CLAIMS

1. A bipolar plate for a hydrogen fuel cell (e.g. a PEM hydrogen fuel cell), coated with a carbon-containing coating, the carbon-containing coating comprising in order:

a) a titanium seed layer;

b) a titanium nitride interfacial layer; and

c) a a-C top layer,

and wherein the coating has a thickness of less than 1.5µm and the bipolar plate is formed from stainless steel.

2. A bipolar plate according to claim 1, wherein the layer of a-C has a volumetric density of greater than 2.5 g/cm^3, for example greater than 3.0 g/cm^3, preferably 3.5 g/cm^3 or greater.

3. A coated bipolar plate according to any preceding claim, wherein the carbon-containing coating consists of in order:

a) a titanium seed layer;

b) a titanium nitride interfacial layer; and

c) a a-C top layer.

4. A bipolar plate according to any preceding claim, wherein the layer of a-C has a molar hydrogen content of 5% or less and/or a molar nitrogen content of 5% or less.

5. A bipolar plate according to any preceding claim, wherein the layer of a-C has an sp^2 carbon content of 50% to 80% (e.g. an average sp^2 carbon content of about 55%).

6. A bipolar plate according to any preceding claim, wherein the layer of a-C has an sp^3 carbon content of 30% to 60% (e.g. an average sp^3 carbon content of about 45%).

7. A bipolar plate according to any preceding claim, wherein the layer of a-C has a hardness of 1500HV to 2000HV.

8. A bipolar plate according to any preceding claim, wherein the carbon-containing coating comprises in order:

a) a titanium seed layer with a thickness of 0.5µm or less;

b) a titanium nitride interfacial layer with a thickness of 0.5µm or less; and

c) a a-C top layer with a thickness of 1.0µm or less,

and wherein the bipolar plate is formed from stainless steel and has a thickness of 0.5mm or less.

9. A bipolar plate according to any preceding claim, wherein the a-C layer has a molar hydrogen content of 5% or less, an sp^2 carbon content of 50% to 70%, and an sp^3 carbon content of 30% to 60%.

10. A bipolar plate for a hydrogen fuel cell, coated with a carbon-containing coating, the carbon-containing coating comprising in order:

a) a seed layer comprising a metal or alloy (e.g. titanium);

b) an interfacial layer comprising a carbide or nitride of the metal / alloy in the seed layer; and

c) a top layer comprising a-C (e.g. consisting of a-C);

wherein the a-C has a density of greater than 3.0g/cm^3, a molar hydrogen content of 5% or less, an sp^2 carbon content of 40% to 70%, and an sp^3 carbon content of 30% to 60%.

11. A bipolar plate according to claim 10, wherein the layer of a-C has a molar hydrogen content of 2% or less.

12. A bipolar plate according to any of claims 10 to 11, wherein the layer of a-C has an average sp^2 carbon content of about 55% and/or wherein the layer of a-C has an average sp^3 carbon content of about 45%.

13. A bipolar plate according to any of claims 10 to 12, wherein the bipolar plate is formed from stainless steel.

14. A bipolar plate according to any of claims 10 to 13, wherein the bipolar plate and seed layer are adjacent, the seed layer and interfacial layer are adjacent, and interfacial layer and top layer comprising a-C layer are adjacent.

15. A bipolar plate according to any of claims 10 to 14, wherein the carbon-containing coating comprises in order:

a) a seed layer comprising a metal or alloy with a thickness of 0.5µm or less;

b) an interfacial layer comprising a carbide or nitride of the metal / alloy in the seed layer with a thickness of 0.5µm or less; and

c) a top layer comprising a-C with a thickness of 1.0µm or less;

wherein the a-C has a density of greater than 2.0g/cm^3, a molar hydrogen content of 5% or less, an sp^2 carbon content of 40% to 80%, preferably 40% to 70% and an sp^3 carbon content of 20% to 60%, preferably 30% to 60%.

16. A hydrogen fuel cell comprising one or more bipolar plates according to any of claims 1 to 15.

17. A method of coating a bipolar plate for a PEM hydrogen fuel cell with a carbon-containing coating, the method comprising:

a) applying onto the plate a seed layer comprising a metal (e.g. titanium);

b) applying onto the seed layer an interfacial layer comprising a nitride or carbide of the metal; and

c) applying onto the interfacial layer a layer comprising a-C,

wherein the a-C has a density of greater than 3.0g/cm^3, a molar hydrogen content of 5% or less, an sp^2 carbon content of 40% to 80%, preferably 40% to 70% and an sp^3 carbon content of 20% to 60%, preferably 30% to 60%.

18. A method of coating a bipolar plate for a PEM hydrogen fuel cell with a carbon-containing coating according to any of claims 10 to 17, wherein the method comprises:

a) applying onto the plate a seed layer comprising a metal via a HIPIMS, DC pulse or metallic FCVA deposition process;

b) applying onto the seed layer an interfacial layer comprising a nitride or carbide of the metal via a sputtering process; and

c) applying onto the interfacial layer a layer comprising a-C via an FCVA process.

19. A method of coating a bipolar plate for a PEM hydrogen fuel cell according to claim 18, wherein the seed layer is titanium and the interfacial layer is titanium nitride.

20. A method of coating a bipolar plate for a PEM hydrogen fuel cell according to any of claims 17 to 19, for making a bipolar plate according to any of claims 1 - 15.