What is claimed is:

1. A method of forming a ternary nanocrystal of the general formula M1M2A, wherein M1 and M2 are independent from each other a metal selected from one of Group II, Group III, Group IV, Group VII and Group VIII of the PSE, and A is an element is selected from Group VI or V of the PSE, the method comprising:
   (i) forming a homogenous reaction mixture comprising a metal precursor containing the metals M1 and M2, element A and a non-polar solvent of low boiling point, and
   (ii) bringing the homogenous reaction mixture under elevated pressure to an elevated temperature suitable for forming a nanocrystal.

2. A method of forming a ternary nanocrystal of the general formula M1AB, wherein M1 is a metal selected from one of Group II, Group III, Group IV, Group VII and Group VIII of the PSE, and A and B are independent from each other elements selected from Group V or Group VI of the PSE, the method comprising:
   (i) forming a homogenous reaction mixture comprising a metal precursor containing the metal M1, element A and element B, a non-polar solvent of low boiling point, and
   (ii) bringing the homogenous reaction mixture under elevated pressure to an elevated temperature suitable for forming a nanocrystal.

3. A method of forming a nanocrystal of the general formula M1M2O, wherein M1 and M2 are independent from each other a metal selected from one of Group II, Group III, Group IV, Group VII and Group VIII of the PSE, and O is oxygen, the method comprising:
   (i) forming a homogenous reaction mixture comprising a metal precursor containing the metals M1 and M2 and an oxygen donor, and a non-polar solvent of low boiling point, and
   (ii) bringing the homogenous reaction mixture under elevated pressure to an elevated temperature suitable for forming a nanocrystal.

4. The method of any one of claims 1 - 3, wherein the elevated pressure is from about 50 to 100 atm (from about 50 to about 101bar).

5. The method of any one of claims 1 - 4, wherein the non-polar solvent of low boiling point has a boiling point of less than about 100 °C at atmospheric pressure (1013 mbar).

6. The method of claim 5, wherein the non-polar solvent of low boiling point has a boiling point of less than about 80 °C.

7. The method of any one of claims 1 - 6, wherein the non-polar solvent of low boiling point is selected from the group consisting of hexane, chloroform, carbon tetrachloride, dichloromethane, toluene, benzene, heptane, cyclohexane, pyridine, carbon disulfide, dioxane, diethyl ether, diisopropylether, and tetrahydrofuran and mixture thereof.

8. The method of any one of claims 1 - 7, wherein the homogenous reaction mixture is a solution.

9. The method of any one of claims 1 - 8, wherein the homogenous reaction mixture is formed at a temperature of about 20 to about 70 °C.

10. The method of any one of claims 1 - 9, wherein, the reaction mixture is heated under agitation.

11. The method of claim 10, wherein the agitation is achieved by stirring.

12. The method of any one of claims 1 - 11, wherein the reaction temperature is maintained for a sufficient time to allowing the formation of a nanocrystal.

13. The method of any one of claims 1 - 12, further comprising adding a surfactant.

14. The method of claim 13, wherein the surfactant is selected from the group consisting of an organic carboxylic acid, an organic phosphate, an organic phosphonic acid, an organic phosphine oxide, an organic amine and mixtures thereof.

15. The method of claim 14, wherein organic carboxylic acid has about 8 to about 18 main chain atoms.

16. The method of claims 14 or 15, wherein the organic carboyxlic acid is selected from the group consisting of stearic acid (octadecanoic acid), lauric, acid, oleic acid ([Z]-octadec-9-enoic acid), decanoic acid, dodecanoic acid, tetradecanoic acid, hexadecly hexadecanoic acid, octodecanoic acid, n-undecanoic acid, linoleic acid, ((Z,Z)-9,12-octadecadienoic acid), arachidonic acid ((all-Z)-5,8,11,14-eicosatetraenoic acid), linelaidic acid ((E,E)-9,12-octadecadienoic acid), myristoleic acid (9-tetradecenoic acid), palmitoleic acid (cis-9-hexadecenoic acid), myristic acid (tetradecanoic acid),

palmitic acid (hexadecanoic acid), γ-homolinolenic acid ((Z,Z,Z)-8,11,14-eicosatrienoic acid) and mixtures thereof.

17. The method of claim 14, wherein the organic phosphine oxide is trioctyl phosphine oxide.

18. The method of claim 14, wherein the organic amine is one of an alkylamine having from about 3 to about 30 carbon atoms, and an alkenylamine having from about 2 to about 18 carbon atoms.

19. The method of any one of claims 1 - 18, wherein the metal precursor is formed by dissolving a salt of the metal M1 and a salt of metal M2 in an organic acid at a temperature of about 100 °C to about 450 °C.

20. The method of claim 19, wherein the organic acid for dissolving the salt of metal M1 and the salt of metal M2 is a carboxylic acid of about 8 or more main chain atoms.

21. The method of claim 20, wherein the chain carboxylic acid is selected from the group consisting of stearic acid (octadecanoic acid), lauric acid, oleic acid ([Z]-octadec-9-enoic acid), n-undecanoic acid, linoleic acid, ((Z,Z)-9,12-octadecadienoic acid), arachidonic acid ((all-Z)-5,8,11,14-eicosatetraenoic acid), linelaidic acid ((E,E)-9,12-octadecadienoic acid), myristoleic acid (9-tetradecenoic acid), palmitoleic acid (cis-9-hexadecenoic acid), myristic acid (tetradecanoic acid), palmitic acid (hexadecanoic acid) and γ-homolinolenic acid ((Z,Z,Z)-8,11,14-eicosatrienoic acid). Examples of other surfactants (an organic phosphonic acid, for example) include hexylphosphonic acid and tetra decylphosphonic acid.

22. The method of claim 19, wherein the salt of the metal M1 and the salt of the metal M2 are independently an organic or an inorganic salt.

23. The method of claim 22, wherein the inorganic salt of at least one of the metal M1 and the metal M2 are independently selected from the group consisting of an oxide, a carbonate, a sulfate, and a nitrate.

24. The method of claim 22, wherein the organic salt of at least one of the metal M1 and the metal M2 are a salt of an organic carboxylic acid.

25. The method of claim 24, wherein the organic carboxylic acid is one of acetate and a

carboxylic acid having about 5 to about 20 main chain carbon atoms.

26. The method of any one of claims 1 - 25, wherein M1 and M2 are independent from each other selected from Cd, Zn, Mg, Sr, Ca, Ba, Al, Ga, In, Pb, Sn, Mn, Fe, Co, Ni, and Ir.

27. The method of any one of claims 1 - 26, wherein the elements A and B are independently from each other dissolved in a suitable solvent.

28. The method of any one of claims 1 or 3 - 27, wherein the elements A and B are independent from each other selected from S, Se, Te, P, Bi, and As.

29. The method of any one of claims 1 - 28, wherein a ternary nanocrystal of the general formula M1M2A is formed, and wherein the ternary nanocrystal is of one of the formulas ZnCdSe, CdZnS, CdZnSe, CdZnTe, SnPbS, SnPbSe, and SnPbTe.

30. The method of any one of claims 2 - 28, wherein a ternary nanocrystal of the general formula M1AB is formed, and wherein the ternary nanocrystal is of one of the formulas CdSeS, CdSeTe, CdSTe, ZnSeS, ZnSeTe, ZnSTe, SnSeS, SnSeTe, SnSTe, PbSeS, PbSeTe, and PbSTe.

31. The method of any one of claims 3 - 28, wherein a ternary nanocrystal of the general formula M1M2O is formed, and wherein the ternary nanocrystal is of one of the formulas $MgFe_2O_4$, $CaFe_2O_4$, $SrFe_2O_4$, $ZnFe_2O_4$, $NiFe_2O_4$, $CoFe_2O_4$, and $MnFe_2O_4$.

32. A method of forming a quaternary nanocrystal of general formula M1M2AB, wherein M1 and M2 are independently a metal selected from one of Group II, Group III, Group IV, Group VII and Group VIII of the PSE, and A and B are independent from each other an element selected from Group VI or Group V of the PSE, the method comprising:

(i) forming a homogenous reaction mixture comprising a metal precursor containing the metal M1 and the metal M2, the element A, the element B and a non-polar solvent of low boiling point, and

(ii) bringing the homogenous reaction mixture under elevated pressure to an elevated temperature suitable for forming a nanocrystal.

33. The method of claim 32, wherein the elevated pressure is from about 50 to about 100 atm (from about 50 to about 101bar).

34. The method of claims 32 or 33, wherein the non-polar solvent of low boiling point has a boiling point of less than about 100 °C at atmospheric pressure (1013 mbar).

35. The method of any one of claims 32 - 34, wherein the non-polar solvent of low boiling point has a boiling point of less than about 80 °C at atmospheric pressure (1013 mbar).

36. The method of any one of claims 32 to 35, wherein the non-polar solvent of low boiling point is selected from the group consisting of hexane, chloroform, dichloromethane, carbon tetrachloride, toluene, benzene, heptane, cyclohexane, pyridine, carbon disulfide, dioxane, diethyl ether, diisopropylether, and tetrahydrofuran and mixtures thereof.

37. The method of any one of claims 32 to 36, wherein the homogenous reaction mixture is a solution.

38. The method of any one of claims 32 to 37, wherein the homogenous reaction mixture is formed at a temperature of about 20 to about 70°C.

39. The method of any one of claims 32 to 38, wherein the reaction mixture is heated under agitation.

40. The method of claim 39, wherein the agitation is achieved by stirring.

41. The method of any one of claims 32 to 40, wherein the reaction temperature is maintained for a sufficient time to allow the formation of a nanocrystal.

42. The method of any one of claims 32 to 41, further comprising adding a surfactant.

43. The method of claim 42, wherein the surfactant is selected from the group consisting of an organic carboxylic acid, an organic phosphate, an organic phosphonic acid, an organic phosphine oxide, an organic amine and mixtures thereof.

44. The method of claim 43, wherein organic carboxylic acid has about 8 to about 18 main chain atoms.

45. The method of claims 43 or 44, wherein the organic carboxylic acid is selected from the group consisting of stearic acid (octadecanoic acid), lauric, acid, oleic acid ([Z]-octadec-9-enoic acid), decanoic acid, dodecanoic acid, tetradecanoic acid, hexadecly hexadecanoic acid, octodecanoic acid, n-undecanoic acid, linoleic acid, ((Z,Z)-9,12-octadecadienoic acid), arachidonic acid ((all-Z)-5,8,11,14-eicosatetraenoic acid),

linelaidic acid ((E,E)-9,12-octadecadienoic acid), myristoleic acid (9-tetradecenoic acid), palmitoleic acid (cis-9-hexadecenoic acid), myristic acid (tetradecanoic acid), palmitic acid (hexadecanoic acid), γ-homolinolenic acid ((Z,Z,Z)-8,11,14-eicosatrienoic acid) and mixtures thereof.

46. The method of claim 43, wherein the organic phosphine oxide is trioctyl phosphine oxide

47. The method of claim 43, wherein the organic amine is one of an alkylamine having from about 3 to about 30 carbon atoms and an alkenylamine having from about 2 to about 18 carbon atoms.

48. The method of claim 47, wherein the alkyl amine is selected from the group consisting of hexadecylamine, oleylamine, octadecylamine, bis (2-ethylhexyl) amine, octylamine, dioctylamine, trioctylamine, dodecylamine/laurylamine, didodecylamine tridodecylamine, hexadecylamine, dioctadecylamine, trioctadecylamine.

49. The method of any one of claims 33 to 48, wherein the metal precursor is formed by dissolving a salt of the metal M1 and a salt of metal M2 in an organic acid at a temperature of about 100 °C to about 450 °C.

50. The method of claim 49, wherein the organic acid for dissolving the salt of metal M1 and a salt of metal M2 is a carboyxlic acid of about 8 or more main chain atoms.

51. The method of claim 50, wherein the carboxylic acid is selected from the group consisting of stearic acid (octadecanoic acid), lauric, acid, oleic acid ([Z]-octadec-9-enoic acid), n-undecanoic acid, linoleic acid, ((Z,Z)-9,12-octadecadienoic acid), arachidonic acid ((all-Z)-5,8,11,14-eicosatetraenoic acid), linelaidic acid ((E,E)-9,12-octadecadienoic acid), myristoleic acid (9-tetradecenoic acid), palmitoleic acid (cis-9-hexadecenoic acid), myristic acid (tetradecanoic acid), palmitic acid (hexadecanoic acid) and γ-homolinolenic acid ((Z,Z,Z)-8,11,14-eicosatrienoic acid).

52. The method of claim 46, wherein the salt of the metal M1 and the salt of the metal M2 are independently an organic or an inorganic salt.

53. The method of claim 52, wherein the inorganic salt of at least one of the metal M1 and the metal M2 are selected from the group consisting of an oxide, a carbonate, a sulfate, and a nitrate.

54. The method of claim 52, wherein the organic salt of at least one of the metal M1 and the metal M2 area salt of an organic carboxylic acid.

55. The method of claim 54, wherein the organic carboxylic acid is one of acetate and a carboxylic acid having about 5 to about 20 main chain carbon atoms.

56. The method of any one of the claims 33 to 55, wherein the metals M1 and M2 are independent from each other selected from Cd, Zn, Mg, Ca, Ba,Al, Ga, In, Pb, Sn, Sr, Mn, Fe, Co, Ni, and Ir.

57. The method of any one of the claims 33 to 56, wherein the elements A and B are independently from each other dissolved in a suitable solvent.

58. The method of any one of the claims 32 to 57, wherein the elements A and B are independent from each other selected from S, Se, Te, O, P, Bi, and As.

59. The method of any one of claims 32 - 58, wherein a quaternary nanocrystal of the general formula M1M2AB is formed, and wherein the quaternary nanocrystal is of one of the formulas CdZnSeS, CdZnSeTe, CdZnSTe, CdHgSeS, CdHgSeTe, CdHgSTe, HgZnSeS, HgZnSeTe and HgZnSTe.

What is claimed is:

1. A method of producing a binary nanocrystal of the general formula M1O, wherein M1 is a metal selected from one of Group II, Group III, Group IV, Group VII and Group VIII of the Periodic System of Elements (PSE), and O is oxygen, the method comprising:
(i) forming a homogenous reaction mixture comprising a metal precursor containing the metal M1 and an oxygen donor, and a non-polar solvent of low boiling point having a boiling point of less than 100 °C at atmospheric pressure (1013 hectopascal), and
(ii) bringing the homogenous reaction mixture under elevated pressure in the range of about 10 to 500 atm (10133-506625 hectopascal) to an elevated temperature that is higher than boiling point of the non-polar solvent suitable for forming nanocrystals.

2. The method of claims 1, wherein the elevated pressure is from 50 to 100 atm (50663-101325 hectopascal).

3. The method of claim 2, wherein the non-polar solvent of low boiling point has a boiling point of less than 80 °C at atmospheric pressure (1013 hectopascal).

4. The method of any one of the claims 1 to 3, wherein the non-polar solvent of low boiling point is selected from the group consisting of hexane, chloroform, toluene, benzene, heptane, cyclohexane, dichloromethane, pyridine, carbon tetrachloride, carbon disulfide, dioxane, diethyl ether, diisopropylether, and tetrahydrofuran and mixtures thereof.

5. The method of any one of claims 1 to 4, wherein M1 is selected from Cd, Zn, Mg, Ca, Ba, Al, Ga, In, Pb, Sn, Sr, Mn, Fe, Co, Ni, and Ir.

6. A method of forming a nanocrystal of the general formula M1M2O, wherein M1 and M2 are independent from each other a metal selected from one of Group II, Group III, Group IV, Group VII and Group VIII of the Periodic System of Elements (PSE), and O is oxygen, the method comprising:
(i) forming a homogenous reaction mixture comprising a metal precursor containing the metals M1 and M2 and an oxygen donor, and a non-polar solvent of low boiling point having a boiling point of less than 100 °C at atmospheric pressure (1013 hectopascal), and

(ii) bringing the homogenous reaction mixture under elevated pressure in the range of 10 to 500 atm (10133-506625 hectopascal) to an elevated temperature that is higher than boiling point of the non-polar solvent suitable for forming a nanocrystal.

7. The method of claim 6, wherein the elevated pressure is from 50 to 100 atm (50663-101325 hectopascal).

8. The method of claim 7, wherein the non-polar solvent of low boiling point has a boiling point of less than 80 °C.

9. The method of any one of claims 6 to 8, wherein the non-polar solvent of low boiling point is selected from the group consisting of hexane, chloroform, carbon tetrachloride, dichloromethane, toluene, benzene, heptane, cyclohexane, pyridine, carbon disulfide, dioxane, diethyl ether, diisopropylether, and tetrahydrofuran and mixture thereof.

10. The method of any one of claims 6 to 9, wherein M1 and M2 are independent from each other selected from Cd, Zn, Mg, Sr, Ca, Ba, Al, Ga, In, Pb, Sn, Mn, Fe, Co, Ni, and Ir.