Claims

1. A method for depositing a protective coating on an aerospace component, comprising:

depositing a barrier layer on a surface of the aerospace component; and

depositing a catalytic oxidation layer comprising cerium on the barrier layer.

2. The method of claim 1, wherein the barrier layer comprises aluminum oxide, magnesium-doped aluminum oxide, dopants thereof, or any combination thereof.

3. The method of claim 1, wherein the barrier layer is deposited by an atomic layer deposition (ALD) process, and wherein the ALD process comprises sequentially exposing the aerospace component to an aluminum precursor and an oxidizing agent.

4. The method of claim 3, wherein the aluminum precursor comprises a tris(alkyl) aluminum, a tris(alkoxy) aluminum, aluminum diketonates, complexes thereof, abducts thereof, salts thereof, or any combination thereof, and wherein the oxidizing agent comprises water, ozone, oxygen (O_2), atomic oxygen, nitrous oxide, a peroxide, an alcohol, a plasma thereof, or any combination thereof.

5. The method of claim 1, wherein the barrier layer has a thickness of about 5 nm to about 250 nm.

6. The method of claim 1, wherein the catalytic oxidation layer comprises cerium oxide, zirconium oxide, calcium aluminum manganese oxide, barium yttrium manganese oxide, lanthanum rhodium manganese oxide, lutetium iron oxide, yttrium barium cobalt oxide, lanthanum oxide sulfate, dopants thereof, or any combination thereof.

7. The method of claim 1, wherein the catalytic oxidation layer comprises cerium oxide and a dopant, and wherein the dopant comprises gadolinium, manganese,

strontium, cobalt, copper, aluminum, alloys thereof, oxides thereof, or any combination thereof.

8. The method of claim 1, wherein the catalytic oxidation layer comprises cerium oxide deposited by an atomic layer deposition (ALD) process, wherein the ALD process comprises sequentially exposing the aerospace component to a cerium precursor and an oxidizing agent during an ALD cycle, and wherein the ALD process comprises repeating the ALD cycle until the catalytic oxidation layer has a thickness of about 10 nm to about 500 nm.

9. The method of claim 1, wherein the catalytic oxidation layer has a thickness of about 20 nm to about 100 nm.

10. The method of claim 8, wherein the cerium precursor comprises a cerium β-diketonate compound, a cerium cyclopentadienyl compound, a cerium alkoxide compound, a cerium amide compound, a cerium acetamidinate compound, an adduct thereof, or any combination thereof.

11. The method of claim 10, wherein the cerium precursor comprises a cerium β-diketonate compound, and wherein the cerium β-diketonate compound is $Ce(thd)_4$, $Ce(thd)_3$, $Ce(thd)_3(phen)$, an adduct thereof, or any combination thereof.

12. The method of claim 10, wherein the cerium precursor comprises a cerium cyclopentadienyl compound, and wherein the cerium cyclopentadienyl compound is $(Cp)_3Ce$, $(MeCp)_3Ce$, $(EtCp)_3Ce$, $(PrCp)_3Ce$, $(BuCp)_3Ce$, an adduct thereof, or any combination thereof.

13. The method of claim 10, wherein the cerium precursor comprises a cerium alkoxide compound, and wherein the cerium alkoxide compound is $Ce(mmp)_4$ (cerium tetra(1-methoxy-2-methyl-2-propanolate)), $Ce(dmap)_4$ (cerium tetra(1-

(dimethylamino)propan-2-olate)), $Ce(dmop)_4$ (cerium tetra(2-(4,4-dimethyl-4,5-dihydrooxazol-2-yl)propan-2-olate)), an adduct thereof, or any combination thereof.

14. The method of claim 10, wherein the cerium precursor comprises a cerium amide compound or a cerium acetamidinate compound, and wherein the cerium precursor is $(hmdsa)_3Ce$ or $(^{i}PrCp)_2Ce(N\text{-}^{i}Pr\text{-}amd)$.

15. The method of claim 1, wherein the aerospace component is a fuel nozzle, a combustor liner, a combustor shield, a heat exchanger, a fuel line, a fuel valve, or any combination thereof, wherein the protective coating is deposited on a surface of the aerospace component, and wherein the surface comprises nickel, nickel superalloy, stainless steel, cobalt, chromium, molybdenum, iron, titanium, alloys thereof, or any combination thereof.

16. The method of claim 1, wherein the protective coating is deposited on a surface of the aerospace component, wherein the surface is an interior surface of the aerospace component, and wherein the surface of the aerospace component has an aspect ratio of about 5 to about 1,000.

17. The method of claim 1, wherein the protective coating reduces or suppresses coke formation when the aerospace component is heated in the presence of a fuel.

18. The method of claim 1, wherein the protective coating has a thickness of about 10 nm to about 5,000 nm and a thickness variation of less than 5%.

19. A method for depositing a protective coating on an aerospace component, comprising:

depositing a catalytic oxidation layer comprising cerium oxide on a surface of the aerospace component by an atomic layer deposition (ALD) process, wherein:

the aerospace component is a fuel nozzle, a combustor liner, a combustor shield, a heat exchanger, a fuel line, a fuel valve, or any combination thereof;

the surface of the aerospace component is an interior surface of the aerospace component and has an aspect ratio of about 5 to about 1,000; and

the catalytic oxidation layer has a thickness of about 10 nm to about 500 nm.

20. An aerospace component, comprising:

a protective coating disposed on an interior surface of the aerospace component, wherein the protective coating comprises:

a barrier layer comprising aluminum oxide disposed on the interior surface of the aerospace component; and

a catalytic oxidation layer comprising cerium oxide disposed on the barrier layer.