CLAIMS

We claim:

1. A ceramic article which is resistant to erosion by halogen-containing plasmas used in semiconductor processing, said article comprising: a ceramic formed from a combination of yttrium oxide and zirconium oxide, with yttrium oxide at a molar concentration ranging from about 90 mole % to about 70 mole %, and zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %, wherein a *mean grain size of said ceramic ranges from about 2 μm to about 8 μm.*

2. A ceramic article in accordance with Claim 1, wherein said ceramic is formed from yttrium oxide at a concentration ranging from about 90 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

3. A ceramic article in accordance with Claim 1 or Claim 2, wherein a mean grain size of said ceramic ranges from about 2 μm to about 8 μm.

4. A ceramic article in accordance with Claim 1, wherein a flexural strength of said ceramic ranges from about 120 MPa to about 140 MPa.

5. A ceramic article in accordance with Claim 1, wherein a fracture toughness of said ceramic ranges from about 1.1 $MPa\cdot m^{1/2}$ to about 1.3 $MPa\cdot m^{1/2}$.

6. A ceramic article in accordance with Claim 1 or Claim 2, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

7. A method reducing the plasma erosion of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: selecting said semiconductor processing apparatus to comprise ceramic, said ceramic formed from yttrium oxide at a molar concentration ranging from about 90 mole % to about 70 mole %, and zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %.

8. A method in accordance with Claim 7, further comprising selecting said ceramic for said semiconductor processing apparatus to be formed from yttrium oxide at a molar concentration ranging from about 90 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

9. A method in accordance with Claim 7 or 8, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma is less than about 0.2 μm/hr.

10. A method in accordance with Claim 9, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma ranges from about 0.1 μm/hr to about 0.2 μm/hr.

11. A semiconductor processing apparatus having at least one surface exposed to a halogen-comprising plasma during a process, wherein said semiconductor processing apparatus surface is a ceramic which is resistant to erosion by halogen-containing plasmas, wherein said ceramic is formed from yttrium oxide at a molar concentration ranging from about 90 mole % to about 70 mole %, and zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %.

12. A semiconductor processing apparatus in accordance with Claim 11, wherein *underlying said ceramic is a high purity aluminum alloy.*

13. A method in accordance with Claim 11, wherein said semiconductor processing apparatus is a solid ceramic semiconductor processing apparatus.

14. A semiconductor processing apparatus, said apparatus having at least one surface exposed to a halogen-comprising plasma during a process, wherein said surface is a ceramic which is resistant to erosion by halogen-containing plasmas, wherein said ceramic is formed from zirconium oxide at a molar concentration ranging from about 96 mole % to about 94 mole %, and yttrium oxide at a molar concentration ranging from about 4 mole % to about 6 mole %.

15. A semiconductor processing apparatus in accordance with Claim 14, wherein underlying said ceramic is a high purity aluminum alloy.

16. A semiconductor processing apparatus in accordance with Claim 14, wherein said apparatus is a solid ceramic apparatus.

17. A semiconductor processing apparatus in accordance with Claim 14, wherein said apparatus is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

18. A semiconductor processing apparatus in accordance with Claim 14, wherein a mean grain size of said ceramic ranges from about 0.5 μm to about 8.0 μm.

19. A semiconductor processing apparatus in accordance with Claim 14, wherein a flexural strength of said ceramic ranges from about 1100 MPa to about 1300 MPa.

20. A semiconductor processing apparatus in accordance with Claim 14, wherein a fracture toughness of said ceramic ranges from about 10 $MPa \cdot m^{1/2}$ to about 12 $MPa \cdot m^{1/2}$.

21. A method of reducing the plasma erosion of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: selecting said semiconductor processing apparatus to be a ceramic-comprising article, said ceramic formed from zirconium oxide at a molar concentration ranging from about 96 mole % to

about 94 mole %, and yttrium oxide at a molar concentration ranging from about 4 mole % to about 6 mole %.

22. A method in accordance with Claim 21, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus, upon exposure to a halogen-comprising plasma, is less than about 0.4 μm/hr.

23. A method in accordance with Claim 22, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus, upon exposure to a halogen-comprising plasma, ranges from about 0.1 μm/hr to about 0.4 μm/hr.

24. A method in accordance with Claim 21, wherein at least one surface of said semiconductor processing apparatus, which surface is said ceramic, is exposed to said halogen-comprising plasma during said semiconductor processing.

25. A method in accordance with Claim 24, wherein underlying said ceramic is a high purity aluminum alloy.

26. A method in accordance with Claim 24, wherein said semiconductor processing apparatus is a solid ceramic semiconductor processing apparatus.

CLAIMS

1. A method of reducing surface erosion of a semiconductor apparatus in a halogen-containing plasma, wherein each surface which is exposed to said halogen-containing plasma is protected by a solid solution ceramic coating, said method comprising:

forming said coating from 50 mole % to 75 mole % yttrium oxide, 10 mole % to 30 mole % zirconium oxide, and 10 mole % to 30 mole % of at least one oxide selected from the group consisting of aluminum oxide, hafnium oxide, scandium oxide, neodymium oxide, niobium oxide, samarium oxide, ytterbium oxide, erbium oxide, cerium oxide, and combinations thereof; and

applying said coating over said surface of said substrate, wherein said substrate is formed from the group consisting of aluminum, aluminum alloy, stainless steel, alumina, aluminum nitride, quartz, and combinations thereof.

2. A method in accordance with Claim 1, wherein said coating is applied over said surface of said substrate using an application technique selected from the group consisting of plasma spraying, thermal/flame spraying, chemical vapor deposition, and physical vapor deposition.

3. A method in accordance with Claim 1, wherein said substrate is formed from alumina, aluminum nitride, quartz, and combinations thereof, and wherein said coating is applied over said surface of said substrate using an application technique wherein said coating is sintered over said surface of said substrate using a pressure-less sintering technique.

4. A method in accordance with Claim 3, wherein said pressure-less sintering technique is carried out under a hydrogen-protective atmosphere.

5. A method in accordance with Claim 2, wherein said erosion rate in a halogen containing plasma is 0.2 um/hr or lower, and wherein a flexural strength of a test specimen of said coating is at least 172 MPa.

6. A method in accordance with Claim 3, wherein said erosion rate in a halogen containing plasma is 0.2 um/hr or lower, and wherein a flexural strength of a test specimen of said coating is at least 172 MPa .

7. A method in accordance with Claim 4, wherein said erosion rate in a halogen containing plasma is 0.2 um/hr or lower, and wherein a flexural strength of a test specimen of said coating is at least 172 MPa.

8. A method of reducing surface erosion of a semiconductor apparatus in a halogen-containing plasma, wherein each surface which is exposed to said halogen-containing plasma is protected by a solid solution ceramic coating, and wherein a mechanical properties of said coating are improved over the mechanical properties of a coating formed from yttrium oxide, said method comprising:

forming said coating from 50 mole % to 75 mole % yttrium oxide, 10 mole % to 30 mole % zirconium oxide, and 10 mole % to 30 mole % of aluminum oxide; and

applying said coating over said surface of said substrate, wherein said substrate is formed from the group consisting of aluminum, aluminum alloy, stainless steel, alumina, aluminum nitride, quartz, and combinations thereof.

9. A method in accordance with Claim 8, wherein said coating is applied over said surface of said substrate using an application technique selected from the group consisting of plasma spraying, thermal/flame spraying, chemical vapor deposition, and physical vapor deposition.

10. A method in accordance with Claim 8, wherein said substrate is formed from alumina, aluminum nitride, quartz, and combinations thereof, and wherein said coating is applied over said surface of said substrate using an application technique wherein said coating is sintered over said surface of said substrate using a pressure-less sintering technique.

11. A method in accordance with Claim 10, wherein said pressure-less sintering technique is carried out under a hydrogen-protective atmosphere.

12. A method in accordance with Claim 9, wherein said erosion rate in a halogen containing plasma is

0.2 um/hr or lower, and wherein a flexural strength of a test specimen of said coating is at least 172 MPa .

13. A method in accordance with Claim 9, wherein a fracture toughness of a test specimen of said coating is at least 1.6 MPa . $m^{1/2}$.

14. A method in accordance with Claim 10, wherein said erosion rate in a halogen containing plasma is 0.2 um/hr or lower, and wherein a flexural strength of a test specimen of said coating is at least 172 MPa.

15. A method in accordance with Claim 10, wherein a fracture toughness of a test specimen of said coating is at least 1.6 MPa . $m^{1/2}$.

16. A sintered solid solution-comprising ceramic article which is resistant to erosion by halogen-containing plasmas used in semiconductor processing, said article comprising: a ceramic formed from a combination of yttrium oxide and zirconium oxide, with yttrium oxide at a molar concentration ranging from 90 mole % to 70 mole %, and zirconium oxide at a molar concentration ranging from 10 mole % to 30 mole %, wherein a mean grain size of said ceramic ranges from 2 μm to 8 μm.

17. A sintered solid solution-comprising ceramic article in accordance with Claim 16, wherein said ceramic is formed from yttrium oxide at a concentration ranging from 90 mole % to 80 mole %, and zirconium oxide at a concentration ranging from 10 mole % to 20 mole %.

18. A sintered solid solution-comprising ceramic article in accordance with Claim 16, wherein a flexural strength of said ceramic ranges from 120 MPa to 140 MPa.

19. A sintered solid solution-comprising ceramic article in accordance with Claim 16, wherein a fracture toughness of said ceramic ranges from 1.1 MPa · $m^{1/2}$ to 1.3 MPa · $m^{1/2}$.

20. A sintered solid solution-comprising ceramic article in accordance with Claim 16 or Claim 17, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

21. A method of reducing the plasma erosion of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: selecting said semiconductor processing apparatus to include a sintered solid solution-comprising ceramic article, with said ceramic formed from yttrium oxide at a molar concentration ranging from 90 mole % to 70 mole %, and zirconium oxide at a molar concentration ranging from 10 mole % to 30 mole %, wherein a mean grain size of said ceramic ranges from 2μm to 8 μm.

22. A method in accordance with Claim 21, wherein said sintered solid solution-comprising ceramic is formed from yttrium oxide at a molar concentration ranging from 90 mole % to 80 mole %, and zirconium oxide at a concentration ranging from 10 mole % to 20 mole %.

23. A method in accordance with Claim 21 or Claim 22, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma is less than 0.2μm/hr.

24. A method in accordance with Claim 23, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma ranges from 0.1 μm/hr to 0.2 μm/hr.

25. A sintered solid solution-comprising ceramic semiconductor processing apparatus, wherein said ceramic is resistant to erosion by halogen-containing plasmas, wherein said ceramic is formed from zirconium oxide at a molar concentration ranging from 96 mole% to 94 mole%, and yttrium oxide at a molar concentration ranging from 4 mole% to 6 mole%, and wherein a mean grain size of said sintered solid solution-comprising ceramic ranges from 0.5μm to 8.0μm.

26. A semiconductor processing apparatus in accordance with Claim 25, wherein said apparatus is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

27. A semiconductor processing apparatus in accordance with Claim 25, wherein a flexural strength of said sintered solid solution-comprising ceramic ranges 1100 MPa to 1300 MPa.

28. A semiconductor processing apparatus in accordance with Claim 25, wherein a fracture toughness of said sintered solid solution-comprising ceramic ranges from 10 MPa · $m^{1/2}$ to 12 MPa · $m^{1/2}$.

29. A method of reducing the plasma erosion rate and increasing flexural strength and fracture toughness of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: selecting said semiconductor processing apparatus to be a sintered solid solution-comprising ceramic processing apparatus, with said ceramic formed from zirconium oxide at a molar concentration ranging from 96 mole% to 94 mole%, and yttrium oxide at a molar concentration ranging from 4 mole% to 6 mole%, and wherein a mean grain size of said sintered solid solution-comprising ceramic ranges from 0.5㎛ to 8.0㎛.

30. A method in accordance with Claim 29, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus, upon exposure to a halogen-comprising plasma, ranges from 0.1㎛/hr to 0.4㎛/hr, and wherein a flexural strength of said sintered solid solution-comprising ceramic ranges 1100 MPa to 1300 MPa, and a fracture toughness of said sintered solid solution-comprising ceramic ranges from 10 MPa · $m^{1/2}$ to 12 MPa · $m^{1/2}$.

31. A sintered solid-solution comprising ceramic coating for use on surfaces of semiconductor processing apparatus exposed to halogen plasmas which provides advantageous coating mechanical properties, wherein said coating is formed from zirconium oxide at a molar concentration ranging from 96 mole % to 94 mole % and yttrium oxide at a molar concentration ranging from 4 mole % to 6 mole %, wherein a mean grain size of said sintered coating ranges from 0.5 ㎛to 8.0㎛.

32. A sintered solid-solution comprising ceramic coating in accordance with Claim 31, wherein a flexural strength of a sintered test specimen of said coating ranges from 1100 MPa to 1300 MPa.

33. A sintered solid-solution coating in accordance with Claim 31, wherein a fracture toughness of a sintered test specimen of said coating ranges from 10 MPa · $m^{1/2}$ to 12 MPa · $m^{1/2}$.

34. A semiconductor apparatus having a coating in accordance with Claim 31, or Claim 32, or Claim 33 present on an exterior surface of a substrate which makes up said apparatus.

35. A semiconductor apparatus in accordance with Claim 34, wherein said substrate is formed from a high purity aluminum alloy.

36. A method of reducing plasma erosion of a sintered coating on a surface of a substrate which makes up a semiconductor apparatus while reducing damage to said coating during handling, wherein said coating is formed from zirconium oxide at a molar concentration ranging from 96 mole % to 94 mole % and yttrium oxide at a concentration ranging from 4 mole % to 6 mole %, wherein a mean grain size of said sintered coating ranges from 0.5 ㎛to 8.0㎛.

37. A method in accordance with Claim 36, wherein said coating is sintered in a manner which provides a test specimen which exhibits a flexural strength ranging from 1 100 MPa to 1300 MPa.

38. A method in accordance with Claim 36, wherein said coating is sintered in a manner which provides a test specimen which exhibits a fracture toughness ranging from 10 MPa · $m^{1/2}$ to 12 MPa · $m^{1/2}$.

39. A method in accordance with Claim 36, wherein an erosion rate of a surface of said sintered coating ranges from 0.1 μm/hr to 0.4 μm/hr.

40. An article produced using a method wherein a solid solution ceramic coating is formed directly upon an exterior surface of a body of said article using a technique selected from the group consisting of thermal spraying, plasma spraying, sputtering, and chemical vapor deposition, wherein said body is formed from a material selected from the group consisting of aluminum, aluminum alloy, stainless steel, aluminum nitride, and quartz, and wherein said solid solution ceramic coating is formed from a combination of yttrium oxide and zirconium oxide, wherein a molar concentration of yttrium oxide ranges from about 90 mole % to about 70 mole %, and a molar concentration of zirconium oxide ranges from about 10 mole % to about 30 mole %, in a manner which produces a mean grain size of said solid solution ceramic coating which ranges from about 2 μm to about 8 μm, so that said coating on said article surface is resistant to erosion by halogen-containing plasmas used in semiconductor processing, and wherein a test specimen of a bulk solid solution ceramic material having a molar composition specified above exhibits a flexural strength between about 120 MPa and about 140 MPa.

41. An article in accordance with Claim 40, wherein said solution ceramic coating is formed from yttrium oxide at a concentration ranging from about 90 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

42. An article in accordance with Claim 40 or Claim 41, wherein a fracture toughness of a test specimen of a bulk solution ceramic material having a composition specified in Claim 40 or Claim 41 ranges between about 1.1 MPa . $m^{1/2}$ and about 1.3 MPa. $m^{1/2}$.

43. An article in accordance with Claim 40 or Claim 41, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plane, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

44. An article in accordance with Claim 40 or Claim 41, wherein said solid solution ceramic coating has a plasma erosion rate of less than about 0.2 μm /hr.

45. An article in accordance with Claim 42, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

46. An article in accordance with Claim 44, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

47. A ceramic article which is resistant to erosion by halogen-containing plasmas used in semi-conductor processing, said article comprising: a ceramic formed from a combination of yttrium oxide and zirconium oxide, with yttrium oxide at a molar concentration ranging from about 90 mole % to about 70 mole %, and zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %, wherein a *mean grain size of said ceramic ranges from about 2 μm to about 8 μm.*

48. A ceramic article in accordance with Claim 47, wherein said ceramic is formed from yttrium oxide at a concentration ranging from about 90 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

49. A ceramic article in accordance with Claim 47 or Claim 48, wherein a mean grain size of said ceramic ranges from about 2 μm to about 8 μm.

50. A ceramic article in accordance with Claim 47, wherein a flexural strength of said ceramic ranges from about 120 MPa to about 140 MPa.

51. A ceramic article in accordance with Claim 47, wherein a fracture toughness of said ceramic ranges from about 1.1 MPa. $m^{1/2}$ to 1.3 MPa. $m^{1/2}$.

52. A ceramic article in accordance with Claim 47 or Claim 48, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an

electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

53. A method reducing the plasma erosion of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: selecting said semiconductor processing apparatus to comprise ceramic, said ceramic formed from yttrium oxide at a molar concentration ranging from about 90 mole % to about 70 mole %, and zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %.

54. A method in accordance with Claim 53, further comprising selecting said ceramic for said semiconductor processing apparatus to be formed from yttrium oxide at a molar concentration ranging from about 90 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

55. A method in accordance with any one of claims 53 or claim 54, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma is less than about 0.2 μm/hour.

56. A method in accordance with Claim 55, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma is less than about 0.2 μm/hour.

57. A semiconductor processing apparatus having at least one surface exposed to a halogen-comprising plasma during a process, wherein said semiconductor processing apparatus surface is a ceramic which is resistant to erosion by halogen-containing plasmas, wherein said ceramic is formed from yttrium oxide at a molar concentration ranging from about 90 mole % to about 70 mole %, and zirconium oxide a molar concentration ranging from about 10 mole % to about 30 mole %.

58. A semiconductor processing apparatus in accordance with Claim 57, wherein *underlying said ceramic is a high purity aluminum alloy.*

59. A method in accordance with Claim 57, wherein said semiconductor processing apparatus is a solid ceramic semiconductor processing apparatus.

60. A semiconductor processing apparatus, said apparatus having at least one surface exposed to a halogen-comprising plasma during a process, wherein said surface is a ceramic which is resistant to erosion by halogen-containing plasmas, wherein said ceramic is formed from zirconium oxide at a molar concentration ranging from about 96 mole % to about 94 mole % and yttrium oxide at a molar concentration ranging from about 4 mole % to about 6 mole %.

61. A semiconductor processing apparatus in accordance with Claim 60, wherein underlying said ceramic is a high purity aluminum alloy.

62. A semiconductor processing apparatus in accordance with Claim 60, wherein said apparatus is a solid ceramic apparatus.

63. A semiconductor processing apparatus in accordance with Claim 60, wherein said apparatus is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

64. A semiconductor processing apparatus in accordance with Claim 60, wherein a mean grain size of said ceramic ranges from about 0.5 μm to about 8.0 μm.

65. A semiconductor processing apparatus in accordance with Claim 60, wherein a flexural strength of said ceramic ranges from about 1100 MPa to about 1300 MPa.

66. A semiconductor processing apparatus in accordance with Claim 60, wherein fracture toughness of said ceramic ranges from about 10 MPa. $m^{1/2}$ to about 12 MPa. $m^{1/2}$.

67. A method of reducing the plasma erosion of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: selecting said semiconductor processing apparatus to be a ceramic-comprising article, said ceramic formed from zirconium oxide at a molar concentration ranging from about 96 mole % to about 94 mole %, and yttrium oxide at a molar concentration ranging from about 4 mole % to about 6 mole %.

68. A method in accordance with Claim 67, wherein said plasms erosion rate for a surface of said semiconductor processing apparatus, upon exposure to a halogen-containing plasma, is less than about 0.4 μm/hr.

69. A method in accordance with Claim 68, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus, upon exposure to a halogen-comprising plasma, ranges from about 0.1 μm/hr to about 0.4 μm/hr.

70. A method in accordance with Claim 67, wherein at least one surface of said semiconductor processing apparatus, which surface is said ceramic, is exposed to said halogen-comprising plasma during said semiconductor processing.

71. A method in accordance with Claim 70, wherein underlying said ceramic is a high purity aluminum alloy.

72. A method in accordance with Claim 70, wherein said semiconductor processing apparatus is a solid ceramic semiconductor processing apparatus.

73. A ceramic article which is resistant to erosion by halogen-containing plasmas used in semi-conductor processing, said ceramic article including a solid solution ceramic having at least two phases, said solid solution ceramic formed from yttrium oxide at a molar concentration ranging from about 50 mole % to about 75 mole %; zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %; and at least one other component selected from the group consisting of aluminium oxide, hafnium oxide, scandium oxide, neodymium oxide, niobium oxide, samarium oxide, ytterbium oxide, erbium oxide, cerium oxide, and combinations thereof, said at least one other component concentration ranging from about 10 mole % to about 30 mole %.

74. A ceramic article in accordance with Claim 73, wherein said solid solution ceramic is formed from yttrium oxide at a concentration ranging from about 55 mole % to about 65 mole %, zirconium oxide at a concentration ranging from about 15 mole % to about 25 mole % and said at least one other component at a concentration ranging from about 10 mole % to about 25 mole %.

75. A ceramic article in accordance with Claim 74, wherein said solid solution ceramic is formed from yttrium oxide at a concentration ranging from about 55 mole % to about 65 mole %, zirconium oxide at a concentration ranging from about 20 mole % to about 25 mole % and said at least one other component at a concentration ranging from about 10 mole % to about 20 mole %.

76. A ceramic article in accordance with Claim 73 or Claim 74, or Claim 75, wherein said at least one other component is aluminium oxide.

77. A ceramic article in accordance with Claim 76, wherein a mean grain size of said ceramic ranges from about 0.5μm to about 10μm.

78. A ceramic article in accordance with Claim 73, wherein a flexural strength of said solid solution ceramic ranges from about 150 MPa to about 250 MPa.

79. A ceramic article in accordance with Claim 73, wherein a fracture toughness of said solid solution ceramic ranges from about 1.5 MPa · m½ to about 2.0 MPa · m½.

80. A ceramic article in accordance with Claim 73, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

81. A ceramic article in accordance with Claim 76, wherein said article is selected from the group

consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

82. A method of reducing the plasma erosion of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: employing a solid solution ceramic-comprising article, said solid solution ceramic formed from yttrium oxide at a molar concentration ranging from about 50 mole % to about 75 mole %; zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %; and at least one other component selected from the group consisting of aluminium oxide, hafnium oxide, scandium oxide, neodymium oxide, niobium oxide, samarium oxide, ytterbium oxide, erbium oxide, cerium oxide, and combinations thereof, said at least one other component concentration ranging from about 10 mole % to about 30 mole %.

83. A method in accordance with Claim 82, wherein said solid solution ceramic-comprising article is formed from yttrium oxide at a molar concentration ranging from about 55 mole % to about 65 mole %, zirconium oxide at a concentration ranging from about 15 mole % to about 25 mole % and said at least one other component at a concentration ranging from about 10 mole % to about 25 mole %.

84. A method in accordance with Claim 83, wherein said solid solution ceramic-comprising article is formed from yttrium oxide at a concentration ranging from about 55 mole % to about 65 mole % zirconium oxide at concentration ranging from about 20 mole % to about 25 mole % and said at least on other component at a concentration ranging from about 10 mole % to about 20 mole %.

85. A method in accordance with Claim 82, Claim 83 or Claim 84, wherein said at least one other component is selected to be aluminium oxide.

86. A method in accordance with Claim 82, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma is less than about 0.3μm/hr.

87. A method is accordance with Claim 86, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma ranges from about 0.1 to about 0.3μm/hr.

88. A method in accordance with Claim 85, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma is less than about 0.3μm/hr.

89. A method in accordance with Claim 88, wherein said plasma erosion rate for a surface of said semiconductor processing apparatus upon exposure to a halogen-comprising plasma ranges from about 0.1 to about 0.3μm/hr.

90. A semiconductor processing apparatus which has at least one surface exposed to a halogen-comprising plasma during said semiconductor processing, wherein said semiconductor processing apparatus surface is a solid solution ceramic, said solid solution ceramic being resistant to erosion by halogen-containing plasmas, wherein said ceramic includes at least two phases and is formed from yttrium oxide at a molar concentration ranging from about 50 mole % to about 75 mole % zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole % and at least on other component selected from the group consisting of aluminium oxide, hafnium oxide, scandium oxide, neodymium oxide, niobium oxide, samarium oxide, ytterbium oxide, erbium oxide, cerium oxide, and combinations thereof, said at least one other component concentration ranging from about 10 mole % to about 30 mole %.

91. A semiconductor processing apparatus in accordance with Claim 90, wherein underlying said solid solution ceramic is a high purity aluminium alloy.

92. A semiconductor processing apparatus in accordance with Claim 91, wherein said apparatus is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

93. A semiconductor processing apparatus in accordance with Claim 90, wherein said apparatus is a solid ceramic semiconductor processing apparatus.

94. A semiconductor processing apparatus in accordance with Claim 93, wherein said apparatus is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

95. A method of reducing the plasma erosion of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: spray coating at least a surface of said semiconductor processing apparatus which is exposed to said plasma with a solid solution ceramic formed from yttrium oxide at a molar concentration ranging from about 50 mole % to about 75 mole %; zirconium oxide at a molar concentration ranging from about10 mole % to about 30 mole %; and at least one other component selected from the group consisting of aluminium oxide, hafnium oxide, scandium oxide, neodymium oxide, niobium oxide, samarium oxide, ytterbium oxide, erbium oxide, cerium oxide and combinations thereof, said at least one other component concentration ranging from about 10 mole % to about 30 mole %.

96. A method in accordance with Claim 95, wherein said spray coating is applied over said surface which is exposed to said plasma using thermal spraying or flame spraying or plasma spraying.

97. A method in accordance with Claim 95, wherein said surface is at a temperature of at least about 150 °C – 200 °C at the time said spray coating is carried out.

98. A method is accordance with Claim 95, wherein said surface over which said coating is sprayed is a metal or a ceramic surface.

99. A method in accordance with Claim 96, wherein said surface over which said coating is sprayed is a metal or a ceramic surface.

100. A method in accordance with Claim 97, wherein said surface over which said coating is sprayed is a metal or a ceramic surface.

101. A method in accordance with Claim 98, wherein said surface over which said coating is sprayed is selected from the group consisting of aluminium, aluminium alloy, stainless steel, alumina, aluminium nitride, quartz and combinations thereof.

102. A method in accordance with Claim 99, wherein said surface over which said coating is sprayed is selected from the group consisting of aluminium, aluminium alloy, stainless steel, alumina, aluminium nitride, quartz, and combinations thereof.

103. A method in accordance with Claim 100, wherein said surface over which said coating is sprayed is selected from the group consisting of aluminium, aluminium alloy, stainless steel, alumina, aluminium nitride, quartz, and combinations thereof.

104. A method in accordance with Claim 103, wherein said aluminium alloy is a high purity aluminium alloy.

105. A method in accordance with Claim 101, wherein said surface over which said coating is sprayed is aluminium oxide or aluminium nitride.

106. A method in accordance with Claim 102, wherein said surface over which said coating is sprayed is aluminium oxide or aluminium nitride.

107. A method in accordance with Claim 103, wherein said surface over which said coating is sprayed is aluminium oxide or aluminium nitride.

108. A method of producing an apparatus for use in semiconductor or MEMS processing, wherein a solid solution ceramic coating is formed directly upon an exterior surface of a body of said apparatus using a technique selected from the group consisting of thermal spraying, plasma spraying, sputter-

ing, and chemical vapor deposition, wherein said body is formed from a material selected from the group consisting of aluminum, aluminum alloy, stainless steel, alumina, aluminum nitride, quartz, and combinations thereof, and wherein said solid solution ceramic coating is formed from a combination of yttrium oxide ranges from about 90 mole % to about 70 mole %, and a molar concentration of zirconium oxide ranges from about 10 mole % to about 30 mole %, in a manner which produces a mean grain size of said solid solution ceramic coating which ranges from about 2 μm to about 8 μm, so that said coating on said article surface is resistant to erosion by halogen-containing plasmas used in semiconductor or MEMS processing, and wherein a test specimen of a bulk solid solution ceramic material having a molar composition specified above exhibits a flexural strength between about 120 MPa to about 140 MPa.

109. A method in accordance with Claim 108, wherein said solid solution ceramic coating is formed from yttrium oxide at a concentration ranging from about 90 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

110. A method in accordance with Claim 108 or Claim 109, wherein a fracture toughness of a test specimen of a bulk solid solution ceramic material having a composition specified in Claim 108 or Claim 109 ranges between about 1.1 MPa. $m^{1/2}$ and about 1.3 MPa. $m^{1/2}$.

111. A method in accordance with Claim 108 or Claim 109, wherein an erosion rate of said solid solution ceramic coating in a fluorine-comprising plasma is less than 0.2 μm/hr.

112. A method in accordance with Claim 108 or Claim 109, wherein said coating is formed over a body having a shape selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

113. A sintered solid solution-comprising ceramic article which is resistant to erosion by halogen-containing plasmas used in semiconductor processing, said ceramic having at least two phases, with said ceramic formed from yttrium oxide at a molar concentration ranging from about 50 mole % to about 75 mole %; zirconium oxide at molar concentration ranging from about 10 mole % to about 30 mole %; and at least one other component selected from the group consisting of aluminum oxide, hafnium oxide, scandium oxide, neodymium oxide, niobium oxide, samarium oxide, ytterbium oxide, erbium oxide, cerium oxide, and combinations thereof, said at least one other component concentration ranging from about 10 mole % to about 30 mole %.

114. A sintered solid solution-comprising ceramic article in accordance with Claim 113, wherein said ceramic is formed from yttrium oxide at a concentration ranging from about 55 mole % to about 65 mole %, zirconium oxide at a concentration ranging from about 15 mole % to about 25 mole % and said at least one other component at a concentration ranging from about 10 mole % to about 25 mole %.

115. A sintered solid solution-comprising ceramic article in accordance with Claim 114, wherein said ceramic is formed from yttrium oxide at a concentration ranging from about 55 mole % to about 65 mole %, zirconium oxide at a concentration ranging from about 20 mole % to about 25 mole %, and said at least one other component at a concentration ranging from about 10 mole % to about 20 mole %.

116. A sintered solid solution-comprising ceramic article in accordance with Claim 113, or Claim 114, or Claim 115, wherein said at least one other component is aluminum oxide.

117. A sintered solid solution-comprising ceramic article in accordance with Claim 116, wherein a mean grain size of said ceramic ranges from about 0.5 μm to about 10 μm.

118. A sintered solid solution-comprising ceramic article in accordance with Claim 113, wherein a flexural strength of said ceramic ranges from about 150 MPa to about 250 MPa.

119. A sintered solid solution-comprising ceramic article in accordance with Claim 113, wherein a fracture toughness of said ceramic ranges from about 1.5 MPa. $m^{1/2}$ to about 2.0 MPa. $m^{1/2}$.

120. A sintered solid solution-comprising ceramic article in accordance with Claim 113, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

121. A sintered solid solution-comprising ceramic article in accordance with Claim 116, wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

122. A method of reducing the plasma erosion of a semiconductor processing apparatus contacted by a halogen-containing plasma, comprising: employing a sintered solid solution-comprising ceramic article, with said ceramic formed from yttrium oxide at a molar concentration ranging from about 50 mole % to about 75 mole %; zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %; and at least one other component selected from the group consisting of aluminum oxide, hafnium oxide, scandium oxide, neodymium oxide, niobium oxide, samarium oxide, ytterbium oxide, erbium oxide, cerium oxide, and combinations thereof, said at least one other component concentration ranging from about 10 mole % to about 30 mole %.

123. A method in accordance with Claim 122, wherein said sintered solid solution-comprising ceramic article is formed from yttrium oxide at a molar concentration ranging from about 55 mole % to about 65 mole % zirconium oxide at a concentration ranging from about 15 mole % to about 25 mole % and said at least one other component at a concentration ranging from about 10 mole % to about 25 mole %.

124. A method in accordance with Claim 123, wherein said sintered solid solution-comprising ceramic article is formed from yttrium oxide at a concentration ranging from about 55 mole % to about 65 mole %, zirconium oxide at concentration ranging from about 20 mole % to about 25 mole %, and said at least one other component at a concentration ranging from about 10 mole % to about 20 mole %.

125. A method in accordance with Claim 122, or Claim 123, or Claim 124, wherein said at least one other component is selected to be aluminum oxide.

126. A method in accordance with Claim 122, wherein said plasma erosion rate for a surface of said sintered solid solution-comprising ceramic article upon exposure to a halogen-comprising plasma is less than about 0.3 μm/hr.

127. A method in accordance with Claim 126, wherein said plasma erosion rate for a surface of said sintered solid solution-comprising ceramic article upon exposure to a halogen-comprising plasma ranges from about 0.1 μm/hr to about 0.3 μm/hr.

128. A method in accordance with Claim 125, wherein said plasma erosion rate for a surface of said sintered solid solution-comprising ceramic article upon exposure to a halogen-comprising plasma is less than about 0.3 μm/hr.

129. A method in accordance with Claim 128, wherein said plasma erosion rate for a surface of said sintered solid solution-comprising ceramic article upon exposure to a halogen-comprising plasma ranges from about 0.1 μm/hr to about 0.3 μm/hr.

130. A semiconductor processing apparatus including a substrate which has at least one coated surface which is exposed to a halogen-comprising plasma during said semiconductor processing, wherein said at least one coated surface is a solid solution-comprising ceramic, with said ceramic being resistant to erosion by halogen-containing plasmas, wherein said ceramic includes at least two phases and is formed from yttrium oxide at a molar concentration ranging from about 50 mole % to about 75 mole %; zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole %; and at least one other component selected from the group consisting of aluminum oxide, hafnium oxide, scandium oxide, neodymium oxide, niobium oxide, samarium oxide, ytterbium oxide, erbium oxide, cerium oxide, and combinations thereof, said at least one component concentration ranging from about 10 mole % to about 30 mole %.

131. A semiconductor processing apparatus in accordance with Claim 130, wherein said substrate underlying said coated surface is 99.5% minimum purity aluminum alloy substrate.

132. A semiconductor processing apparatus in accordance with Claim 131, wherein said apparatus is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

133. A semiconductor processing apparatus component which is resistant to erosion by halogen containing plasmas used in semiconductor processing, said apparatus component comprising: a substrate having a ceramic coating on at least one surface, said ceramic coating comprising a solid solution which is formed from a combination of yttrium oxide zirconium oxide, and aluminum oxide, wherein said coating is formed from yttrium oxide at a concentration ranging from about 71.4 % by weight to about 76.9% by weight, a concentration of zirconium oxide ranging from about 14.3 % by weight to about 15.4 % by weight, and a concentration of aluminum oxide ranging from about 7.7 % by weight to about 14.3 % by weight.

134. A semiconductor processing apparatus component in accordance with Claim 133, wherein said substrate is selected from the group consisting of aluminum, aluminum alloy stainless steel alumina, aluminum nitride quartz, and combinations thereof.

135. A semiconductor processing apparatus component in accordance with Claim 133, wherein a mean grain size of a bulk, solid sintered test specimen formed from the materials recited in claim 133 ranges from about 3 micrometers to about 6 micrometers.

136. A semiconductor processing apparatus component in accordance with Claim 133, wherein a plasma erosion rate of a bulk, solid sintered test specimen formed from the materials recited in claim 133 are exposed to a plasma comprising CF_4 and CHF_3 ranges from about 0.1 micrometer/hr to about 0.2 micrometer/hr.

137. A semiconductor processing apparatus component in accordance with Claim 133, wherein a density of a bulk solid sintered test specimen formed from the materials recited in claim 133 ranges from about 4.86 to about 4.9 g/cm^3.

138. A semiconductor processing apparatus component in accordance with Claim 133 wherein a fracture toughness of a test specimen of a bulk solid solution ceramic having the composition recited in claim 133 ranges from about 1.6 $Mpa \cdot m^{1/2}$ to about 1.7 $Mpa \cdot m^{1/2}$.

139. A semiconductor processing apparatus in accordance with Claim 133, wherein said apparatus is selected from the group consisting of a lid a liner, a chamber liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, and a processing kit.

140. A semiconductor processing apparatus component which is resistant to erosion by halogen containing plasmas used in semiconductor processing, said apparatus component comprising: a substrate having a ceramic coating on at least one surface, said ceramic coating comprising a solid solution which is formed from a combination of yttrium oxide, zirconium oxide, and aluminum oxide, wherein said coating is formed from yttrium oxide at a concentration ranging from about 50 mole % to about 75 mole %, a concentration of zirconium oxide ranging from about 10 mole % to about 30 mole %, and a concentration of aluminum oxide ranging from about 10 mole % to about 30 mole %.

141. A semiconductor processing apparatus component in accordance with Claim 140, wherein said substrate is selected from the group consisting of aluminum, aluminum alloy, stainless steel, alumina, aluminum nitride, quartz, and combinations thereof.

142. A semiconductor processing apparatus component in accordance with Claim 140, wherein a plasma erosion rate of a bulk, solid sintered test specimen formed from the materials recited in claim 140, when exposed to a plasma comprising CF_4 and CHF_3 ranges from about 0.1 micrometer/hr to about 0.2 micrometer/hr.

143. A semiconductor processing apparatus in accordance with Claim 140,wherein said apparatus is selected from the group consisting of a lid, a lid liner, a chamber liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, and a processing kit.

144. A bulk ceramic article which is resistant to erosion by halogen-containing plasmas used in semiconductor processing, where said bulk ceramic article (is) formed from yttrium oxide at a molar concentration ranging from about 90 mole % to about 40 mole % and zirconium oxide at a molar concentration ranging from about 10 mole % to about 30 mole % to produce a bulk solid-solution-containing ceramic.

145. A bulk ceramic article in accordance with Claim 144, wherein said bulk ceramic article is formed from yttrium oxide at a concentration ranging from about 90 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

146. A bulk ceramic article in accordance with Claim 144 or Claim 145, wherein a mean grain size of said ceramic ranges from about 2 micrometers to about 8 micrometers.

147. A bulk ceramic article in accordance with Claim 144, wherein a flexural strength of said ceramic ranges from about 120 MPa to about 140 MPa.

148. A bulk ceramic article in accordance with Claim 144, wherein a fracture toughness of said ceramic ranges from about 1.1 MPa $m^{1/2}$ to about 1.3 MPa $m^{1/2}$.

149. A bulk ceramic article in accordance with Claim 144 or Claim 145 wherein said article is selected from the group consisting of a lid, a lid liner, a nozzle, a gas distribution plate, a shower head, an electrostatic chuck component, a shadow frame, a substrate holding frame, a processing kit, and a chamber liner.

150. A method of reducing plasma erosion of a bulk ceramic article useful as a semiconductor processing apparatus when contacted by a halogen-containing plasma, while improving the mechanical properties of said article, comprising: forming said bulk ceramic article useful as a semiconductor processing apparatus from yttrium oxide at a molar concentration ranging from about 90 mole % to about 70 mole % and zirconium oxide at a molar concentration ranging from about 10 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

151. A method in accordance with Claim 150, wherein said bulk ceramic article useful as semiconductor processing apparatus is formed from yttrium oxide at a molar concentration ranging from about 90 mole % to about 80 mole %, and zirconium oxide at a concentration ranging from about 10 mole % to about 20 mole %.

152. A method in accordance with Claim 150 or Claim 151, wherein said plasma erosion rate for a surface of said bulk ceramic article useful as a semiconductor processing apparatus upon exposure to a halogen-comprising plasma is less than about 0.2 micrometers/hr.

153. A method in accordance with Claim 152, wherein said plasma erosion rate for a surface of said bulk ceramic article useful as a semiconductor processing apparatus upon exposure to a halogen-comprising plasma ranges from about 0.1 to about 0.2 micrometers.hr.