CLAIMS

1. A bipolar plate for a 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 and wherein the a-C layer has a density of greater than 2.5 g/cm^3.

2. A bipolar plate according to claim 1, 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.

3. A bipolar plate according to any of claims 1 or 2, 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.

4. A bipolar plate according to any of claims 1 to 3, wherein the layer of a-C has an sp^2 carbon content of 50% to 80%.

5. A bipolar plate according to any of claims 1 to 4, wherein the layer of a-C has an sp^3 carbon content of 30% to 60%.

6. A bipolar plate according to any of claims 1 to 5, wherein the layer of a-C has a hardness of 1500HV to 2000HV.

7. A bipolar plate according to any of claims 1 to 6, 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.

8. A bipolar plate according to any of claims 1 to 7, 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%.

9. 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;

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;

wherein the coating has a thickness of less than 1.5µm, and the a-C has a density of greater than 2.5 g/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%.

10. A bipolar plate according to claim 9, wherein the layer of a-C has a molar hydrogen content of 2% or less.

11. A bipolar plate according to any of claims 9 to 10, 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%.

12. A bipolar plate according to any of claims 9 to 11, wherein the bipolar plate is formed from stainless steel.

13. A bipolar plate according to any of claims 9 to 12, 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.

14. A bipolar plate according to any of claims 9 to 13, 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 2.5 .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%.

15. A hydrogen fuel cell comprising one or more bipolar plates according to any of claims 1 to 14.

16. 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;

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 coating has a thickness of less than 1.5µm, and the a-C has a density of greater than 2.5 g/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%.

17. A method of coating a bipolar plate for a PEM hydrogen fuel cell with a carbon-containing coating according to any of claims 9 to 16, 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.

18. A method of coating a bipolar plate for a PEM hydrogen fuel cell according to claim 17, wherein the seed layer is titanium and the interfacial layer is titanium nitride.

19. A method of coating a bipolar plate for a PEM hydrogen fuel cell according to any of claims 16 to 18, for making a bipolar plate according to any of claims 1 - 14.