CLAIMS

1. An aqueous slurry composition 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 $Al:PO_4$ higher than about 1:3, the first binder characterized by an absence of hexavalent chromium; 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 $Al:PO_4$ higher than about 1:3, the second binder characterized by an absence of hexavalent chromium.

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

3. The aqueous slurry composition 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.

4. The aqueous slurry composition of claim 1, wherein the molar ratio of $Al:PO_4$ in the second binder of the topcoat slurry ranges from about 1:2.1 to about 1:2.8, and the molar ratio of $Al:PO_4$ in the first binder of the basecoat slurry ranges from about 1:2.1 to about 1:2.8.

5. The aqueous slurry composition of claim 1, wherein the molar ratio of $Al:PO_4$ in the second binder of the topcoat slurry ranges from about 1:2.4 to about 1:2.7 and the molar ratio of $Al:PO_4$ in the first binder of the basecoat slurry ranges from about 1:2.4 to about 1:2.7.

6. The aqueous slurry composition of claim 1, wherein the basecoat slurry comprises aluminum oxide Al_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 about 2.5 to 3.0 microns and a 90^{th} percentile of the particle size distribution has a diameter of between about 4.0 to about 4.5 microns.

7. The aqueous slurry composition 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 about 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 about 3.0 microns.

8. A multilayer coating system for hot corrosion protection of a substrate, comprising:

a substrate;

a basecoat on said substrate, said basecoat comprising:

a first ceramic matrix formed from a slurry comprising a first hexavalent chromium-free, aluminum-phosphate based binder, wherein said first hexavalent chromium-free, aluminum-phosphate based binder has a molar ratio of $Al:PO_4$ higher than about 1:3; and

metallic oxide particles embedded into the first ceramic matrix;

a topcoat, comprising:

a second ceramic matrix formed from a slurry comprising a second hexavalent chromium-free, aluminum-phosphate based binder, wherein said second hexavalent chromium-free, aluminum-phosphate based binder has a molar ratio of $Al:PO_4$ higher than about 1:3.

9. The multilayer coating system of claim 8, wherein the substrate is a nickel-based superalloy substrate.

10. The multilayer coating system of claim 8, 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.

11. The multilayer coating system of claim 8, wherein the molar ratio of $Al:PO_4$ in the first hexavalent chromium-free, aluminum-phosphate based binder ranges from about 1:2.1 to about 1:2.9 and the molar ratio of $Al:PO_4$ in the second hexavalent chromium-free, aluminum-phosphate based binder ranges from about 1:2.1 to about 1:2.9.

12. The multilayer coating system of claim 8, wherein the molar ratio of $Al:PO_4$ in the first hexavalent chromium-free, aluminum-phosphate based binder ranges from about 1:2.4 to about 1:2.7 and the molar ratio of $Al:PO_4$ in the second hexavalent chromium-free, aluminum-phosphate based binder ranges from about 1:2.4 to about 1:2.7.

13. The multilayer coating system of claim 8, wherein the metal oxide particles embedded or otherwise generally incorporated in the first ceramic matrix comprise aluminum oxide in a particle size distribution characterized in that a 50^{th} percentile of the particle size distribution has a diameter of between about 2.5 to 3.0 microns and a 90^{th} percentile of the particle size distribution has a diameter of between about 4.0 to about 4.5 microns.

14. The multilayer system of claim 8, wherein the topcoat further comprises trivalent chromium oxide Cr_2O_3 with a particle size distribution characterized in that a 50^{th} percentile of the particle size distribution has a diameter of between about 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 about 3.0 microns.

15. A method of preparing a multilayer coating system for hot corrosion protection of a substrate, comprising:

preparing surface of a metal substrate;

applying a basecoat slurry, said basecoat slurry comprising a first binder comprising an aluminum phosphate based aqueous solution having a molar ratio of $Al:PO_4$ higher than about 1:3, the first binder characterized by an absence of hexavalent chromium, and further wherein metal oxide particles are incorporated into the first binder;

curing the basecoat slurry to form a basecoat,

applying a topcoat slurry onto the basecoat, the topcoat slurry comprising a second binder comprising an aluminum phosphate based aqueous solution having a molar ratio of $Al:PO_4$ higher than about 1:3, the second binder characterized by an absence of hexavalent chromium; and

curing the topcoat slurry to form a topcoat.

16. The method of claim 15, further comprising:

incorporating aluminum oxide Al_2O_3 particles into the basecoat slurry; and

incorporating, particles of trivalent chromium oxide Cr_2O_3 into the topcoat slurry.

17. The method of claim 15 further comprising applying the basecoat slurry to form the basecoat at a thickness of between 0.5 to 3.0 mils.

18. The method of claim 15, further comprising applying the topcoat slurry to form the topcoat at a thickness of between 0.1 to 0.5 mils.

19. The method of claim 15, wherein the step of curing the basecoat slurry and the step of curing the topcoat slurry occurs in range of 600°F to 1000°F.