below -15 °C.

23. The block copolymer of claim 22, wherein the PB block has a T_g ranging from -60 °C to -28 °C.

24. The block copolymer of claim 19, wherein the block copolymer comprises 5 wt % to 95 wt % of PA block and 95 wt % to 5 wt % of PB block.

25. In an elastomeric composition, the improvement comprising the block copolymer of claim 1.

26. An elastomer composition comprising the block copolymer of claim 1, wherein the block copolymer is vulcanized, cross-linked, compatibilized, and/or compounded with one or more other elastomer, additive, modifier and/or filler.

27. In a toughened engineering thermoplastic composition, the improvement comprising the block copolymer of claim 1.

28. In an asphalt composition, the improvement comprising the block copolymer of claim 1 as an asphalt additive, modifier, and/or filler.

29. The asphalt composition of claim 28 further comprising a bitumen component.

30. An adhesive composition comprising:
the block copolymer of claim 1 and
a tackifier and/or a plasticizer.

31. In a vehicle tire, the improvement comprising the block copolymer of claim 1.

32. The vehicle tire of claim 31, wherein the tire is vulcanized, cross-linked, compatibilized, and/or compounded with one or more other material.

33. A method of preparing a thermoplastic block copolymer, said method comprising:

providing a radically polymerizable monomer, represented by A, or a polymer block PA comprising one or more units of monomer A;

providing a radically polymerizable plant oil monomer containing one or more triglycerides, represented by B; and

radical polymerizing monomer A or the polymer block PA with monomer B, in the presence of an initiator and a transition-metal catalyst system to form the thermoplastic block copolymer.

34. The method of claim 33, wherein said radical polymerizing comprises:

a) radical polymerizing monomer A in a solvent suitable for dissolving PA; and

b) radical polymerizing monomer B in a solvent suitable for dissolving PA and PB, with PA from step a) being the initiator, to form a diblock copolymer PA-PB.

35. A method of preparing a thermoplastic block copolymer, said method comprising:

providing a radically polymerizable plant oil monomer containing one or more triglycerides, represented by B, or a polymer block PB comprising one or more units of monomer B;

providing a radically polymerizable monomer, represented by A; and

radical polymerizing monomer B or the polymer block PB with monomer A, in the presence of an initiator and a transition-metal catalyst system, to form the thermoplastic block copolymer.

36. The method of claim 35, wherein said radical polymerizing comprises:

a) radical polymerizing monomer B in a solvent suitable for dissolving PB; and

b) radical polymerizing monomer A in a solvent suitable for dissolving PA and PB, with PB from step a) as the initiator, to form the diblock copolymer PB-PA.

37. The method of claim 34 or 36 further comprising:

c) radical polymerizing monomer A or monomer B with the formed block copolymer in step b) as the initiator, thereby adding an additional polymer block to the block copolymer formed in step b).

38. The method of claim 37 further comprising:

d) repeating step c) to form a multiple block copolymer.

39. The method of claim 33 or 35, further comprising:

catalytically hydrogenating the PB block to partial or full saturation after said radical polymerizing.

40. The method of claim 33 or 35, wherein said radical polymerizing is carried out by atom transfer radical polymerization.

41. The method of claim 33 or 35, wherein the monomer A is vinyl, acrylic, diolefin, nitrile, dinitrile, or acrylonitrile monomer.

42. The method of claim 33 or 35, wherein the monomer A is selected from the group consisting of styrene, α-methyl styrene, t-butyl styrene, vinyl xylene, vinyl naphthalene, vinyl pyridine, divinyl benzene, methyl acrylate, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, heptyl (meth)acrylate, hexyl (meth)acrylate, acrylonitrile, adiponitrile, methacrylonitrile, butadiene, isoprene, and mixtures thereof.

43. The method of claim 42, wherein the monomer A is styrene.

44. The method of claim 33 or 35, wherein the plant oil is soybean oil, linseed oil, flax seed oil, or rapeseed oil.

45. The method of claim 33 or 35, wherein the plant oil is acrylated epoxidized plant oil.

46. The method of claim 33 or 35, wherein the monomer A is styrene, and the monomer B is soybean oil.

47. The method of claim 33 or 35, wherein said radical polymerizing is carried out at a temperature of 65 to 100 °C.

48. The method of claim 34, wherein said radical polymerizing of step a) forms a PA block having a molecular weight of 1 to 300 kDa.

49. The method of claim 34 or 36, wherein the diblock copolymer PA-PB or PB-PA has a molecular weight of 5 to 500 kDa.

50. The method of claim 37, wherein said radical polymerizing of step c) forms a block copolymer PA-PB-PA having a molecular weight of 7 to 1000 kDa.

51. The method of claim 34 or 36, wherein the solvent is toluene, THF, chloroform, cyclohexane, or a mixture thereof.

52. The method of claim 51, wherein the monomer concentration dissolved in the solvent ranges from 5 % to 100% weight percentage monomer.

53. The method of claim 33 or 35, wherein the initiator is an aryl halide.

54. The method of claim 53, wherein the initiator is benzyl chloride.

55. The method of claim 33 or 35, wherein the transition-metal catalyst system comprises a transition-metal compound and a ligand capable of coordinating to the transition metal of the transition-metal compound.

56. The method of claim 55, wherein the transition-metal compound is CuCl.

57. The method of claim 55, wherein the ligand is a N-, O-, P-, or S- containing compound capable of coordinating with the transition metal in a form of σ- or π- bond.

58. The method of claim 57, wherein the ligand is pentamethyldiethylenetriamine (PMDETA).

59. A thermoplastic polymer comprising one or more units of a radically polymerizable plant oil monomer containing one or more triglycerides.

60. The thermoplastic polymer of claim 59, wherein the thermoplastic polymer comprises a polymerized linear-chain or branched-chain plant oil, or radicals thereof.

61. The thermoplastic polymer of claim 59, wherein the plant oil is soybean oil, linseed oil, flax seed oil, or rapeseed oil.

62. The thermoplastic polymer of claim 59, wherein the plant oil is acrylated epoxidized plant oil.

63. A method of preparing a thermoplastic polymer or polymer block, said method comprising:

providing a radically polymerizable plant oil monomer containing one or more triglycerides; and

radical polymerizing said plant oil monomer, in the presence of an initiator and a transition-metal catalyst system to form the thermoplastic polymer or polymer block.

64. The method of claim 63, wherein said radical polymerizing is carried out by atom transfer radical polymerization.

65. The method of claim 63, wherein the plant oil is soybean oil, linseed oil, flax seed oil, or rapeseed oil.

66. The method of claim 63, wherein the plant oil is acrylated epoxidized plant oil.

67. The block copolymer of claim 1, wherein the block copolymer is a thermoplastic elastomer.

68. The an asphalt composition of claim 28, wherein the asphalt composition comprises 1 to 5 wt % of the block copolymer.

69. The method of claim 33 or 35, wherein the method is carried out in the presence of a counter-catalyst and a solvent at a temperature ranging from 65 to 85 °C.

70. The method of claim 69, wherein the solvent concentration ranges from 15 % to 60 % by mass ratio of the solvent to the monomer B.

WHAT IS CLAIMED:

1. A thermoplastic block copolymer comprising at least one PA block and at least one PB block, wherein PA represents a polymer block comprising one or more units of monomer A and PB represents a polymer block comprising one or more units of monomer B, with monomer A being a vinyl, acrylic, diolefin, nitrile, dinitrile, or acrylonitrile monomer, and monomer B being a radically polymerizable plant oil monomer containing one or more triglycerides.

2. The thermoplastic block copolymer of claim 1, wherein the thermoplastic block copolymer has a triblock polymer architecture of PA-PB-PA or PB-PA-PB.

3. The thermoplastic block copolymer of claim 1, wherein the thermoplastic block copolymer has a pentablock polymer architecture of PA-PB-PA-PB-PA or PB-PA-PB-PA-PB.

4. The thermoplastic block copolymer of claim 1, wherein the thermoplastic block copolymer has a $(PA\text{-}PB)_n$ architecture, wherein n is an integer ranging from 2 to 10.

5. The thermoplastic block copolymer of claim 1, wherein the thermoplastic block copolymer has a $(PA\text{-}PB)_n\text{-}PA$ architecture, wherein n is an integer ranging from 2 to 10.

6. The thermoplastic block copolymer of claim 1, wherein the thermoplastic block copolymer has a $PB\text{-}(PA\text{-}PB)_n$ architecture, wherein n is an integer ranging from 2 to 10.

7. The thermoplastic block copolymer of claim 1, wherein the PA block comprises repeating units of monomer A and the PB block comprises repeating units of monomer B.

8. The thermoplastic block copolymer of claim 1, wherein the PA block comprises a polymerized linear-chain or branched-chain A monomer, or radicals thereof.

9. The thermoplastic block copolymer of claim 1, wherein the monomer A is selected from the group consisting of styrene, α-methyl styrene, t-butyl styrene, vinyl xylene, vinyl naphthalene, vinyl pyridine, divinyl benzene, methyl acrylate, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, heptyl (meth)acrylate, hexyl (meth)acrylate, acrylonitrile, adiponitrile, methacrylonitrile, butadiene, isoprene, and mixtures thereof.

10. The thermoplastic block copolymer of claim 9, wherein the monomer A is styrene.

11. The thermoplastic block copolymer of claim 1, wherein the PB block comprises a polymerized linear-chain or branched-chain plant oil, or radicals thereof.

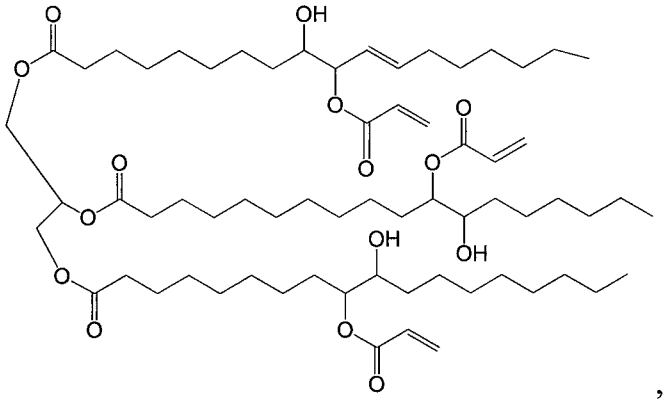
12. The thermoplastic block copolymer of claim 11, wherein the PB block comprises polymerized triglyceride or mixtures thereof.

13. The thermoplastic block copolymer of claim 12, wherein the polymerized triglyceride or mixtures thereof comprises one or more conjugated sites.

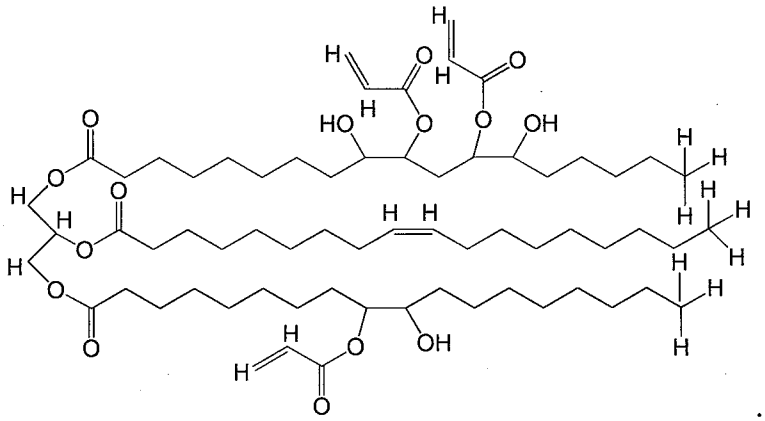
14. The thermoplastic block copolymer of claim 13, wherein the conjugated site is formed by acrylate groups.

15. The thermoplastic block copolymer of claim 12, wherein the triglyceride is acrylated epoxidized triglyceride.

16. The thermoplastic block copolymer of claim 12, wherein the triglyceride is:



, or



17. The thermoplastic block copolymer of claim 1, wherein the PB block is polymerized plant oil which is subsequently partially or fully saturated via catalytic hydrogenation post-polymerization.

18. The thermoplastic block copolymer of claim 1, wherein the plant oil is soybean oil, linseed oil, flax seed oil, or rapeseed oil.

19. The thermoplastic block copolymer of claim 1, wherein the thermoplastic block copolymer has a PA-PB-PA triblock polymer architecture, with the PA block being a linear-chain polystyrene or radicals thereof, and the PB block being a linear-chain or branched-chain polymerized soybean oil or radicals thereof.

20. The thermoplastic block copolymer of claim 19, wherein the soybean oil is acrylated epoxidized soybean oil.

21. The thermoplastic block copolymer of claim 19, wherein the thermoplastic block copolymer has a molecular weight ranging from 7 kDa to 1000 kDa.

22. The thermoplastic block copolymer of claim 19, wherein the PB block has a glass transition temperature (T_g) below -15 °C.

23. The thermoplastic block copolymer of claim 22, wherein the PB block has a T_g ranging from -60 °C to -28 °C.

24. The thermoplastic block copolymer of claim 19, wherein the thermoplastic block copolymer comprises 5 wt % to 95 wt % of PA block and 95 wt % to 5 wt % of PB block.

25. In an elastomeric composition, the improvement comprising the thermoplastic block copolymer of claim 1.

26. An elastomer composition comprising the thermoplastic block copolymer of claim 1, wherein the thermoplastic block copolymer is vulcanized, cross-linked, compatibilized, and/or compounded with one or more other elastomer, additive, modifier and/or filler.

27. In a toughened engineering thermoplastic composition, the improvement comprising the thermoplastic block copolymer of claim 1.

28. In an asphalt composition, the improvement comprising the thermoplastic block copolymer of claim 1 as an asphalt additive, modifier, and/or filler.

29. The asphalt composition of claim 28 further comprising a bitumen component.

30. An adhesive composition comprising:
the thermoplastic block copolymer of claim 1 and
a tackifier and/or a plasticizer.

31. In a vehicle tire, the improvement comprising the thermoplastic block copolymer of claim 1.

32. The vehicle tire of claim 31, wherein the tire is vulcanized, cross-linked, compatibilized, and/or compounded with one or more other material.

33. A method of preparing a thermoplastic block copolymer, said method comprising:

providing a radically polymerizable monomer, represented by A, or a polymer block PA comprising one or more units of monomer A;

providing a radically polymerizable plant oil monomer containing one or more triglycerides, represented by B; and

radical polymerizing monomer A or the polymer block PA with monomer B, in the presence of an initiator and a transition-metal catalyst system to form the thermoplastic block copolymer.

34. The method of claim 33, wherein said radical polymerizing comprises:

a) radical polymerizing monomer A in a solvent suitable for dissolving PA; and

b) radical polymerizing monomer B in a solvent suitable for dissolving PA and PB, with PA from step a) being the initiator, to form a diblock copolymer PA-PB.

35. A method of preparing a thermoplastic block copolymer, said method comprising:

providing a radically polymerizable plant oil monomer containing one or more triglycerides, represented by B, or a polymer block PB comprising one or more units of monomer B;

providing a radically polymerizable monomer, represented by A; and

radical polymerizing monomer B or the polymer block PB with monomer A, in the presence of an initiator and a transition-metal catalyst system, to form the thermoplastic block copolymer.

36. The method of claim 35, wherein said radical polymerizing comprises:

a) radical polymerizing monomer B in a solvent suitable for dissolving PB; and

b) radical polymerizing monomer A in a solvent suitable for dissolving PA and PB, with PB from step a) as the initiator, to form the diblock copolymer PB-PA.

37. The method of claim 34 or 36 further comprising:

c) radical polymerizing monomer A or monomer B with the formed block copolymer in step b) as the initiator, thereby adding an additional polymer block to the block copolymer formed in step b).

38. The method of claim 37 further comprising:

d) repeating step c) to form a multiple block copolymer.

39. The method of claim 33 or 35, further comprising:

catalytically hydrogenating the PB block to partial or full saturation after said radical polymerizing.

40. The method of claim 33 or 35, wherein said radical polymerizing is carried out by atom transfer radical polymerization.

41. The method of claim 33 or 35, wherein the monomer A is vinyl, acrylic, diolefin, nitrile, dinitrile, or acrylonitrile monomer.

42. The method of claim 33 or 35, wherein the monomer A is selected from the group consisting of styrene, α-methyl styrene, t-butyl styrene, vinyl xylene, vinyl naphthalene, vinyl pyridine, divinyl benzene, methyl acrylate, methyl (meth)acrylate, ethyl (meth)acrylate, propyl (meth)acrylate, butyl (meth)acrylate, heptyl (meth)acrylate, hexyl (meth)acrylate, acrylonitrile, adiponitrile, methacrylonitrile, butadiene, isoprene, and mixtures thereof.

43. The method of claim 42, wherein the monomer A is styrene.

44. The method of claim 33 or 35, wherein the plant oil is soybean oil, linseed oil, flax seed oil, or rapeseed oil.

45. The method of claim 33 or 35, wherein the plant oil is acrylated epoxidized plant oil.

46. The method of claim 33 or 35, wherein the monomer A is styrene, and the monomer B is soybean oil.

47. The method of claim 33 or 35, wherein said radical polymerizing is carried out at a temperature of 65 to 100 °C.

48. The method of claim 34, wherein said radical polymerizing of step a) forms a PA block having a molecular weight of 1 to 300 kDa.

49. The method of claim 34 or 36, wherein the diblock copolymer PA-PB or PB-PA has a molecular weight of 5 to 500 kDa.

50. The method of claim 37, wherein said radical polymerizing of step c) forms a block copolymer PA-PB-PA having a molecular weight of 7 to 1000 kDa.

51. The method of claim 34 or 36, wherein the solvent is toluene, THF, chloroform, cyclohexane, or a mixture thereof.

52. The method of claim 51, wherein the monomer concentration dissolved in the solvent ranges from 5 % to 100% weight percentage monomer.

53. The method of claim 33 or 35, wherein the initiator is an aryl halide.

54. The method of claim 53, wherein the initiator is benzyl chloride.

55. The method of claim 33 or 35, wherein the transition-metal catalyst system comprises a transition-metal compound and a ligand capable of coordinating to the transition metal of the transition-metal compound.

56. The method of claim 55, wherein the transition-metal compound is CuCl.

57. The method of claim 55, wherein the ligand is a N-, O-, P-, or S-containing compound capable of coordinating with the transition metal in a form of σ- or π- bond.

58. The method of claim 57, wherein the ligand is pentamethyldiethylenetriamine (PMDETA).

59. A thermoplastic polymer comprising repeating units of a radically polymerizable plant oil monomer containing one or more triglycerides.

60. The thermoplastic polymer of claim 59, wherein the thermoplastic polymer comprises a polymerized linear-chain or branched-chain plant oil, or radicals thereof.

61. The thermoplastic polymer of claim 59, wherein the plant oil is soybean oil, linseed oil, flax seed oil, or rapeseed oil.

62. The thermoplastic polymer of claim 59, wherein the plant oil is acrylated epoxidized plant oil.

63. A method of preparing a thermoplastic polymer or polymer block, said method comprising:

providing a radically polymerizable plant oil monomer containing one or more triglycerides; and

radical polymerizing said plant oil monomer, in the presence of an initiator and a transition-metal catalyst system to form the thermoplastic polymer or polymer block.

64. The method of claim 63, wherein said radical polymerizing is carried out by atom transfer radical polymerization.

65. The method of claim 63, wherein the plant oil is soybean oil, linseed oil, flax seed oil, or rapeseed oil.

66. The method of claim 63, wherein the plant oil is acrylated epoxidized plant oil.

67. The an asphalt composition of claim 28, wherein the asphalt composition comprises 1 to 5 wt % of the thermoplastic block copolymer.

68. The method of claim 33 or 35, wherein the method is carried out in the presence of a counter-catalyst and a solvent at a temperature ranging from 65 to 85 °C.

69. The method of claim 68, wherein the solvent concentration ranges from 15 % to 60 % by mass ratio of the solvent to the monomer B.