CLAIMS

1. A thermal emissivity coating composition comprising: a dry admixture of a set of emissivity agents including titanium dioxide, wherein a weight percentage of the titanium dioxide is less than approximately 22% by weight of the coating composition and at least approximately 10% by weight of the coating composition; and
a set of matrix strength enhancers including silicon carbide, wherein the silicon carbide is present in an amount ranging between about 8% to less than 30% by weight of the coating composition, and the emissivity agents and the matrix strength enhancers have a particle size of approximately 65 to 325-mesh.

2. The thermal emissivity coating composition of claim 1, wherein the set of emissivity agents includes in addition to titanium dioxide at least one emissivity agent selected from the group consisting of silicon carbide, chromium oxide, silicon dioxide, iron oxide, boron silicide, boron carbide, silicon tetraboride, molybdenum disilicide, tungsten disilicide, and zirconium diboride.

3. The thermal emissivity coating composition of claim 1, wherein the set of matrix strength enhancers includes in addition to silicon carbide at least one matrix strength enhancer selected from the group consisting of hafnium diboride, hafnium carbide, hafnium nitride, tantalum diboride, tantalum carbide, tantalum nitride, titanium diboride, titanium carbide, titanium nitride, zirconium diboride, zirconium carbide, and zirconium nitride.

4. The thermal emissivity coating composition of claim 1, further comprising at least one filler selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, calcium oxide, and boron oxide.

5. A thermal emissivity coating composition comprising a dry admixture of:
titanium dioxide in an amount of 13.9 to 27.8 % by weight of the coating composition;
aluminium oxide in an amount of 2.8 to 7.5 % by weight of the coating composition;
silicon carbide in an amount of 8.3 to 25 % by weight of the coating composition;

chromium oxide in an amount of 4.2 to 11.1 % by weight of the coating composition; and silicon dioxide in an amount of approximately 5.6 % by weight of the coating composition.

6. A thermal emissivity coating composition comprising:
an admixture of a set of emissivity agents including titanium dioxide, wherein a weight percentage of titanium dioxide is less than approximately 22% by weight of the coating composition and at least approximately 8% by weight of the coating composition;
a set of matrix strength enhancer including silicon carbide; and
a binder solution component comprising phosphoric acid,
wherein the silicon carbide is present in an amount less than 29.4 % by weight of the coating composition, wherein the emissivity agents and the matrix strength enhancers have a particle size of approximately 65 to 325-mesh.

7. The thermal emissivity coating composition of claim 6, further comprising about 2.08% to about 85.71% by weight on a dry basis filler selected from aluminum oxide, silicon dioxide, magnesium oxide, calcium oxide and boron oxide.

8. The thermal emissivity coating composition of claim 6, wherein the binder solution component is in an amount of 2 to 30 % by weight of the composition.

9. The thermal emissivity coating composition of claim 6, wherein the binder solution component comprises phosphoric acid in a concentration range of 10 to 20 v/v %.

10. The thermal emissivity coating composition of claim 6 has a bulk density in the range of 1.5 to 1.7 kg/L.

11. A thermal emissivity coating composition comprising a wet admixture of:
titanium dioxide in an amount of 10 to 40 % by weight of the coating composition;
aluminium oxide in an amount of 2 to 54 % by weight of the coating composition;
silicon carbide in an amount of 6 to 18 % by weight of the coating composition;
chromium oxide in an amount of 3 to 8 % by weight of the coating composition;

silicon dioxide in an amount of approximately 4 % by weight of the coating composition; and

a binder solution component in an amount of 2 to 28 % by weight of the coating composition, in which the solution component comprises phosphoric acid.

12. A method of preparing a thermal emissivity coating composition for a substrate, the method comprising:

obtaining titanium dioxide;

providing a set of emissivity agents including the titanium dioxide;

providing a set of matrix strength enhancers including silicon carbide;

providing a set of fillers, at least one filler selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, calcium oxide, and boron oxide;

providing a binder solution component comprising phosphoric acid; and combining the set of emissivity agents, the set of matrix strength enhancers, the set of fillers and the binder solution component, wherein the at least one filler comprises about 2 wt% to about 60 wt% on a wet basis of the coating composition and the titanium dioxide comprises less than approximately 22% by weight of the coating composition and at least approximately 8% by weight of the coating composition on a wet basis; and

the silicon carbide is present in an amount less than 29.4 % by weight of the coating composition on a wet basis; and the emissivity agents and the matrix strength enhancers have a particle size of 65 to 325-mesh.

13. The method of claim 12, wherein the thermal emissivity coating composition is prepared by:

providing a mixing container;

introducing predetermined amount of ceramic precursors, emissivity agents, and matrix strength enhancers into the mixing container;

stirring the ceramic precursors, the emissivity agents and the matrix strength enhancers in the mixing container;

adding at least one binder into the mixing container, in which the binder is an aqueous solution of phosphoric acid having concentration in the range from approximately 10 % to 20 % volume/volume;

stirring until uniform binder dispersion evidenced by residues no larger than about 250 micron is achieved; and

collecting the resultant coating composition from the mixing container;

wherein the ceramic precursors include a filler selected from the group consisting of aluminum oxide, silicon dioxide, magnesium oxide, calcium oxide, and boron oxide; and

the emissivity agents include titanium dioxide and an additional emissivity agent selected from silicon carbide, chromium oxide, silicon dioxide, iron oxide, boron silicide, boron carbide, silicon tetraboride, molybdenum disilicide, tungsten disilicide, and zirconium diboride;

the emissivity agents, the ceramic precursors and the matrix strength enhancers have a particle size of 65 to 325-mesh.

14. The method of claim 12, wherein the set of emissivity agents includes in addition to titanium dioxide at least one emissivity agent selected from the group consisting of silicon carbide, chromium oxide, silicon dioxide, iron oxide, boron silicide, boron carbide, silicon tetraboride, molybdenum disilicide, tungsten disilicide, and zirconium diboride.

15. The method of claim 12, wherein the set of matrix strength enhancers includes in addition to silicon carbide at least one matrix strength enhancer selected from the group consisting of hafnium diboride, hafnium carbide, hafnium nitride, tantalum diboride, tantalum carbide, tantalum nitride, zirconium diboride, zirconium carbide, and zirconium nitride.

16. The method of claim 12, wherein the binder solution component is in an amount of 2 to 30 % by weight of the composition.

17. The method of claim 12, wherein the binder solution component comprises phosphoric acid in a concentration range of 10 to 20 v/v %.

18. The method of claim 12, wherein the thermal emissivity coating has a bulk density in the range of 1.5 to 1.7 kg/L.

19. The method of claim 12, further comprising:
providing a substrate having a plurality of surfaces; and
applying the coating composition to at least one surface of the substrate with a sprayer.

20. The method of claim 12, wherein the substrate is selected from the group consisting of silica insulating brick, ceramic fiber, ceramic module, refractory brick, plastic refractory, castable refractory, refractory mortar, fiberlite, ceramic tiles, an array of fiber board, and metal and the substrate comprises a portion of a furnace, a fire heater, a ceramic automotive part, a refractory aerospace part, or a marine part.

21. The method of claim 20, wherein the furnace comprises a cracking furnace.