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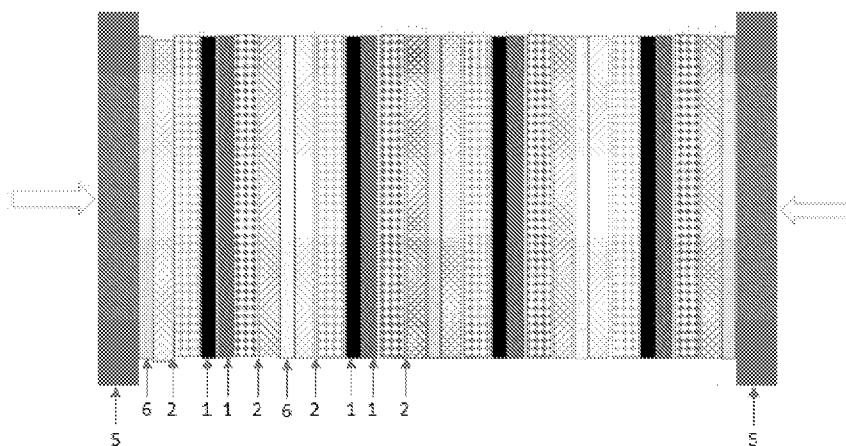


Fig. 3

(57) Abstract: The invention relates to a water electrolyzer and a manufacturing method for a water electrolyzer. The water electrolyzer includes a plurality of bonded plate units arranged in a first direction, each of the plurality of bonded plate units including at least one polar plate and at least one porous transportation layer arranged in the first direction. In each of the plurality of bonded plate units, each of the at least one polar plate is connected to one of the at least one porous transportation layer adjacent thereto through vacuum pressure diffusion bonding. The water electrolyzer and the manufacturing method of the invention have improved performance.



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WATER ELECTROLYZER AND MANUFACTURING METHOD FOR WATER ELECTROLYZER

TECHNICAL FIELD

[0001] The invention relates to the field of water electrolysis. In particular, the invention relates to a water electrolyzer and a manufacturing method for a water electrolyzer.

BACKGROUND

[0002] Hydrogen can be produced efficiently and at low cost from renewable energy source through water electrolysis. Proton exchange membrane electrolysis (PEMWE) is one of the technologies for water electrolysis, which is suitable for synergy with renewable energy power generation such as wind and solar energy, due to its short starting time and dynamic response to the power change. Fig. 1 shows a schematic structural view of a proton exchange membrane water electrolyzer in the prior art. The critical component of the proton exchange membrane water electrolyzer is an electrolysis stack, which is typically composed of a polar plate (BPP), a porous transportation layer (PTL) and a catalyst coated membrane (CCM, i.e., a proton exchange membrane coated with catalyst). The material for the polar plate must have good electric conductivity, and the material for the polar plate with flow channels requires good machining and forming ability. In addition, the material for the polar plate at the anode side also requires good corrosion resistance and oxidation resistance. The material for the polar plate at the anode side is usually titanium. The material for the porous transportation layer at the anode side is usually titanium and alloys thereof. The material for the porous transportation layer at the cathode side is usually porous carbon paper or stainless steel.

[0003] Oxidation may occur at the titanium material of the polar plate in contact with oxygen and water inside the PEMWE stack. The performance of the electrolyzer may be continuously reduced due to power loss of the electrical contact resistance between the polar plate and the porous transportation layer. In order to solve these problems and to protect the titanium plate, precious metal coatings and alloys are often used. The coatings can significantly reduce a corrosion rate, but further processing of the coatings, the precious metal material and

the expensive base material, i.e. titanium, make such polar plates very costly. The porous transportation layer at the anode side made of titanium or alloys thereof may also be oxidized on the contact surfaces between the polar plate and the porous transportation layer and between the porous transportation layer and the catalyst coated membrane. Due to increase of the surface oxidation, the power loss will increase with extension of the running time.

SUMMARY

[0004] In view of above, the technical problem to be solved by the invention is to provide an improved water electrolyzer and an improved manufacturing method for a water electrolyzer.

[0005] The above technical problem is solved by a water electrolyzer according to the invention. The water electrolyzer includes a plurality of bonded plate units arranged in a first direction, each of the plurality of bonded plate units including at least one polar plate and at least one porous transportation layer arranged in the first direction. In each of the plurality of bonded plate units, each of the at least one polar plate is connected to one of the at least one porous transportation layer adjacent thereto through vacuum pressure diffusion bonding. There is no significant interface between the two material layers connected together through vacuum pressure diffusion bonding, thereby effectively reducing power losses due to contact resistance between the different layers.

[0006] According to a preferable embodiment of the invention, the plurality of bonded plate units may include one or more of: at least one anode bonded plate unit including a polar plate as an anode plate and an anode-side porous transportation layer (2); at least one cathode bonded plate unit including a polar plate as a cathode plate and a cathode-side porous transportation layer; and at least one bipolar bonded plate unit including an anode-side porous transportation layer, a polar plate as an anode plate, a polar plate as a cathode plate and a cathode-side porous transportation layer arranged in order in the first direction.

[0007] According to another preferable embodiment of the invention, the polar plate as the anode plate and the polar plate as the cathode plate in each bipolar bonded plate unit may be connected to each other through vacuum pressure diffusion bonding. Alternatively, the polar plate as the anode plate and the polar plate as the cathode plate in each bipolar bonded plate

unit may also be formed integrally as a bipolar plate.

[0008] According to another preferable embodiment of the invention, a surface of the anode-side porous transportation layer facing away from the respective anode plate in each of the at least one anode bonded plate unit and/or the at least one bipolar bonded plate unit may be coated with a first conductive corrosion protection layer. The surface of the anode-side porous transportation layer facing away from the respective anode plate is used to contact with a respective catalyst coated membrane. Preferably, the first conductive corrosion protection layer may include or be made of a material capable of functioning as water splitting catalyst.

[0009] According to another preferable embodiment of the invention, a surface of the cathode-side porous transportation layer facing away from the respective cathode plate in each of the at least one cathode bonded plate unit and/or the at least one bipolar bonded plate unit may be coated with a second conductive corrosion protection layer. The surface of the cathode-side porous transportation layer facing away from the respective cathode plate is used to contact with a respective catalyst coated membrane. Preferably, the second conductive corrosion protection layer may include or be made of a material capable of functioning as hydrogen reduction catalyst.

[0010] According to another preferable embodiment of the invention, a surface of each of the plurality of bonded plate units may be nitrified. The nitride cover layer may improve corrosion resistance.

[0011] According to another preferable embodiment of the invention, the at least one polar plate and the at least one porous transportation layer in each of the plurality of bonded plate units may be coated with weld material for vacuum pressure diffusion bonding respectively.

[0012] The above technical problem is also solved by a manufacturing method for a water electrolyzer according to the invention. The water electrolyzer includes a plurality of bonded plate units arranged in a first direction, each of the plurality of bonded plate units including at least one polar plate and at least one porous transportation layer arranged in the first direction. The manufacturing method includes: in each of the plurality of bonded plate units, connecting each of the at least one polar plate to one of the at least one porous transportation layer adjacent thereto through vacuum pressure diffusion bonding. There is no

significant interface between the two material layers connected together through vacuum pressure diffusion bonding, thereby effectively reducing power losses due to contact resistance between the different layers.

[0013] According to a preferable embodiment of the invention, the manufacturing method may include arranging the plurality of bonded plate units between two end plates in the first direction, and, in the course of vacuum pressure diffusion bonding, applying pressure forces from the two end plates opposite to each other, such that each of the at least one polar plate is connected to one of the at least one porous transportation layer adjacent thereto in the respective bonded plate unit.

[0014] According to another preferable embodiment of the invention, the manufacturing method may further include: arranging one or more ceramic separator in such a way that, in the course of vacuum pressure diffusion bonding, a surface of each porous transportation layer facing away from the respective polar plate to be connected in the same bonded plate unit indirectly abuts, via a respective ceramic separator, an adjacent one of the two end plates or another porous transportation layer in the adjacent bonded plate unit, and removing the one or more ceramic separator from the plurality of bonded plate units after vacuum pressure diffusion bonding.

[0015] According to another preferable embodiment of the invention, the plurality of bonded plate units may include at least one bipolar bonded plate unit including an anode-side porous transportation layer, a polar plate as an anode plate, a polar plate as a cathode plate and a cathode-side porous transportation layer arranged in order in the first direction, and the manufacturing method may further include arranging the polar plate as the anode plate and the polar plate as the cathode plate in each bipolar bonded plate unit in contact with each other, and in the course of vacuum pressure diffusion bonding, connecting the polar plate as the anode plate and the polar plate as the cathode plate in each bipolar bonded plate unit to each other through vacuum pressure diffusion bonding.

[0016] According to another preferable embodiment of the invention, the manufacturing method may further include, prior to connecting through vacuum pressure diffusion bonding, spraying a powder on a surface of each porous transportation layer facing away from the respective polar plate to be connected in the same bonded plate unit, and, in the

course of vacuum pressure diffusion bonding, sintering the powder to form an conductive corrosion protection layer. The process of sintering and vacuum pressure diffusion bonding can thereby be carried out simultaneously.

[0017] According to another preferable embodiment of the invention, the manufacturing method may further include, in the course of vacuum pressure diffusion bonding, sintering a porous mesh to form at least one of the porous transportation layers of the plurality of bonded plate units. The process of sintering and vacuum pressure diffusion bonding can thereby be carried out simultaneously.

[0018] According to another preferable embodiment of the invention, the manufacturing method may further include, in the course of vacuum pressure diffusion bonding, introducing nitrogen gas to nitride a surface of the plurality of bonded plate units. The nitride cover layer may improve corrosion resistance.

[0019] According to another preferable embodiment of the invention, the manufacturing method may further include, prior to connecting through vacuum pressure diffusion bonding, coating the polar plate and the porous transportation layer in each of the plurality of bonded plate units with weld material, and, in the course of vacuum pressure diffusion bonding, connecting the polar plate and the porous transportation layer in each of the plurality of bonded plate units to each other via the weld material. The process of vacuum pressure diffusion bonding is easy to be achieved with respect to the weld material due to its fusibility.

BRIEF DESCRIPTION OF THE DRAWINGS

[0020] The invention is further described below in conjunction with the accompanying drawings. The elements with the same function are denoted by the same reference numeral throughout the drawings. In the drawings,

[0021] Fig. 1 shows a schematic view of a proton exchange membrane water electrolyzer in the prior art;

[0022] Fig. 2 shows a schematic view of bonded plate units of a water electrolyzer according to an exemplary embodiment of the invention during vacuum pressure diffusion bonding; and

[0023] Fig. 3 shows a schematic view of bonded plate units of a water electrolyzer according to another exemplary embodiment of the invention during vacuum pressure diffusion bonding.

DETAILED DESCRIPTION

[0024] Detailed embodiments of the water electrolyzer and manufacturing method for the water electrolyzer of the invention will be described below with reference to the accompanying drawings. The following detailed description and the accompanying drawings serve to exemplify the principles of the invention. The invention is not limited to the preferable embodiments described, and the scope of the invention is defined by the claims.

[0025] According to embodiments of the invention, a water electrolyzer is proposed. Water electrolyzers are used to electrolyze water to produce hydrogen and can thereby be used in fuel cells or other scenarios where hydrogen is required.

[0026] In an exemplary embodiment of the invention, the water electrolyzer includes a plurality of polar plates 1, a plurality of porous transportation layers 2 and one or more catalyst coated membranes 3. These structures are all substantially flat plate-like structures extending in parallel. The direction perpendicular to the extension planes of the structures (the left-right direction in the drawing) may be referred to as a first direction. The plate-like structures described above are thereby arranged in the first direction.

[0027] The amount of the polar plates 1 is the same as the amount of the porous transportation layers 2. Each of the polar plates 1 may have a flow channel formed therein for leading the product gas out (as shown in Fig. 2), or the polar plate 1 may have no flow channel and the flow channel can be provided by the adjacent porous transportation layer (as shown in Fig. 3). Each of the porous transportation layers 2 may have a structure formed by a single layer (as shown in Fig. 2) or a composite structure composed of multiple layers (as shown in Fig. 3). Each of the polar plates 1 abuts the corresponding porous transportation layer 2 in the first direction and is connected to the corresponding porous transportation layer 2 together through vacuum pressure diffusion bonding in order to form a bonded plate unit.

[0028] Every two bonded plate units adjacent in the first direction constitute a pair of electrodes, and one corresponding catalyst coated membrane 3 is arranged between each pair

of the electrodes. Each of the catalyst coated membranes 3 is a proton exchange membrane coated with catalyst 4 on both sides. Each of the one or more catalyst coated membrane 3 is arranged between two of the plurality of bonded plate units in the first direction. Thus, every two corresponding bonded plate units as well as the catalyst coated membrane 3 between them constitute an electrolyzer unit in which water can be electrolyzed. In each electrolyzer unit, the polar plates 1 of the two bonded plate units are located outermost. Two corresponding porous transportation layers 2 are located between the two polar plates 1, and in turn the catalyst coated membrane 3 is located between the two porous transportation layers 2. In other words, the porous transportation layer 2 of each bonded plate unit in each electrolyzer unit faces and contacts the respective catalyst coated membrane 3 in the first direction. The polarity (i.e., anode or cathode) of two bonded plate units in each electrolyzer unit are different. The polar plate 1 in each anode bonded plate unit is used as an anode plate, and the porous transportation layer 2 in each anode bonded plate unit is used as an anode-side porous transportation layer. Accordingly, the polar plate 1 in each cathode bonded plate unit is used as a cathode plate, and the porous transportation layer 2 in each cathode bonded plate unit is used as a cathode-side porous transportation layer. The anode bonded plate units and the cathode bonded plate units are alternately arranged in the first direction. Therefore, the anode bonded plate unit in each electrolyzer unit is adjacent to the respective cathode bonded plate unit in another electrolyzer unit adjacent thereto in the first direction (if there is an adjacent electrolyzer unit), and vice versa. In this arrangement, the anode plate of the anode bonded plate unit in an electrolyzer unit abuts the cathode plate of the cathode bonded plate unit in the adjacent electrolyzer unit (if there is an adjacent electrolyzer unit), and vice versa. The anode plate and the cathode plate abutting each other may be connected together or formed integrally as a bipolar plate, so that the two bonded plate units form a bipolar bonded plate unit. In each bipolar bonded plate unit, the anode-side porous transportation layer, the anode plate, the cathode plate and the cathode-side porous transportation layer are arranged in order in the first direction. If the anode plate and the cathode plate in a bipolar bonded plate unit are connected together, it is preferable to connect the anode plate and the cathode plate through vacuum pressure diffusion bonding as well.

[0029] Since the polar plate 1 and the porous transportation layer 2 in each bonded

plate unit are connected together through vacuum pressure diffusion bonding, the materials on the contact surfaces of the polar plate 1 and the porous transportation layer 2 are mutually infiltrated, thereby forming a unitary component, and as a result there is no significant interface or contact surface between the polar plate 1 and the porous transportation layer 2. This can suppress generation of an electric contact resistance at the interface, thereby reducing power losses caused by the electric contact resistance.

[0030] The polar plate 1 and the porous transportation layer 2 may be made of different materials. Preferably, the surface of the bonded plate unit may also be subjected to a coating process to prevent oxidation and corrosion. The coating may be carried out by means of physical vapor deposition, electroplating, spraying, etc. For example, the surface of the anode-side porous transportation layer 2 facing away from the respective anode plate in each of the anode bonded plate units and/or the bipolar bonded plate units (which contacts the anode side of the respective catalyst coated membrane 3) may be coated with a first conductive corrosion protection layer, and the first conductive corrosion protection layer is formed of, for example, iridium and its alloys, iridium and its alloy oxide, and carbide, platinum, gold, and so on. In addition, the first conductive corrosion protection layer preferably includes or is made of a material capable of functioning as water splitting catalyst, such as iridium and its alloys, iridium and its alloy oxide and carbide. Therefore, the first conductive corrosion protection layer can protect the surface of the anode-side porous transportation layer 2, and can further serve as water splitting catalyst.

[0031] In addition, in order to avoid electrochemical corrosion between the different metals of the porous transportation layers 2 and of the polar plates 1, high pressure cold spraying or vacuum plasma spraying of a titanium powder layer may be performed on the anode plates 1. The spray deposited titanium powder may be sintered in the course of bonding.

[0032] Similarly, the surface of the cathode-side porous transportation layer 2 facing away from the respective cathode plate in each of the cathode bonded plate units and/or the bipolar bonded plate units (which contacts the cathode side of the respective catalyst coated membrane 3) may be coated with a second conductive corrosion protection layer, and the second conductive corrosion protection layer is formed of, for example, platinum, gold, carbon, and so on. In addition, the second conductive corrosion protection layer preferably includes or

is made of a material capable of functioning as hydrogen reduction catalyst, such as platinum and so on. Therefore, the second conductive corrosion protection layer can protect the surface of the cathode-side porous transportation layer 2, and can further serve as hydrogen reduction catalyst.

[0033] Preferably, the surface of the bonded plate units may also be nitrided in order to further improve corrosion resistance. In addition, the porous transportation layer of the cathode side plate unit may also be provided with a carbon gas diffusion layer.

[0034] Preferably, the polar plate 1 and the porous transportation layer 2 in each of the plurality of bonded plate units may be coated with weld material for vacuum pressure diffusion bonding respectively. The weld material will be fused to achieve vacuum pressure diffusion bonding. The process of vacuum pressure diffusion bonding is easy to be achieved with respect to the weld material due to its fusibility.

[0035] According to embodiments of the invention, a manufacturing method for the aforesaid water electrolyzer is also proposed. As previously described, the water electrolyzer includes a plurality of bonded plate units arranged in the first direction, and each of the plurality of bonded plate units includes at least one polar plate and at least one porous transportation layer arranging in the first direction. In the manufacturing method, the polar plate and the respective porous transportation layer in each of the bonded plate units are connected to each other through vacuum pressure diffusion bonding. A preferable embodiment of the manufacturing method will be described below with reference to Figs. 2 and 3.

[0036] Figs. 2 and 3 shows a schematic view of a plurality of bonded plate units of a water electrolyzer according to different embodiments during vacuum pressure diffusion bonding. As described above, the difference between the bonded plate units in Fig. 2 and the bonded plate units in Fig. 3 is that the polar plates in Fig. 2 are formed with channels and the porous transportation layers in Fig. 3 have a composite structure composed of multiple layers. Despite of the above structural difference, the manufacturing method is applicable to both the embodiments in Figs. 2 and 3 in the same way.

[0037] As shown in Figs. 2 and 3, a plurality of bonded plate units, each of which includes at least one polar plate 1 and at least one porous transportation layer 2 to be connected through vacuum pressure diffusion bonding, are arranged in the first direction. Each polar plate

1 is arranged adjacent to the respective porous transportation layer 2 to be connected. All the bonded plate units to be connected may be arranged between two end plates 5 in the first direction, and pressure forces are then applied from the two end plates 5 opposite to each other respectively, under a high-temperature, high-pressure and vacuum condition, so that these bonded plate units are clamped between the two end plates 5 in the first direction and each polar plate 1 abuts the respective porous transportation layer 2.

[0038] All the components have been well cleaned before being fixed for bonding. The components arranged as shown are placed into a vacuum furnace and then are heated to a diffusion temperature above 600 °C (typically above 800 °C) and then are subjected to a pressure load to promote diffusion bonding. Under a condition of high temperature, high pressure and vacuum, the polar plate 1 and the porous transportation layer 2 in each bonded plate unit are subjected to vacuum pressure diffusion bonding. The end plates 5 will be removed from the bonded plate units after the polar plate 1 and the porous transportation layer 2 in each bonded plate unit are connected through vacuum pressure diffusion bonding. Then a plurality of bonded plate units are obtained and will be used to form a complete water electrolyzer together with other components such as the catalyst coated membranes 3 as shown in Fig. 1.

[0039] Preferably, one or more ceramic separator 6 may be arranged in such a way that, in the course of vacuum pressure diffusion bonding, a surface of each porous transportation layer 2 facing away from the respective polar plate 1 to be connected in the same bonded plate unit (that is, the surface used to contact the catalyst coated membrane 3 in the finished water electrolyzer) indirectly abuts, via a respective ceramic separator 6, an adjacent end plate 5 or another porous transportation layer 2 in the adjacent bonded plate unit. The ceramic separator 6 will not be bonded to the porous transportation layer 2 in contact and can be removed from the plurality of bonded plate units after vacuum pressure diffusion bonding. Then the catalyst coated membranes 3 may be arranged between the porous transportation layers 2 in the bonded plate units.

[0040] Preferably, if there is any bipolar bonded plate unit including a polar plate 1 as an anode plate and a polar plate 1 as a cathode plate to be connected to each other (as shown in Figs. 2 and 3 and described in the above embodiments), when the plurality of bonded plate units to be connected are arranged between the two end plates, the polar plate 1 as the anode

plate and the polar plate 1 as the cathode plate in each bipolar bonded plate unit may be arranged in contact with each other. Then, in the course of vacuum pressure diffusion bonding, the polar plate 1 as the anode plate and the polar plate 1 as the cathode plate in each bipolar bonded plate unit are connected to each other through vacuum pressure diffusion bonding.

[0041] Preferably, it is possible to spray a powder on a surface of each of the porous transportation layers 2 facing away from the respective polar plate 1 to be connected in the same bonded plate unit (that is, the surface used to contact the respective catalyst coated membrane 3) prior to connecting through vacuum pressure diffusion bonding, and, in the course of vacuum pressure diffusion bonding, sinter the powder to form a conductive corrosion protection layer. The conductive corrosion protection layer sintered here may include both the first conductive corrosion protection layer of the anode plate unit and the second conductive corrosion protection layer of the cathode plate unit. That is, both the first and second conductive corrosion protection layers may be sintered during vacuum pressure diffusion bonding.

[0042] Preferably, in the manufacturing method, if the porous transportation layer 2 has a sintered porous mesh such as a fiber sinter mesh, a woven sinter mesh and so on, the process of sintering the porous mesh may be combined with the process of vacuum pressure diffusion bonding. That is, it is also possible to sinter a porous mesh to form the porous transportation layer 2 of the bonded plate unit in the course of vacuum pressure diffusion bonding.

[0043] Preferably, in the manufacturing method, in the course of vacuum pressure diffusion bonding (in particular in a later period of the course of vacuum pressure diffusion bonding), nitrogen gas may also be introduced to form nitride on the surfaces of the bonded plate units in order to improve corrosion resistance.

[0044] Preferably, in the manufacturing method, prior to connecting through vacuum pressure diffusion bonding, the polar plate 1 and the porous transportation layer 2 in each of the plurality of bonded plate units may be coated with weld material. And then, in the course of vacuum pressure diffusion bonding, the polar plate 1 and the respective porous transportation layer 2 in each of the plurality of bonded plate units may be connected to each other via the weld material.

[0045] In contrast to the solution in the prior art where the polar plate is separate from

the porous transportation layer, the water electrolyzer and the manufacturing method for the same of the invention connect the polar plate and the porous transportation layer together through vacuum pressure diffusion bonding, thereby forming an integral component. There is no significant interface between the polar plate and the porous transportation layer in the bonded plate unit formed in this way, which suppresses generation of an electric contact resistance at the interface, thereby reducing power losses caused by the electric contact resistance. This allows efficiency of the water electrolyzer to be effectively improved.

[0046] Although possible embodiments have been described by way of example in the above description, it should be understood that, there are still a large number of example variations through a combination of all the known and furthermore readily conceivable technical features and embodiments to a person skilled in the art. It should also be understood that the exemplary embodiments are merely examples, and such embodiments never limit the scope, application, and construction of the invention in any way. The foregoing description is to provide a technical guidance for converting at least one exemplary embodiment to a person skilled in the art, and various changes may be made without departing from the protection scope of the claims, especially in the function and structure of the components.

LIST OF REFERENCE NUMERALS

- 1 polar
- 2 porous transportation layer
- 3 catalyst coated membrane
- 4 catalyst
- 5 end plate
- 6 ceramic separator

WHAT IS CLAIMED IS:

1. A water electrolyzer, comprising a plurality of bonded plate units arranged in a first direction, each of the plurality of bonded plate units comprising at least one polar plate (1) and at least one porous transportation layer (2) arranged in the first direction,

characterized in that

in each of the plurality of bonded plate units, each of the at least one polar plate (1) is connected to one of the at least one porous transportation layer (2) adjacent thereto through vacuum pressure diffusion bonding.

2. The water electrolyzer of claim 1, wherein the plurality of bonded plate units comprise one or more of:

at least one anode bonded plate unit comprising a polar plate (1) as an anode plate and an anode-side porous transportation layer;

at least one cathode bonded plate unit comprising a polar plate (1) as a cathode plate and a cathode-side porous transportation layer; and

at least one bipolar bonded plate unit comprising an anode-side porous transportation layer, a polar plate (1) as an anode plate, a polar plate (1) as a cathode plate and a cathode-side porous transportation layer arranged in order in the first direction.

3. The water electrolyzer of claim 2, wherein the polar plate (1) as the anode plate and the polar plate (1) as the cathode plate in each bipolar bonded plate unit are connected to each other through vacuum pressure diffusion bonding.

4. The water electrolyzer of claim 2, wherein the polar plate (1) as the anode plate and the polar plate (1) as the cathode plate in each bipolar bonded plate unit are formed integrally as a bipolar plate (1).

5. The water electrolyzer of claim 2, wherein a surface of the anode-side porous transportation layer (2) facing away from the respective anode plate in each of the at least one anode bonded plate unit and/or the at least one bipolar bonded plate unit is coated with a first conductive corrosion protection layer.

6. The water electrolyzer of claim 5, wherein the first conductive corrosion protection layer comprises or is made of a material capable of functioning as water splitting catalyst.

7. The water electrolyzer of claim 2, wherein a surface of the cathode-side porous transportation layer (2) facing away from the respective cathode plate in each of the at least one cathode bonded plate unit and/or the at least one bipolar bonded plate unit is coated with a second conductive corrosion protection layer.

8. The water electrolyzer of claim 7, wherein the second conductive corrosion protection layer comprises or is made of a material capable of functioning as hydrogen reduction catalyst.

9. The water electrolyzer of claim 1, wherein a surface of each of the plurality of bonded plate units is nitrided.

10. The water electrolyzer of any of claims 1 to 9, wherein the at least one polar plate (1) and the at least one porous transportation layer (2) in each of the plurality of bonded plate units are coated with weld material for vacuum pressure diffusion bonding respectively.

11. A manufacturing method for a water electrolyzer, the water electrolyzer comprising a plurality of bonded plate units arranged in a first direction, each of the plurality of bonded plate units comprising at least one polar plate (1) and at least one porous transportation layer (2) arranged in the first direction,

characterized in that the manufacturing method comprises:

in each of the plurality of bonded plate units, connecting each of the at least one polar plate (1) to one of the at least one porous transportation layer (2) adjacent thereto through vacuum pressure diffusion bonding.

12. The manufacturing method of claim 11, wherein the manufacturing method comprises arranging the plurality of bonded plate units between two end plates (5) in the first direction, and, in the course of vacuum pressure diffusion bonding, applying pressure forces from the two end plates (5) opposite to each other, such that each of the at least one polar plate (1) is connected to one of the at least one porous transportation layer (2) adjacent thereto in the respective bonded plate unit.

13. The manufacturing method of claim 12, wherein the manufacturing method further comprises:

arranging one or more ceramic separator (6) in such a way that, in the course of vacuum pressure diffusion bonding, a surface of each porous transportation layer (2) facing away from the respective polar plate (1) to be connected in the same bonded plate unit indirectly abuts, via a respective ceramic separator (6), an adjacent one of the two end plates (5) or another porous transportation layer (2) in the adjacent bonded plate unit, and

removing the one or more ceramic separator (6) from the plurality of bonded plate units after vacuum pressure diffusion bonding.

14. The manufacturing method of claim 13, wherein the plurality of bonded plate units comprise at least one bipolar bonded plate unit comprising an anode-side porous transportation layer (2), a polar plate (1) as an anode plate, a polar plate (1) as a cathode plate and a cathode-side porous transportation layer (2) arranged in order in the first direction, and the manufacturing method further comprises arranging the polar plate (1) as the anode plate and the polar plate (1) as the cathode plate in each bipolar bonded plate unit in contact with each other, and in the course of vacuum pressure diffusion bonding, connecting the polar plate (1) as the anode plate and the polar plate (1) as the cathode plate in each bipolar bonded plate unit to each other through vacuum pressure diffusion bonding.

15. The manufacturing method of claim 11, wherein the manufacturing method further comprising, prior to connecting through vacuum pressure diffusion bonding, spraying a powder on a surface of each porous transportation layer (2) facing away from the respective polar plate (1) to be connected in the same bonded plate unit, and, in the course of vacuum pressure diffusion bonding, sintering the powder to form an conductive corrosion protection layer.

16. The manufacturing method of claim 11, wherein the manufacturing method further comprises, in the course of vacuum pressure diffusion bonding, sintering a porous mesh to form at least one of the porous transportation layers (2) of the plurality of bonded plate units.

17. The manufacturing method of claim 11, wherein the manufacturing method further comprises, in the course of vacuum pressure diffusion bonding, introducing nitrogen gas to nitride a surface of the plurality of bonded plate units.

18. The manufacturing method of any of claims 11-17, wherein the manufacturing method further comprises, prior to connecting through vacuum pressure diffusion bonding, coating the polar plate (1) and the porous transportation layer (2) in each of the plurality of bonded plate units with weld material, and, in the course of vacuum pressure diffusion bonding, connecting the polar plate (1) and the porous transportation layer (2) in each of the plurality of bonded plate units to each other via the weld material.

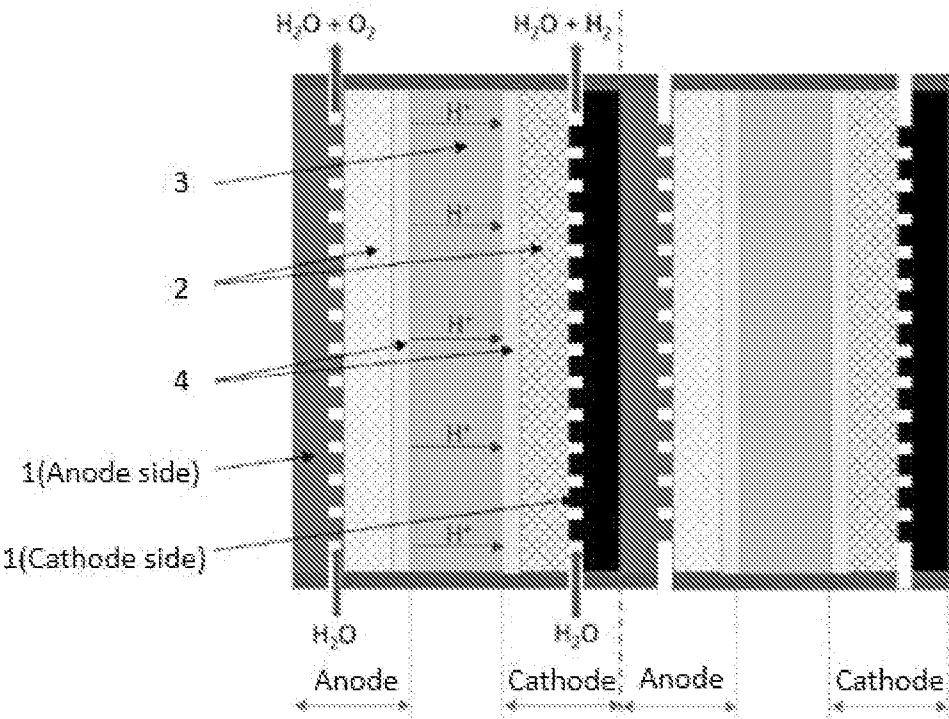


Fig.1

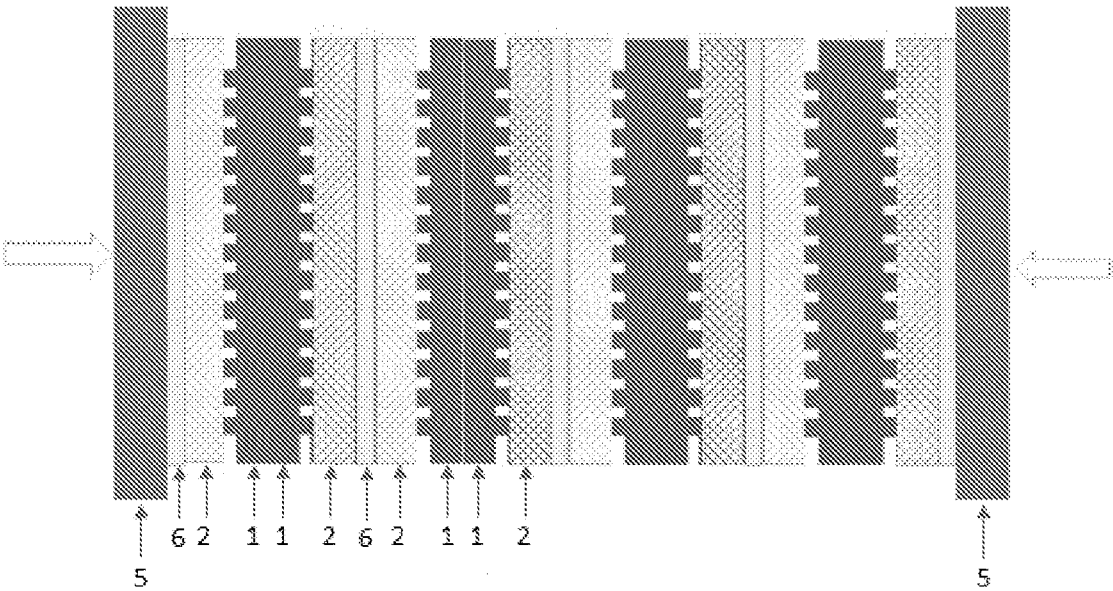


Fig. 2

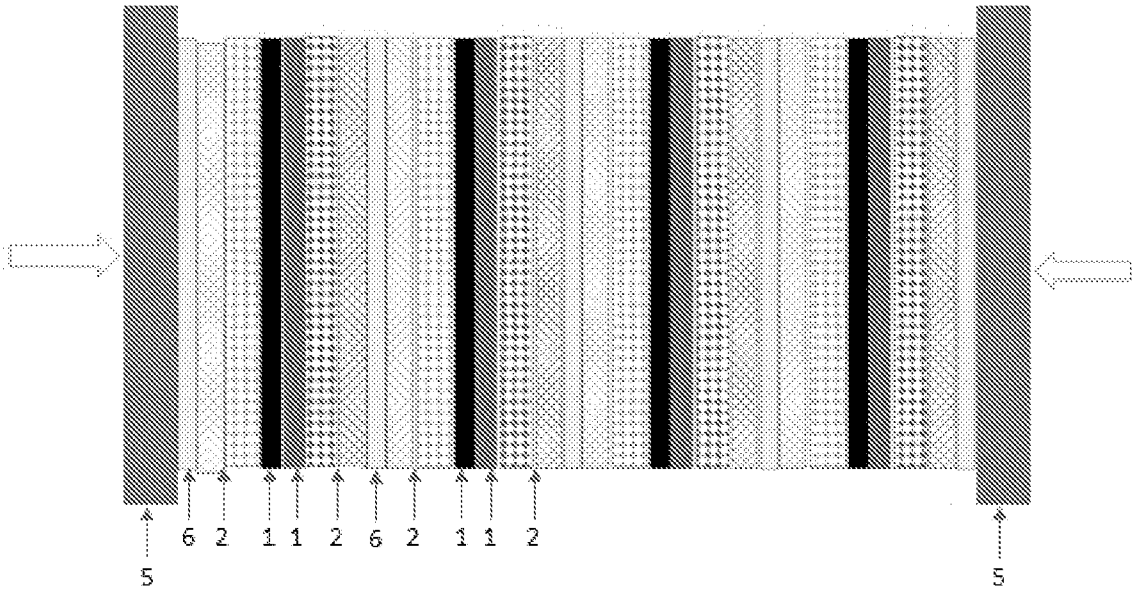


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/113758

A. CLASSIFICATION OF SUBJECT MATTER

C25B1/04(2021.01)i;H01M8/0206(2016.01)i

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: C25B,H01M

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

CNTXT, ENTXT, ENTXT, DWPI, CNKI: electrolyzer, electrolytic, plate, bipolar, layer, diffusion, vacuum, pressure, weld+, bond+, connect+, corrosion

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2021197718 A1 (FORSCHUNGSZENTRUM JUELICH GMBH) 07 October 2021 (2021-10-07) description, page 4 line 14 to page 15 line 6 and figures 1-10	1-3,10,11,16,18
Y	WO 2021197718 A1 (FORSCHUNGSZENTRUM JUELICH GMBH) 07 October 2021 (2021-10-07) description, page 4 line 14 to page 15 line 6 and figures 1-10	4-10,12-15,17,18
Y	KR 20180025275 A (ELCHEM TECH. CO., LTD.) 08 March 2018 (2018-03-08) description, paragraphs 0006-0015	4-10,15,17,18
X	WO 2022128510 A1 (FORSCHUNGSZENTRUM JUELICH GMBH) 23 June 2022 (2022-06-23) description, page 1 line 5 to page 17 line 3 and figures 1-4	1-3,10-14,16,18
Y	WO 2022128510 A1 (FORSCHUNGSZENTRUM JUELICH GMBH) 23 June 2022 (2022-06-23) description, page 1 line 5 to page 17 line 3 and figures 1-4	4-10,12-15,17,18



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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“P” document published prior to the international filing date but later than the priority date claimed

“T” later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

“X” document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

“Y” document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

“&” document member of the same patent family

Date of the actual completion of the international search

28 April 2023

Date of mailing of the international search report

10 May 2023

Name and mailing address of the ISA/CN

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/113758

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO 2022105960 A1 (SCHAEFFLER TECHNOLOGIES AG CO. KG) 27 May 2022 (2022-05-27) description, page 4 line 6 to page 10 line 15 and figures 1-7	1-18
Y	US 2011275006 A1 (HAWKES, JUSTIN R. et al.) 10 November 2011 (2011-11-10) description, paragraphs 0004-0025 and figure 1	1-18
Y	CN 109967987 A (HANGZHOU WEIKONG ENERGY SAVING TECHNOLOGY CO., LTD.) 05 July 2019 (2019-07-05) description, paragraphs 0005-0027 and figures 1-2	1-18

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2022/113758

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
WO	2021197718	A1	07 October 2021	EP	4128399	A1	08 February 2023
				DE	102020109430	A1	07 October 2021
KR	20180025275	A	08 March 2018	KR	101939666	B1	17 January 2019
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WO	2022105960	A1	27 May 2022	DE	102020130694	A1	25 May 2022
US	2011275006	A1	10 November 2011	US	8835074	B2	16 September 2014
				WO	2010085248	A1	29 July 2010
CN	109967987	A	05 July 2019	None			