CLAIMS

1. A process for coating a substrate with a ceramic thermal barrier coating, the substrate comprising an airfoil, the process comprising:

generating a plume of ceramic deposition material from a first source and a second source;

alternating the composition of the plume by generating vapor from the first and second sources in an alternating manner; and

moving the substrate relative to the first and second sources,

wherein:

the moving of the substrate moves a given region of the substrate through the plume with a period greater than a duration of generation of the vapor plume from the second source; and

the relative speed of the moving and the frequency of alternation of the composition of the vapor plume are effective to deposit a matrix with embedded second phase patches of the coating from the first source and second source, respectively.

2. The process of claim 1 wherein:

the moving consists of a single rotation.

3. The process of claim 1 wherein:

a duration of generation of the vapor plume from the first source is 400-5000% of said period; and

a duration of generation of the vapor plume from the second source is 30-99% of said period.

4. The process of claim 1 wherein:

the first source comprises a yttria stabilized zirconia; and

the second source comprises at least 40 mole percent of oxides having the formula Ln_2O_3, where Ln is selected from the lanthanide La through Lu, Y, Sc, In, Ca, and Mg.

5. The process of claim 1 wherein:

the first source comprises a yttria stabilized zirconia; and

the second source comprises at least 40 mole percent of oxides having the formula Ln_2O_3, where Ln is selected from the lanthanide La through Lu, Y, Sc, In, Ca, and Mg with the balance zirconia (ZrO_2), hafnia (HfO_2), titania (TiO_2), or mixtures thereof.

6. The process of claim 1 wherein:

the generating the plume of ceramic deposition material from the first source and the second source comprises electron beam vaporization of the first source and the second source.

7. The process of claim 1 wherein:

each of the second phase patches represents less than 85% of the surface area of the substrate.

8. The process of claim 1 wherein:

deposition material from the first source forms a matrix;

deposition material from the second source forms second phases embeded within the matrix.

9. The process of claim 8 wherein:

the second phases have a characteristic thickness (T_6) of less than 2.0 micrometers (μm); and

the spacing between second phases has a characteristic thickness (T_5) of less than 8.0 micrometers (μm).

10. The process of claim 8 wherein:

the matrix comprises a yttria stabilized zirconia; and

the second phases comprise at least 40 mole percent of oxides having the formula Ln_2O_3, where Ln is selected from the lanthanides La through Lu, Y, Sc, In, Ca, and Mg with the balance zirconia (ZrO_2), hafnia (HfO_2), titania (TiO_2), or mixtures thereof.

11. The process of claim 8 wherein:

the second phases have characteristic thickness (T_6) of 0.15–1.0μm; and

a ratio of the second phases characteristic thickness (T_6) to the spacing (T_5) between second phases, thickness-wise, is between 1:3 and 1:4.

12. The process of claim 8 wherein:

the matrix with embedded second phases form a layer having a thickness (T_4) of at least 76 micrometers.

13. The process of claim 8 wherein:

the matrix with embedded second phases form a layer having a thickness (T_4) of 76–350 micrometers.

14. The process of claim 8, further comprising:

applying a bondcoat; and

applying a first TBC layer between the bondcoat and the

matrix.

15. The process of claim 14, wherein:

the first TBC layer has a nominal composition differing from a composition of the matrix by the presence of one or more additives in a total amount of up to 1.0 weight percent.

16. The process of claim 8 wherein:

the characteristic thickness (T_6) of the second phases is 0.15–1.0 micrometers (μm), and

the characteristic thickness (T_5) of the spacing between second phases is 0.5–3.0 micrometers (μm).

17. The process of claim 8, further comprising:

applying an additional coating layer with a homogeneous chemistry atop the matrix with embedded second phases.

18. The process of claim 17 wherein:

the additional coating layer is more resistant to attack by molten silicate deposits than is the matrix.

19. The process of claim 8, further comprising:

applying an additional coating layer atop the matrix and comprising oxyapatite and/or garnet.

20. The process of claim 8, wherein:

the matrix and second phases are in a layer of the thermal barrier coating system with thickness (T_4) wherein the second phases account for 5–20% of said layer by volume.

21. The process of claim 1 wherein:

the generating a plume of ceramic deposition material from the first source and the second source is via electron beam physical vapor deposition; and

the alternating of the composition comprises applying the electron beam to the first and second sources in an alternating manner comprising:

a duration of applying the electron beam to the first source of 400-5000% of said period alternating with a duration of applying the electron beam to the second source of 30-99% of said period greater than a duration of generation of the vapor plume from the second source.

22. The process of claim 1 wherein:

the first source comprises a yttria stabilized zirconia.

23. A process for coating a substrate with a ceramic thermal barrier coating, the process comprising:

generating a plume of ceramic deposition material from a first source and a second source;

alternating the composition of the plume by generating vapor from the first and second sources in an alternating manner; and

moving the substrate relative to the first and second sources,

wherein:

the first source comprises a yttria stabilized zirconia;

the second source comprises at least 40 mole percent of oxides having the formula Ln_2O_3, where Ln is selected from the lanthanide La through Lu, Y, Sc, In, Ca, and Mg;

the moving of the substrate moves a given region of the substrate through the plume with a period greater than a

duration of generation of the vapor plume from the second source;

deposition material from the first source forms a matrix; and

deposition material from the second source forms second phases embeded within the matrix.

24. A process for coating a substrate with a ceramic thermal barrier coating, the process comprising:

generating a plume of ceramic deposition material from a first source and a second source;

alternating the composition of the plume by generating vapor from the first and second sources in an alternating manner; and

moving the substrate relative to the first and second sources,

wherein:

deposition material from the first source forms a matrix;

deposition material from the second source forms second phases embeded within the matrix;

the moving of the substrate moves a given region of the substrate through the plume with a period greater than a duration of generation of the vapor plume from the second source;

the matrix comprises a yttria stabilized zirconia; and

the second phases comprise at least 40 mole percent of oxides having the formula Ln_2O_3, where Ln is selected from the lanthanides La through Lu, Y, Sc, In, Ca, and Mg with the balance zirconia (ZrO_2), hafnia (HfO_2), titania (TiO_2), or mixtures thereof.

25. A process for coating a substrate with a ceramic thermal barrier coating, the process comprising:

generating a plume of ceramic deposition material from a first source and a second source;

alternating the composition of the plume by generating vapor from the first and second sources in an alternating manner; and

moving the substrate relative to the first and second sources,

wherein:

deposition material from the first source forms a matrix;

deposition material from the second source forms second phases embeded within the matrix;

the moving of the substrate moves a given region of the substrate through the plume with a period greater than a duration of generation of the vapor plume from the second source; and

the method further comprises applying an additional coating layer atop the matrix and comprising oxyapatite and/or garnet.

26. A process for coating a substrate with a ceramic thermal barrier coating, the process comprising:

generating a plume of ceramic deposition material from a first source and a second source;

alternating the composition of the plume by generating vapor from the first and second sources in an alternating manner; and

moving the substrate relative to the first and second sources,

wherein:

a duration of generation of the vapor plume from the first

source is 400-5000% of said period; and

a duration of generation of the vapor plume from the second source is 30-99% of said period.