CLAIMS

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

exposing an aerospace component to a first precursor and a first reactant to form a first deposited layer on a surface of the aerospace component by a chemical vapor deposition (CVD) process or a first atomic layer deposition (ALD) process;

exposing the aerospace component to a second precursor and a second reactant to form a second deposited layer on the first deposited layer by a second ALD process, wherein the first deposited layer and the second deposited layer have different compositions from each other, and wherein a nanolaminate film stack comprises the first deposited layer and the second deposited layer; and

annealing the aerospace component and converting the nanolaminate film stack into a coalesced film.

2. The method of claim 1, wherein the first deposited layer is formed by the first ALD process and the method further comprises sequentially exposing the aerospace component to the first precursor and the first reactant to form the first deposited layer.

3. The method of claim 2, wherein each cycle of the first ALD process comprises exposing the aerospace component to the first precursor, conducting a pump-purge, exposing the aerospace component to the first reactant, and conducting the pump-purge, and each cycle is repeated from 2 times to about 500 times to form the first deposited layer prior to forming the second deposited layer.

4. The method of claim 1, wherein the first deposited layer is formed by the CVD process and the method further comprises simultaneously exposing the aerospace component to the first precursor and the first reactant to form the first deposited layer.

5. The method of claim 1, wherein the first deposited layer comprises chromium oxide, chromium nitride, aluminum oxide, or aluminum nitride, wherein the second deposited layer comprises aluminum oxide, aluminum nitride, silicon oxide, silicon nitride, silicon carbide, yttrium oxide, yttrium nitride, yttrium silicon nitride, hafnium oxide, hafnium

nitride, hafnium silicide, hafnium silicate, titanium oxide, titanium nitride, titanium silicide, titanium silicate, or any combination thereof, and wherein if the first deposited layer comprises aluminum oxide or aluminum nitride, then the second deposited layer does not comprises aluminum oxide or aluminum nitride.

6. The method of claim 1, wherein the first precursor comprises a chromium precursor or an aluminum precursor, and the first reactant comprises an oxidizing agent, a nitriding agent, or a combination thereof.

7. The method of claim 1, wherein the second precursor comprises an aluminum precursor or a hafnium precursor, and the second reactant comprises an oxidizing agent, a nitriding agent, or a combination thereof.

8. The method of claim 1, wherein the first precursor comprises bis(cyclopentadiene) chromium, bis(pentamethylcyclopentadiene) chromium, bis(isoproplycyclopentadiene) chromium, bis(ethylbenzene) chromium, chromium hexacarbonyl, chromium acetylacetonate, chromium hexafluoroacetylacetonate, a chromium diazadienyl, isomers thereof, complexes thereof, abducts thereof, salts thereof, or any combination thereof.

9. The method of claim 1, wherein the first precursor or the second precursor comprises an aluminum precursor, and 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.

10. The method of claim 9, wherein the aluminum precursor comprises trimethylaluminum, triethylaluminum, tripropylaluminum, tributylaluminum, trimethoxyaluminum, triethoxyaluminum, tripropoxyaluminum, tributoxyaluminum, aluminum acetylacetonate, aluminum hexafluoroacetylacetonate, trisdipivaloylmethanatoaluminum, isomers thereof, complexes thereof, abducts thereof, salts thereof, or any combination thereof.

11. The method of claim 1, wherein the first precursor or the second precursor comprises a hafnium precursor, and wherein the hafnium precursor comprises bis(methylcyclopentadiene) dimethylhafnium, bis(methylcyclopentadiene) methylmethoxyhafnium, bis(cyclopentadiene) dimethylhafnium, tetra(tert-butoxy) hafnium, hafniumum isopropoxide, tetrakis(dimethylamino) hafnium (TDMAH), tetrakis(diethylamino) hafnium (TDEAH), tetrakis(ethylmethylamino) hafnium (TEMAH), isomers thereof, complexes thereof, abducts thereof, salts thereof, or any combination thereof.

12. The method of claim 1, wherein the method further comprises depositing from 2 pairs to about 1,000 pairs of the first deposited layer and the second deposited layer while increasing a thickness of the nanolaminate film stack.

13. The method of claim 1, wherein each of the first deposited layer and the second deposited layer independently has a thickness of about 0.1 nm to about 150 nm.

14. The method of claim 1, wherein the first deposited layer comprises aluminum oxide and the second deposited layer comprises hafnium oxide, and wherein a concentration of hafnium is about 0.01 at% to about 10 at% within the nanolaminate film stack.

15. The method of claim 1, wherein the nanolaminate film stack has a thickness of about 1 nm to about 5,000 nm.

16. The method of claim 1, wherein the aerospace component is a turbine blade, a turbine vane, a support member, a frame, a rib, a fin, a pin fin, a combustor fuel nozzle, a combustor shield, an internal cooling channel, or any combination thereof.

17. The method of claim 1, wherein the surface of the aerospace component is an interior surface of the aerospace component, and wherein the surface of the aerospace component comprises nickel, nickel superalloy, aluminum, chromium, iron, titanium, hafnium, alloys thereof, or any combination thereof.

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

forming a nanolaminate film stack on a surface of the aerospace component, wherein the nanolaminate film stack comprises alternating layers of a first deposited layer and a second deposited layer;

sequentially exposing the aerospace component to a first precursor and a first reactant to form the first deposited layer on the surface by atomic layer deposition, wherein the first deposited layer comprises chromium oxide, chromium nitride, aluminum oxide, aluminum nitride, or any combination thereof;

sequentially exposing the aerospace component to a second precursor and a second reactant to form the second deposited layer on the first deposited layer by atomic layer deposition, wherein the second deposited layer comprises aluminum oxide, aluminum nitride, silicon oxide, silicon nitride, silicon carbide, yttrium oxide, yttrium nitride, yttrium silicon nitride, hafnium oxide, hafnium nitride, hafnium silicide, hafnium silicate, titanium oxide, titanium nitride, titanium silicide, titanium silicate, or any combination thereof, and wherein the first deposited layer and the second deposited layer have different compositions from each other; and

annealing the aerospace component and converting the nanolaminate film stack into a coalesced film.

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

exposing an aerospace component to a first precursor and a first reactant to form a first deposited layer on the aerospace component by a chemical vapor deposition (CVD) process or a first atomic layer deposition (ALD) process;

exposing the aerospace component to a second precursor and a second reactant to form a second deposited layer on the first deposited layer by a second ALD process, wherein the first deposited layer and the second deposited layer have different compositions from each other, and wherein a nanolaminate film stack comprises the first deposited layer and the second deposited layer;

depositing from 2 pairs to about 500 pairs of the first deposited layer and the second deposited layer while increasing a thickness of the nanolaminate film stack; and

annealing the aerospace component and converting the nanolaminate film stack into a coalesced film.

20. The method of claim 19, wherein the coalesced film comprises a metal oxide and one or more dopants, and wherein the dopant comprises yttrium, hafnium, zirconium, strontium, lanthanum, neodymium, cerium, or any combination thereof.