CLAIMS:

1. A method of discriminating between, in a surface layer of an alloy comprising a transition metal, a first transition metal in a first oxidation state and a second transition metal in a second oxidation state different from the first oxidation state, the method comprising the step of:

(i) applying an oxidation state sensor molecule to the surface of the alloy, wherein the oxidation state sensor molecule is capable of selectively associating with the first transition metal, such that the distribution of the oxidation state sensor molecule on the surface can be used to discriminate between the first and second transition metals.

2. The method according to claim 1, wherein the alloy is part of an aircraft component.

3. The method according to claim 2, wherein the aircraft component is selected from a turbine blade, an engine casing and an aerofoil.

4. The method according to any one of claims 1 to 3, wherein the first oxidation state is greater than zero and the second oxidation state is zero.

5. The method according to any one of claims 1 to 4, wherein the oxidation state sensor molecule comprises an oxidation state discriminating group.

6. The method according to claim 5, wherein the oxidation state discriminating group comprises a Lewis base group, which Lewis base group is a heterocyclic group and comprises an atom selected from the group consisting of N, O and S.

7. The method according to claim 6, wherein the heterocyclic group is selected from a group consisting of pyrrole, imidazole, pyrazole, oxazole, thiaozle, pyridine, pyridazine, pyrimidine and pyrazine.

8. The method according to any one of claims 5 to 7, wherein the sensor comprises a plurality of oxidation state discriminating groups.

9. The method according to any one of the preceding claims, wherein the sensor further comprises a probe group for signalling a change in the coordination or environment of the sensor, and wherein the probe group comprises a luminescent or radioactive group.

10. The method according to claim 9, wherein the probe group comprises a fluorophore, preferably a fluorescein or a fluorescein derivative.

11. The method according to any one of the preceding claims, wherein the first transition metal is the second transition metal in a different oxidation state.

12. The method according to any one of the preceding claims, wherein the first transition metal is selected from the group consisting of Ni(II), Ni(III), Co(II), Co(III), Fe(II), Fe(III), Fe(V), Cu(I) and Cu(II).

13. The method according to any one of the preceding claims, wherein the second transition metal is selected from the group consisting of Ni(0), Co(0), Fe(0) and Cu(0).

14. The method according to any one of the preceding claims, wherein the alloy is a superalloy.

15. The method according to any one of the preceding claims, wherein the alloy is a single crystal metal alloy or a polycrystalline alloy.

16. The method according to any one of the preceding claims, wherein the sensor is applied to the surface as an aqueous solution.

17. The method according to any one of the preceding claims, the method further comprising the step of:

(ii) removing excess oxidation state sensor molecules from the surface of the alloy, preferably by washing the surface with a solvent or buffered solution.

18. The method according to any one of the preceding claims, further comprising the step of:

(iii) modifying the oxidation state sensor molecule on the surface of the alloy, preferably modified to include a probe group as defined in claim 9 or 10.

19. The method according to any one of the preceding claims, further comprising the step of:

(iv) detecting a signal from the sensor on the surface of the alloy, preferably by an imaging means.

20. The method according to any one of the preceding claims, further including the step of:

(v) removing the oxidation state sensor molecule from the alloy surface, preferably by washing the surface with an aqueous acid solution.

21. A method of discriminating between, in a surface layer of an alloy comprising a transition metal, a first transition metal in a first oxidation state and a second transition metal of a second oxidation state different from the first oxidation state, wherein an oxidation state sensor molecule is selectively associated with the first transition metal, the method comprising the step of:

(i) modifying the oxidation state sensor molecule on the surface of the alloy, such that the distribution of the modified oxidation state sensor molecule on the surface can be used to discriminate between the first and second transition metals.

22. A method of discriminating between, in a surface layer of an alloy comprising a transition metal, a first transition metal in a first oxidation state and a second transition metal of a second oxidation state different from the first oxidation state, wherein an oxidation state sensor molecule is selectively associated with the first transition metal, the method comprising the step of:

(i) detecting the oxidation state sensor molecule on the surface of the alloy, such that the distribution of the sensor is detected and can be used to discriminate between the first and second transition metals.

23. A method for discriminating between, in a surface layer of an alloy comprising a transition metal, a first transition metal in a first oxidation state, a second transition metal in a second oxidation state different from the first oxidation state and a third transition metal in a third oxidation state different from the first and second oxidation states, the method comprising the steps of:

(i) applying a first oxidation state sensor molecule to a first portion of the surface of the alloy,

wherein the first oxidation state sensor molecule is capable of selectively associating with the first transition metal, such the distribution of the first oxidation state sensor molecule can be used to discriminate between the first and second transition metals; the method further comprising the step of:

(ii) applying a second oxidation state sensor molecule to a second portion of the surface of the alloy,

wherein the second oxidation state sensor molecule is capable of selectively associating with the third transition metal, such the distribution of the second oxidation state sensor molecule can be used to discriminate between the first, second and third transition metals.

CLAIMS

1. A method of determining the distribution of degradation of a vehicle component previously exposed to degradation conditions during use, the vehicle component including a surface layer of an alloy comprising a first transition metal in a first oxidation state and a second transition metal in a second oxidation state different from the first oxidation state, wherein the first and second transition metals are the same or different transition metal elements, the method comprising the step of:

(i) applying to the surface layer of the vehicle component a first oxidation state sensor molecule that selectively binds to the first transition metal in the first oxidation state and not with the second transition metal in the second oxidation state, wherein the first oxidation state sensor molecule includes an oxidation state discriminating group and a probe group attached to the oxidation state discriminating group, such that the oxidation state discriminating group selectively binds to the first transition metal, and the probe group includes a luminescent or radioactive group effective to emit an observable signal; and

(ii) observing the surface of the alloy to determine the location of the first oxidation state sensor molecule associated with the first transition metal in the first oxidation state.

2. The method according to claim 1, wherein the first oxidation state is greater than zero and the second oxidation state is zero.

3. The method according to claim 1, wherein the sensor comprises a plurality of oxidation state discriminating groups.

4. The method according to claim 1, wherein the first transition metal element is the same as the second transition metal element.

5. The method according to claim 1, wherein the alloy is a superalloy.

6. The method according to claim 1, wherein the alloy is a single crystal metal alloy or a polycrystalline alloy.

7. The method according to claim 1, wherein the sensor is applied to the surface as an aqueous solution.

8. A method according to claim 1, wherein said surface layer of said alloy comprises a transition metal, a first transition metal in a first oxidation state, a second transition metal in a second oxidation state different from the first oxidation state and a third transition metal in a third oxidation state different from the first and second oxidation states, and wherein the method additionally comprises the step of: applying a second oxidation state sensor molecule to a second portion of the surface of the alloy, wherein the second oxidation state sensor molecule selectively binds to the third transition metal, such the distribution of the second oxidation state sensor molecule can be used to discriminate between the first, second and third transition metals.

9. The method according to claim 1, wherein the alloy is part of an aircraft component.

10. The method according to claim 9, wherein the aircraft component is selected from a turbine blade, an engine casing and an aerofoil.

11. The method according to claim 1, wherein the oxidation state discriminating group comprises a Lewis base group, which Lewis base group is a heterocyclic group and comprises an atom selected from the group consisting of N, O and S.

12. The method according to claim 11, wherein the heterocyclic group is selected from a group consisting of pyrrole, imidazole, pyrazole, oxazole, thiaozle, pyridine, pyridazine, pyrimidine and pyrazine.

13. The method according to claim 1, wherein the probe group comprises a fluorophore.

14. The method according to claim 13, wherein said fluorophore is a fluorescein or a fluorescein derivative.

15. The method according to claim 1, wherein the first transition metal is selected from the group consisting of Ni(II), Ni(III), Co(II), Co(III), Fe(II), Fe(III), Fe(V), Cu(I) and Cu(II).

16. The method according to claim 15, wherein the second transition metal is selected from the group consisting of Ni(0), Co(0), Fe(0) and Cu(0).

17. The method according to claim 1, the method further comprising the step of: (iii) removing excess oxidation state sensor molecules from the surface of the alloy.

18. The method according to claim 17, further comprising the step of:
(iv) observing a signal from the sensor on the surface of the alloy by an imaging means.

19. The method according to claim 18, further including the step of:
(v) removing the oxidation state sensor molecule from the alloy surface by washing the surface with an aqueous acid solution.

20. The method according to claim 17, wherein said modifying step modifies the surface of the alloy to include a probe group comprising a fluorophore.

21. A method of determining the distribution of degradation of a vehicle component previously exposed to degradation conditions during use, the vehicle component including a surface layer of an alloy comprising a first transition metal in a first oxidation state and a second transition metal in a second oxidation state different from the first oxidation state, wherein the first and transition metals are

the same or different transition metal elements, and wherein an oxidation state sensor molecule is selectively bound to the first transition metal, wherein the first oxidation state sensor molecule includes an oxidation state discriminating group that selectively binds to the first transition metal, the method comprising the step of:

(i) modifying the oxidation state sensor molecule on the surface of the alloy by attaching a probe group to the oxidation state discriminating group, the probe group including luminescent or radioactive group effective to emit an observable signal,

such that the distribution of the modified oxidation state sensor molecule on the surface can be used to discriminate between the first and second transition metals.

22. A method of determining the distribution of degradation of a vehicle component previously exposed to degradation conditions during use, the vehicle component including a surface layer comprising an alloy comprising a first transition metal in a first oxidation state and a second transition metal of a second oxidation state different from the first oxidation state, wherein the first and second transition metals are the same or different transition metal elements, and an oxidation state sensor molecule is selectively bound to the first transition metal, wherein the first oxidation state sensor molecule includes an oxidation state discriminating group and a probe group attached to the oxidation state discriminating group, such that the oxidation state discriminating group selectively binds to the first transition metal, and the probe group includes a luminescent or radioactive group effective to emit an observable signal, the method comprising the step of:

(i) observing the oxidation state sensor molecule on the surface of the alloy and using the distribution of the sensor molecule to discriminate between the first and second transition metals.