CLAIMS

1. A process of purifying a polymer, comprising:

providing an organic solution containing a polyimide or polyamic ester in at least one polar, aprotic polymerization solvent;

adding at least one purification solvent to the organic solution to form a diluted organic solution, the at least one purification solvent is less polar than the at least one polymerization solvent and has a lower water solubility than the at least one polymerization solvent at 25ºC;

washing the diluted organic solution with water or an aqueous solution, the washing comprises mixing the diluted organic solution with water or an aqueous solution to form a mixture having an organic phase and an aqueous phase, and removing the aqueous phase to obtain a washed polymer-containing organic solution; and

removing a portion of the at least one purification solvent in the washed polymer-containing organic solution to obtain a solution containing a purified polyimide or polyamic ester;

wherein the process avoids precipitation of the polyimide or polyamic ester.

2. The process of claim 1, wherein the at least one polymerization solvent comprises dimethylformamide, dimethylacetamide, N-formylmorpholine, N-methylpyrrolidinone, N-ethylpyrrolidinone, dimethylsulfoxide, gamma-butyrolactone, hexamethyl phosphoric acid triamide, tetrahydrofuran, methyltetrahydrofuran, or 1,4-dioxane.

3. The process of claim 1, wherein the at least one polymerization solvent comprises at least one water miscible solvent.

4. The process of claim 1, wherein the at least one purification solvent comprises an ester, an ether, a ketone, or a hydrocarbon optionally substituted by at least one halide.

5. The process of claim 4, wherein the least one purification solvent comprises methyl acetate, ethyl acetate, n-propyl acetate, isopropyl acetate, n-butyl acetate, isobutyl

acetate, sec-butyl acetate, cyclohexyl acetate, ethyl lactate, propylene glycol monomethyl ether acetate, tetrahydrofurfuryl acetate, propyl formate, butyl formate, isobutyl formate, pentyl formate, ε-caprolactone, diethyl ether, dipropyl ether, dibutyl ether, dicyclohexyl ether, cyclopentyl methyl ether, methyl tert-butyl ether, ethyl tert-butyl ether, anisole, phenyl ethyl ether, diphenyl ether, 1,2-dimethoxypropane, 1,2-dimethoxyethane, 2-butanone, 2-pentanone, 3-pentanone, methyl isobutyl ketone, ethyl isobutyl ketone, methyl isopropyl ketone, cyclopentanone, cyclohexanone, acetophenone, isophorone, mesityl oxide, benzene, toluene, xylene, ethyl benzene, chlorobenzene, 1,2-dichlorobenzene, α,α,α-trifluorotoluene, pentane, hexane, heptane, octane, cyclohexane, methylcyclohexane, or cyclohexene.

6. The process of claim 1, wherein the least one purification solvent comprises at least one water immiscible solvent.

7. The process of claim 1, wherein adding at least one purification solvent further comprises adding at least one purification co-solvent that has a water solubility higher than the at least one purification solvent.

8. The process of claim 7, wherein the at least one purification co-solvent comprises acetone, gamma-butyrolactone, furan, tetrahydrofuran, methyl tetrahydrofuran, tetrahydrofurfuryl methyl ether, or 1,4-dioxane.

9. The process of claim 8, wherein the at least one purification co-solvent comprises at least one water miscible solvent.

10. The process of claim 1, wherein the aqueous solution comprises an acid or a base.

11. The process of claim 1, wherein washing the diluted organic solution substantially removes the at least one polymerization solvent or another impurity in the diluted organic solution.

12. The process of claim 1, wherein the process further comprises adding at least one isolation solvent to the washed polymer-containing organic solution before removing at least a portion of the at least one purification solvent.

13. The process of claim 12, wherein the at least one isolation solvent has a boiling point higher than a boiling point of the at least one purification solvent.

14. The process of claim 12, wherein the at least one isolation solvent comprises a ketone, an ester, a hydrocarbon, a sulfoxide, or an ether.

15. The process of claim 14, wherein the at least one isolation solvent comprises methyl ethyl ketone, methyl isobutyl ketone, 2-heptanone, cyclopentanone, cyclohexanone, xylene, gamma-butyrolactone, dimethylsulfoxide, propylene glycol monomethyl ether acetate, propylene glycol monomethyl ether, or ethyl lactate.

16. The process of claim 12, wherein the at least one isolation solvent is different from the at least one purification solvent.

17. The process of claim 12, wherein the at least one isolation solvent is the same as the at least one purification solvent.

18. The process of claim 1, wherein the portion of the at least one purification solvent is removed by evaporation or distillation.

19. The process of claim 1, wherein the organic solution containing a polyimide or polyamic ester in at least one polar, aprotic polymerization solvent is obtained from a polymerization reaction without isolating the polyimide or polyamic ester.

20. The process of claim 1, further comprising concentrating the solution containing a purified polyimide or polyamic ester after the removing step.

21. A process of preparing a film on a substrate, comprising:

providing an organic solution containing a polyimide or polyamic ester in at least one polar, aprotic polymerization solvent;

adding at least one purification solvent to the organic solution to form a diluted organic solution, wherein the at least one purification solvent is less polar than the at least one polymerization solvent and has a lower water solubility than the at least one polymerization solvent at 25ºC;

washing the diluted organic solution with water or an aqueous solution to obtain a washed polymer-containing organic solution;

removing a portion of the at least one purification solvent in the washed polymer-containing organic solution to obtain a solution containing a purified polyimide or polyamic ester; and

coating the solution containing a purified polyimide or polyamic ester on a substrate to form a film;

wherein the process avoids precipitation of the polyimide or polyamic ester.

22. The process of claim 21, wherein the at least one polymerization solvent comprises dimethylformamide, dimethylacetamide, N-formylmorpholine, N-methylpyrrolidinone, N-ethylpyrrolidinone, dimethylsulfoxide, gamma-butyrolactone, hexamethyl phosphoric acid triamide, tetrahydrofuran, methyltetrahydrofuran, or 1,4-dioxane.

23. The process of claim 21, wherein the at least one polymerization solvent comprises at least one water miscible solvent.

24. The process of claim 21, wherein the at least one purification solvent comprises an ester, an ether, a ketone, or a hydrocarbon optionally substituted by at least one halide.

25. The process of claim 24, wherein the least one purification solvent comprises methyl acetate, ethyl acetate, n-propyl acetate, isopropyl acetate, n-butyl acetate, isobutyl

acetate, sec-butyl acetate, cyclohexyl acetate, ethyl lactate, propylene glycol monomethyl ether acetate, tetrahydrofurfuryl acetate, propyl formate, butyl formate, isobutyl formate, pentyl formate, ε-caprolactone, diethyl ether, dipropyl ether, dibutyl ether, dicyclohexyl ether, cyclopentyl methyl ether, methyl tert-butyl ether, ethyl tert-butyl ether, anisole, phenyl ethyl ether, diphenyl ether, 1,2-dimethoxypropane, 1,2-dimethoxyethane, 2-butanone, 2-pentanone, 3-pentanone, methyl isobutyl ketone, ethyl isobutyl ketone, methyl isopropyl ketone, cyclopentanone, cyclohexanone, acetophenone, isophorone, mesityl oxide, benzene, toluene, xylene, ethyl benzene, chlorobenzene, 1,2-dichlorobenzene, α,α,α-trifluorotoluene, pentane, hexane, heptane, octane, cyclohexane, methylcyclohexane, or cyclohexene.

26. The process of claim 21, wherein the least one purification solvent comprises at least one water immiscible solvent.

27. The process of claim 21, wherein adding at least one purification solvent further comprises adding at least one purification co-solvent that has a water solubility higher than the at least one purification solvent.

28. A process of preparing a film on a substrate, comprising:

providing an organic solution containing a polyimide or polyamic ester in at least one polar, aprotic polymerization solvent;

adding at least one purification solvent to the organic solution to form a diluted organic solution, wherein the at least one purification solvent is less polar than the at least one polymerization solvent and has a lower water solubility than the at least one polymerization solvent at 25ºC, and adding at least one purification solvent further comprises adding at least one purification co-solvent that has a water solubility higher than the at least one purification solvent;

washing the diluted organic solution with water or an aqueous solution to obtain a washed polymer-containing organic solution;

removing a portion of the at least one purification solvent in the washed polymer-containing organic solution to obtain a solution containing a purified polyimide or polyamic ester; and

coating the solution containing a purified polyimide or polyamic ester on a substrate to form a film;

wherein the at least one purification co-solvent comprises acetone, gamma-butyrolactone, furan, tetrahydrofuran, methyl tetrahydrofuran, tetrahydrofurfuryl methyl ether, or 1,4-dioxane.

29. The process of claim 28, wherein the at least one purification co-solvent comprises at least one water miscible solvent.

30. The process of claim 21, wherein the aqueous solution comprises an acid or a base.

31. The process of claim 21, wherein washing the diluted organic solution comprises adding water or an aqueous solution to the diluted organic solution.

32. The process of claim 31, wherein washing the diluted organic solution further comprises forming a mixture having an organic phase and an aqueous phase.

33. The process of claim 32, wherein washing the diluted organic solution further comprises removing the aqueous phase.

34. The process of claim 21, wherein washing the diluted organic solution substantially removes the at least one polymerization solvent or another impurity in the diluted organic solution.

35. The process of claim 21, wherein the process further comprises adding at least one isolation solvent to the washed polymer-containing organic solution before removing a portion of the at least one purification solvent.

36. A process of preparing a film on a substrate, comprising:

providing an organic solution containing a polyimide or polyamic ester in at least one polar, aprotic polymerization solvent;

adding at least one purification solvent to the organic solution to form a diluted organic solution, wherein the at least one purification solvent is less polar than the at least one polymerization solvent and has a lower water solubility than the at least one polymerization solvent at 25ºC;

washing the diluted organic solution with water or an aqueous solution to obtain a washed polymer-containing organic solution;

adding at least one isolation solvent to the washed polymer-containing organic solution;

removing a portion of the at least one purification solvent in the washed polymer-containing organic solution to obtain a solution containing a purified polyimide or polyamic ester; and

coating the solution containing a purified polyimide or polyamic ester on a substrate to form a film;

wherein the at least one isolation solvent has a boiling point higher than a boiling point of the at least one purification solvent.

37. A process of preparing a film on a substrate, comprising:

providing an organic solution containing a polyimide or polyamic ester in at least one polar, aprotic polymerization solvent;

adding at least one purification solvent to the organic solution to form a diluted organic solution, wherein the at least one purification solvent is less polar than the at least one polymerization solvent and has a lower water solubility than the at least one polymerization solvent at 25ºC;

washing the diluted organic solution with water or an aqueous solution to obtain a washed polymer-containing organic solution;

adding at least one isolation solvent to the washed polymer-containing organic solution;

removing a portion of the at least one purification solvent in the washed polymer-containing organic solution to obtain a solution containing a purified polyimide or polyamic ester; and

coating the solution containing a purified polyimide or polyamic ester on a substrate to form a film;

wherein the at least one isolation solvent comprises a ketone, an ester, a hydrocarbon, a sulfoxide, or an ether.

38. The process of claim 37, wherein the at least one isolation solvent comprises methyl ethyl ketone, methyl isobutyl ketone, 2-heptanone, cyclopentanone, cyclohexanone, xylene, gamma-butyrolactone, dimethylsulfoxide, propylene glycol monomethyl ether acetate, propylene glycol monomethyl ether, or ethyl lactate.

39. The process of claim 35, wherein the at least one isolation solvent is different from the at least one purification solvent.

40. A process of preparing a film on a substrate, comprising:

providing an organic solution containing a polyimide or polyamic ester in at least one polar, aprotic polymerization solvent;

adding at least one purification solvent to the organic solution to form a diluted organic solution, wherein the at least one purification solvent is less polar than the at least one polymerization solvent and has a lower water solubility than the at least one polymerization solvent at 25ºC;

washing the diluted organic solution with water or an aqueous solution to obtain a washed polymer-containing organic solution;

adding at least one isolation solvent to the washed polymer-containing organic solution;

removing a portion of the at least one purification solvent in the washed polymer-containing organic solution to obtain a solution containing a purified polyimide or polyamic ester; and

coating the solution containing a purified polyimide or polyamic ester on a substrate to form a film;

wherein the at least one isolation solvent is the same as the at least one purification solvent.

41. The process of claim 21, wherein the portion of the at least one purification solvent is removed by evaporation or distillation.

42. The process of claim 21, wherein the organic solution containing a polyimide or polyamic ester in at least one polar, aprotic polymerization solvent is obtained from a polymerization reaction without isolating the polyimide or polyamic ester.

43. The process of claim 21, further comprising concentrating the solution containing a purified polyimide or polyamic ester after the removing step.

44. The process of claim 21, wherein the coating step is performed by ink jet printing, spin coating, spray coating, dip coating, roller coating, or dynamic surface tension coating.

45. The process of claim 21, further comprising removing the film from the substrate.

46. A free-standing film obtained by the process of claim 45.

47. An article, comprising a semiconductor substrate and a film prepared by the process of claim 45 on the semiconductor substrate.