applications of the present invention will become apparent to one of ordinary skill in the art.

Summary of the Invention

[0008] In a first aspect of the present invention, a reactive element (RE)-doped aluminide coating derived from a slurry formulation comprising: a RE donor powder comprising a RE component selected from the group consisting of hafnium (Hf), zirconium (Zr), yttrium (Y), lanthanum (La), cerium (Ce), , and any combination thereof; a halide-containing activator powder selected from the group consisting of aluminum fluoride, ammonium fluoride, chromium fluoride, ammonium chloride, chromium chloride, hafnium chloride, hafnium fluoride, hafnium oxychloride, zirconium chloride, zirconium fluoride, zirconium oxychloride, lanthanum chloride, yttrium chloride and any combination thereof; an inert filler powder; and a binder solution, said binder solution comprising a binder material dissolved in a solvent.

[0008a] In yet another aspect, there is provided a reactive element (RE) enriched layer derived from a slurry formulation, said slurry formulation comprising a RE donor powder comprising a RE component selected from the group consisting of hafnium (Hf), zirconium (Zr), yttrium (Y), lanthanum (La), cerium (Ce), and any combination thereof; a halide-containing activator powder selected from the group consisting of aluminum fluoride, ammonium fluoride, chromium fluoride, ammonium chloride, chromium chloride, hafnium chloride, hafnium fluoride, hafnium oxychloride, zirconium chloride, zirconium fluoride, zirconium oxychloride, lanthanum chloride, yttrium chloride and any combination thereof; an inert filler powder; and a binder solution, said binder solution comprising a binder material dissolved in a solvent; wherein said slurry formulation is characterized by an absence of a carrier gas.

[0009] In a second aspect of the present invention, a RE-enriched layer which is a precursor to a reactive element (RE)-doped aluminide coating, said RE-enriched layer deposited along a substrate and comprising:
at least one RE selected from the group consisting of Hf, Zr, Y, La, and Ce in a concentration ranging from about 20-50 percent of the total weight of the RE-

enriched layer; said RE-enriched layer chemically bonded to the surface of the substrate; said RE-enriched layer having a thickness of about 0.2 to about 10 micrometers.

[00010] In a third aspect of the present invention, a method for producing a RE-enriched layer onto a part, comprising the steps of: providing a RE donor slurry comprising a RE donor and a halide activator; applying said RE donor slurry onto the part; heating the RE donor slurry to generate a halide vapor; reacting the halide vapor with said RE component contained in the donor slurry to produce RE halide gases; transporting said RE halide gases with the part surface in the absence of a carrier gas; depositing said RE onto the part in the absence of a carrier gas; followed by diffusing said RE into the part; and then chemically

Claims

1. A reactive element (RE) enriched layer derived from a slurry formulation, said slurry formulation comprising:

a RE donor powder comprising a RE component selected from the group consisting of hafnium (Hf), zirconium (Zr), yttrium (Y), lanthanum (La), cerium (Ce), and any combination thereof;

a halide-containing activator powder selected from the group consisting of aluminum fluoride, ammonium fluoride, chromium fluoride, ammonium chloride, chromium chloride, hafnium chloride, hafnium fluoride, hafnium oxychloride, zirconium chloride, zirconium fluoride, zirconium oxychloride, lanthanum chloride, yttrium chloride and any combination thereof;

an inert filler powder; and

a binder solution, said binder solution comprising a binder material dissolved in a solvent;

wherein said slurry formulation is characterized by an absence of a carrier gas.

2. The slurry formulation of claim 1, wherein said donor powder is in the range from about 1% to about 50% of the slurry weight, said halide-containing activator powder is in a range from about 0.1 to about 10% of the slurry weight, said the binder solution is in a range from 15% to about 50% of the slurry weight; and inert filler material is in a range from 10 to 80% of the slurry weight, wherein the aggregate of said donor powder, said halide-containing activator powder, said inert filler powder, and said binder solution is equal to 100% of the slurry weight.

3. The slurry formulation of claim 1, wherein said donor powder is in the range from about 10% to about 30% of the slurry weight, said halide-containing activator powder is in a range from about 1 to about 5% of the slurry weight, said binder solution is in a range from 20% to about 35% of the slurry weight and inert filler material is in a range from 30 to 70% of the slurry weight, wherein the aggregate of said donor powder, said halide-containing activator

powder, said inert filler powder, and said binder solution is equal to 100% of the slurry weight.

4. A method for producing a reactive element (RE)-enriched layer onto a part, comprising the steps of:

providing a RE donor slurry comprising a RE donor and a halide activator;

applying said RE donor slurry onto the part;

heating the RE donor slurry to generate a halide vapor;

reacting the halide vapor with said RE component contained in the donor slurry to produce RE halide gases;

transporting said RE halide gases onto the part surface in the absence of a carrier gas;

depositing said RE onto the part; followed by
diffusing said RE into the part; and then
chemically bonding the RE-enriched layer onto the part; and
removing the slurry residues from the RE-enriched layer.

5. The method of claim 4, further comprising the additional steps of:
depositing an aluminum-based material onto the part so as not interfere with the preceding deposition of said RE halide gases;
diffusing an aluminum-based material into said RE-enriched layer;
aluminizing said RE-enriched layer; thereby
forming an RE-doped aluminide coating.

6. The method of claim 4, further comprising the step of applying a ceramic thermal barrier coating over said RE-doped aluminide coating.

7. The method of claim 4, wherein said RE component comprises Hf.

8. The method of claim 4, wherein said RE-enriched layer has a thickness of about 0.2 micrometers to about 10 micrometers.

9. The method of claim 4, wherein said RE-enriched layer has a thickness ranging from about 0.5 to 5 micrometers.

10. The method of claim 5, wherein said aluminizing is a vapor phase aluminizing process.

11. The method of claim 4, further comprising forming the RE-enriched layer onto a part, said part being a region of a turbine blade, said region being an under-platform, cooling cavity, and/or tip holes of the turbine blade.

12. The method of claim 4, further comprising the step of performing an electroplating process to deposit a platinum group metal selected from platinum, palladium, iridium, and rhodium and any combination thereof, said deposition of the platinum group metal performed either prior to applying the RE donor slurry onto the part or after depositing the RE-enriched layer.

13. A reactive-element (RE)-doped aluminide coating prepared by a process, comprising the steps of:

providing a RE donor slurry comprising a RE donor and a halide activator;

applying said RE donor slurry onto the part surface;

heating the halide activator to generate a halide vapor;

reacting the halide vapor with said RE component contained in the donor slurry to produce RE halide gases;

transporting said RE halide gases with the part surface in the absence of a carrier gas;

depositing said RE onto the part surface; followed by

diffusing said RE into the part surface; and then

forming the RE-enriched layer onto the part;

removing the slurry residues from the RE-enriched layer;

depositing an aluminum-based material onto the part surface so as not interfere with the deposition of said RE halide gases;

diffusing an aluminum-based material into said RE-enriched layer;

aluminizing said RE-enriched coating layer; and

forming an RE-doped aluminide coating.

14. The reactive-element (RE)-doped aluminide coating of claim 13, prepared by the process, further comprising forming the RE-enriched layer further comprises a thickness that is substantially uniform across the part surface as detected by optical microscopy or scanning electron microscopy.

15. The reactive-element (RE)-doped aluminide coating of claim 13, prepared by the process further comprising performing an electroplating to deposit a platinum group metal selected from platinum, palladium, iridium, and rhodium and any combination thereof, said deposition of the platinum group metal performed either prior to applying the RE donor slurry onto the part or after depositing the RE-enriched layer.

16. The reactive-element (RE)-doped aluminide coating of claim 13, prepared by the process, further comprising applying a ceramic thermal barrier coating over said RE-doped aluminide coating.

17. A reactive-element (RE)-doped platinum aluminide coating adapted for use as an improved bond coat for ceramic thermal barrier coatings, said bond coat prepared by a process, comprising the steps of:

depositing a platinum group metal selected from the group consisting of platinum, palladium, iridium, rhodium and any combination thereof;

providing a RE donor slurry comprising a RE donor and a halide activator;

applying said RE donor slurry onto the part surface;

heating the halide activator to generate a halide vapor;

reacting the halide vapor with said RE component contained in the donor slurry to produce RE halide gases;

transporting said RE halide gases with the part surface in the absence of a carrier gas;

depositing said RE onto the part surface; followed by

diffusing said RE into the part surface; and then

forming the RE-enriched layer onto the part;

removing the slurry residues from the RE-enriched layer;

depositing an aluminum-based material onto the part surface so as to not interfere with the deposition of said RE halide gases;

diffusing an aluminum-based material into said RE-enriched layer;

aluminizing said RE-enriched coating layer;

forming an RE-doped platinum aluminide coating; and

applying a ceramic thermal barrier coating over said RE-doped platinum aluminide coating.