Claims

1. A method for converting methane to methanol, comprising the steps of

   - providing a structure comprising:
     a multi-layer cathode having a backside and a front side, said cathode comprising the following layers in the following order from the backside towards the front side: a conductive metal layer, a wide-band gap layer, a cathodic conductive layer, an optional insulator layer, and a porous support layer incorporating catalytic transition metal centres, wherein the porous support material is a zeolite layer, a zeolite-like material or a carbonaceous material and wherein the transition metal atoms in said centres are pairwise bridged by an oxygen atom during operation;

     an anode positioned at a distance from and facing the cathode front side;

     a first node conductively connected to the cathodic conductive layer and a second node conductively connected to the anode;

   - applying a first bias voltage to the first node and a second bias voltage to the second node, generating hot electrons;

   - directing said hot electrons towards the porous support,

   - conveying a stream comprising methane to the porous support, and

   - recovering methanol from a stream leaving the porous support.

2. The method of claim 1, wherein the structure comprises an additional electric circuit comprising a node conductively connected to the backside conductive metal layer, and a negative bias voltage is applied to that node, causing the shuttling of holes, whereby that negative bias voltage is provided by a voltage source having a negative end connected to the backside conductive metal layer and a positive end connected to a ground potential or to the anode.

3. The method of claim 1 or 2, wherein the metal in the catalytic transition metal centres are Fe, Cu or mixtures of these.

4. The method of any preceding claim wherein the conductive metal layer is an aluminium layer.

5. The method of any preceding claim wherein wide-band-gap layer is a NiOx layer.

6. The method of any preceding claim wherein the cathodic conductive layer is a silicon or aluminium layer.

7. The method of any preceding claim wherein the optional insulator layer is a silicon dioxide or aluminium oxide layer.

8. The method of any of claims 1 to 7 wherein the porous support material layer comprises at least one material selected from the group consisting of carbon nanotubes, graphene and fullerenes.

9. The method of any preceding claim, wherein unreacted hydrocarbon is recovered from the stream leaving the porous support and recycled to the stream conveyed to the porous support.

10. The method of any preceding claim, wherein the structure further comprises at least one cathode terminal conductively connected to the cathode and at least one anode terminal conductively connected to the anode.

11. A device for converting methane to methanol, comprising

- a multi-layer cathode having a backside and a front side, said cathode comprising the following layers in the following order from the backside towards the front side: a conductive metal layer, a wide-band gap layer, a cathodic conductive layer, an optional insulator layer, and a porous support layer incorporating catalytic transition metal centres, wherein the porous support material layer is a zeolite layer, a zeolite-like material or a carbonaceous material and wherein the transition metal atoms in said centres are pairwise bridge by an oxygen atom;
- an anode positioned at a distance from and facing the cathode front-side;
- means for conveying a stream comprising a hydrocarbon to the porous support;
- means for recovering product from a stream leaving the porous support, and
- an electric circuit comprising at least one cathode terminal conductively connected to the cathodic conductive layer and at least one anode terminal conductively connected to the anode.

12. The device according to claim 11, further comprising an additional electric circuit comprising a node conductively connected to the conductive metal layer.

13. The device of any claim 11 to 12, wherein the metal in catalytic transition metal centres are Fe, Cu or mixtures of these.

14. The device of any claim 11 to 13, wherein the conductive metal layer is an aluminium layer.

15. The device of any claim 11 to 14 wherein the wide-band-gap layer is a NiOx layer.

16. The device of any claim 11 to 15, wherein the cathodic conductive layer is a silicon or aluminium layer.

17. The device of any claim 11 to 16, wherein the optional insulator layer is a silicon dioxide or aluminium oxide layer.

18. The device of any claim 11 to 17, wherein the porous support material layer comprises at least one material selected from the group consisting of carbon nanotubes, graphene and fullerenes.

19. The device of any claim 11 to 18, wherein the multi-layered cathode is planar.

20. The device of any claim 11 to 18, wherein the multi-layered cathode is cylindrical.