CLAIMS

1. An aqueous slurry combination for the production of a multilayer coating system for hot corrosion protection of a substrate comprising:

a basecoat slurry, comprising:

a first binder comprising an aluminum phosphate based aqueous solution having a molar ratio of Al:P higher than 1:3, the first binder characterized by an absence of hexavalent chromium; and

metallic particles or a combination of metallic particles and metal oxide particles incorporated into the first binder;

a topcoat slurry, comprising:

a second binder comprising an aluminum phosphate based aqueous solution having a molar ratio of Al:P higher than 1:3, the second binder characterized by an absence of hexavalent chromium.

2. The aqueous slurry combination of claim 1, wherein the metal oxide particles are selected from the group consisting of aluminum oxide, titanium oxide, zirconium oxide, and chromium oxide.

3. The aqueous slurry combination of claim 1, wherein the metallic particles are selected from the group consisting of MCr, MAl, MCrAl, or MCrAlY alloys (where M=Ni, Co, Fe or a combination thereof).

4. The aqueous slurry combination of claim 1, wherein the metal oxide particles of the basecoat slurry comprise aluminum oxide (Al_2O_3) particles incorporated into said first binder, and the topcoat slurry comprises trivalent chromium oxide (Cr_2O_3) particles incorporated into said second binder.

5. The aqueous slurry combination of claim 1, wherein the molar ratio of Al:P in the second binder of the topcoat slurry ranges from 1:2.1 to 1:2.9, and the molar ratio of Al:P in the first binder of the basecoat slurry ranges from 1:2.1 to 1:2.9.

6. The aqueous slurry combination of claim 1, wherein the molar ratio of Al:P in the second binder of the topcoat slurry ranges from 1:2.4 to 1:2.7 and the molar ratio of Al:P in the first binder of the basecoat slurry ranges from 1:2.4 to 1:2.7.

7. The aqueous slurry combination of claim 1, wherein either metallic particles or metal oxide particles, or both in combination in basecoat slurry have a particle size distribution characterized in that a 50^{th} percentile of the particle size distribution has a diameter of between 1 to 10 microns.

8. The aqueous slurry combination of claim 1, wherein the topcoat slurry further comprises trivalent chromium oxide (Cr_2O_3) particles with a particle size distribution characterized in that a 50^{th} percentile of the particle size distribution has a diameter of between 1.0 and 2.0 microns and the 90^{th} percentile of the particle size distribution has a diameter of less than or equal to 3.0 microns.

9. An inorganic overlay coating system for hot corrosion protection of a substrate, comprising:

a basecoat comprising a first hexavalent chromium-free, aluminum-phosphate based binder having a molar ratio of Al:P higher than 1:3, and metallic particles or a combination of metallic particles and metal oxide particles embedded into the first aluminum-phosphate binder, and

a topcoat comprising a second hexavalent chromium-free, aluminum-phosphate based binder having a molar ratio of Al:P higher than 1:3.

10. The inorganic overlay coating system of claim 9, wherein the molar ratio of Al:P in the first hexavalent chromium-free, aluminum-phosphate based binder ranges from 1:2.1 to 1:2.9 and the molar ratio of Al:P in the second hexavalent chromium-free, aluminum-phosphate based binder ranges from 1:2.1 to 1:2.9.

11. The inorganic overlay coating system of claim 9, wherein the molar ratio of Al:P in the first hexavalent chromium-free, aluminum-phosphate based binder ranges from 1:2.4 to 1:2.7

and the molar ratio of Al:P in the second hexavalent chromium-free, aluminum-phosphate based binder ranges from 1:2.4 to 1:2.7.

12. The inorganic overlay coating system of claim 9, wherein the metal oxide particles are selected from the group consisting of aluminum oxide, titanium oxide, zirconium oxide, and chromium oxides.

13. The inorganic overlay coating system of claim 9, wherein the metallic particles are selected from the group consisting of MCr, MAl, MCrAl, or MCrAlY alloys (where M=Ni, Co, Fe or a combination thereof).

14. The inorganic overlay coating system of claim 9, wherein the metal oxide particles or metallic particles or both in combination have a particle size distribution characterized in that a 50^{th} percentile of the particle size distribution has a diameter of between 1 to 10 microns

15. The inorganic overlay coating system of claim 9, wherein the metal oxide particles are embedded or otherwise generally incorporated in the first ceramic matrix of the basecoat, said metal oxide particles comprising aluminum oxide Al_2O_3, and further wherein trivalent chromium oxide Cr_2O_3 particles are embedded or otherwise generally incorporated in the second ceramic matrix of the topcoat.

16. The inorganic overlay coating system of claim 9, wherein the topcoat comprises chromium oxide (Cr_2O_3) particles having a particle size distribution characterized in that a 50^{th} percentile of the particle size distribution has a diameter of between 1.0 and 2.0 microns and the 90^{th} percentile of the particle size distribution has a diameter of less than or equal to 3.0 microns.

17. A durable multilayer coating system for enhanced high-temperature oxidation and hot corrosion protection of a substrate, comprising:

a substrate;

a metallic bond coat on the said substrate;

an inorganic coating on the said metallic bond coat, said inorganic coating comprising:

a basecoat comprising a first hexavalent chromium-free, aluminum-phosphate based binder having a molar ratio of Al:P higher than 1:3, and metallic particles or a combination of metallic particles and metal oxide particles embedded into the first aluminum-phosphate binder, and

a topcoat comprising a second hexavalent chromium-free, aluminum-phosphate based binder having a molar ratio of Al:P higher than 1:3.

18. The multilayer coating system of claim 17, wherein the molar ratio of Al:P in the first hexavalent chromium-free, aluminum-phosphate based binder ranges from 1:2.1 to 1:2.9 and the molar ratio of Al:P in the second hexavalent chromium-free, aluminum-phosphate based binder ranges from 1:2.1 to 1:2.9.

19. The multilayer coating system of claim 17, wherein the molar ratio of Al:P in the first hexavalent chromium-free, aluminum-phosphate based binder ranges from 1:2.4 to 1:2.7 and the molar ratio of Al:P in the second hexavalent chromium-free, aluminum-phosphate based binder ranges from 1:2.4 to 1:2.7.

20. The multilayer coating system of claim 17, wherein the metal oxide particles are selected from the group consisting of aluminum oxide, titanium oxide, zirconium oxide, and chromium oxides.

21. The multilayer coating system of claim 17, wherein the metallic particles are selected from the group of MCr, MAl, MCrAl, or MCrAlY alloys (where M=Ni, Co, Fe or a combination thereof).

22. The multilayer coating system of claim 17, wherein the metal oxide particles or metallic particles or both in combination have a particle size distribution characterized in that a 50^{th} percentile of the particle size distribution has a diameter of between 1 to 10 microns

23. The multilayer coating system of claim 17, wherein the metal oxide particles are embedded or otherwise generally incorporated in the first ceramic matrix of the basecoat, said

metal oxide particles comprising aluminum oxide Al_2O_3, and further wherein trivalent chromium oxide Cr_2O_3 particles are embedded or otherwise generally incorporated in the second ceramic matrix of the topcoat.

24. The multilayer coating system of claim 17, wherein chromium oxide (Cr_2O_3) particles have a particle size distribution characterized in that a 50^{th} percentile of the particle size distribution has a diameter of between 1.0 and 2.0 microns and the 90^{th} percentile of the particle size distribution has a diameter of less than or equal to 3.0 microns.

25. The multilayer coating system of claim 17, wherein the metallic bond coat is selected from the group consisting of aluminide, chromium-rich coating, platinum aluminide, chromium aluminide, platinum-modified chrome, MCrAlY alloys (where M=Ni, Co, Fe or a combination thereof).