CLAIMS

1. 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 80 mole % to 70 mole %, and zirconium oxide at a molar concentration ranging from 20 mole % to 30 mole %, wherein a mean grain size of said ceramic ranges from 2 μm to 8 μm.

2. A sintered solid solution-comprising ceramic article in accordance with Claim 1, wherein said ceramic article comprises yttrium oxide at a concentration ranging from 72.1 mole % to 70 mole %, and zirconium oxide at a concentration ranging from 27.9 mole % to 30 mole %.

3. A sintered solid solution-comprising ceramic article in accordance with Claim 1, wherein a flexural strength of said ceramic ranges from 120 MPa to 140 MPa.

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

5. A sintered solid solution-comprising 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.

6. 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 article comprising yttrium oxide at a molar concentration ranging from 80 mole % to 70 mole %, and zirconium oxide at a molar concentration ranging from 20 mole % to 30 mole %, wherein a mean grain size of said ceramic ranges from 2μm to 8 μm.

7. A method in accordance with Claim 6, wherein said sintered solid solution-comprising ceramic article comprises yttrium oxide at a molar concentration ranging from 72.1 mole % to 70 mole %, and zirconium oxide at a concentration ranging from 27.9 mole % to 30 mole %.

8. A method in accordance with Claim 6 or Claim 7, 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.

9. A method in accordance with Claim 8, 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.

10. A method for producing an article comprising forming a solid solution ceramic coating 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 comprises a material selected from the group consisting of aluminum, aluminum alloy, stainless steel, aluminum nitride, and quartz, and wherein said solid solution ceramic coating comprises a combination of yttrium oxide and zirconium oxide, wherein a molar concentration of yttrium oxide ranges from about 80 mole % to about 70 mole %, and a molar concentration of zirconium oxide ranges from about 20 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.

11. A method in accordance with Claim 10, wherein said solution ceramic coating comprises yttrium oxide at a concentration ranging from about 72.1 mole % to about 70 mole %, and zirconium oxide at a concentration ranging from about 27.9 mole % to about 30 mole %.

12. A method in accordance with Claim 10 or Claim 11, 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. $m^{1/2}$.

13. A method in accordance with Claim 10 or Claim 11, 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.

14. n method in accordance with Claim 10 or Claim 11, wherein said solid solution ceramic coating has a plasma erosion rate of less than about 0.2 μm /hr.

15. A method in accordance with Claim 12, 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.

16. A method in accordance with Claim 14, 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.

17. A ceramic article which is resistant to erosion by halogen-containing plasmas used in semi-conductor processing, said article comprising: a ceramic comprising a combination of yttrium oxide and zirconium oxide, with yttrium oxide at a molar concentration ranging from about 80 mole % to about 70 mole %, and zirconium oxide at a molar concentration ranging from about 20 mole % to about 30 mole %, wherein a mean grain size of said ceramic ranges from about 2 μm to about 8 μm.

18. A ceramic article in accordance with Claim 17, wherein said ceramic comprises yttrium oxide at a concentration ranging from about 72.1 mole % to about 70 mole %, and zirconium oxide at a concentration ranging from about 27.9 mole % to about 30 mole %.

19. A ceramic article in accordance with Claim 17 or Claim 18, wherein a mean grain size of said ceramic ranges from about 2 μm to about 8 μm.

20. A ceramic article in accordance with Claim 17, wherein a flexural strength of said ceramic ranges from about 120 MPa to about 140 MPa.

21. A ceramic article in accordance with Claim 17, wherein a fracture toughness of said ceramic ranges from about 1.1 MPa. $m^{1/2}$ to 1.3 MPa. $m^{1/2}$.

22. A ceramic article in accordance with Claim 17 or Claim 18, 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.

23. 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 comprises yttrium oxide at a molar concentration ranging from about 80 mole % to about 70 mole %, and zirconium oxide at a molar concentration ranging from about 20 mole % to about 30 mole %.

24. A method in accordance with Claim 23, further comprising selecting said ceramic for said semiconductor processing apparatus to comprise yttrium oxide at a molar concentration ranging from about 72.1 mole % to about 70 mole %, and zirconium oxide at a concentration ranging from about 27.9 mole % to about 30 mole %.

25. A method in accordance with any one of claims 23 or claim 24, 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.

26. A method in accordance with Claim 25, 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.

27. 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 comprises yttrium oxide at a molar concentration ranging from about 80 mole % to about 70 mole %, and zirconium oxide a molar concentration ranging from about 20 mole % to about 30 mole %.

28. A semiconductor processing apparatus in accordance with Claim 27, wherein underlying said ceramic is a high purity aluminum alloy.

29. A method in accordance with Claim 27, wherein said semiconductor processing apparatus is a solid ceramic semiconductor processing apparatus.

30. 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, sputtering, and chemical vapor deposition, wherein said body comprises 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 comprises a combination of yttrium oxide ranges from about 80 mole % to about 70 mole %, and a molar concentration of zirconium oxide ranges from about 20 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.

31. A method in accordance with Claim 30, wherein said solid solution ceramic coating comprises yttrium oxide at a concentration ranging from about 72.1 mole % to about 70 mole %, and zirconium oxide at a concentration ranging from about 27.9 mole % to about 30 mole %.

32. A method in accordance with Claim 30 or Claim 31, 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. $m^{1/2}$.

33. A method in accordance with Claim 30 or Claim 31, wherein an erosion rate of said solid solution ceramic coating in a fluorine-comprising plasma is less than 0.2 μm/hr.

34. A method in accordance with Claim 30 or Claim 31, 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.

35. A bulk ceramic article which is resistant to erosion by halogen-containing plasmas used in semiconductor processing, where said bulk ceramic article comprises yttrium oxide at a molar concentration ranging from about 80 mole % to about 70 mole % and zirconium oxide at a molar concentration ranging from about 20 mole % to about 30 mole % to produce a bulk solid-solution-containing ceramic.

36. A bulk ceramic article in accordance with Claim 35, wherein said bulk ceramic article comprises yttrium oxide at a concentration ranging from about 72.1 mole % to about 70 mole %, and zirconium oxide at a concentration ranging from about 27.9 mole % to about 30 mole %.

37. A bulk ceramic article in accordance with Claim 35 or Claim 36, wherein a mean grain size of said ceramic ranges from about 2 micrometers to about 8 micrometers.

38. A bulk ceramic article in accordance with Claim 35, wherein a flexural strength of said ceramic ranges from about 120 MPa to about 140 MPa.

39. A bulk ceramic article in accordance with Claim 35, wherein a fracture toughness of said ceramic ranges from about 1.1 MPa $m^{1/2}$ to about 1.3 MPa $m^{1/2}$.

40. A bulk ceramic article in accordance with Claim 35 or Claim 36 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.

41. 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 80 mole % to about 70 mole % and zirconium oxide at a molar concentration ranging from about 20 mole % to about 30 mole %.

42. A method in accordance with Claim 41, wherein said bulk ceramic article useful as semiconductor processing apparatus comprises yttrium oxide at a molar concentration ranging from about 72.1 mole % to about 70 mole %, and zirconium oxide at a concentration ranging from about 27.9 mole % to about 30 mole %.

43. A method in accordance with Claim 41 or Claim 42, 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.

44. A method in accordance with Claim 43, 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.