

BIPOLAR PLATE STRUCTURE

Field Of Invention

The invention generally relates to a bipolar plate used in fuel cells. In particular, the invention relates to a bipolar plate structure for providing continuous flow of fluid through channels formed therein for improving efficiency of fuel cells.

Background

A fuel cell is an electrochemical device used for generating electricity, in which the oxidation of a fuel is utilised to produce electricity. Examples of fuels include hydrogen, hydrocarbons and alcohols. The fuel cell typically comprises several unit cells connected in series in the form of a stack, in which each unit cell comprises a pair of electrodes, namely a cathode and an anode, and an electrolyte disposed between a pair of bipolar plates. There are various types of electrolytes such as membranes, potassium hydroxide, phosphoric acid, alkali carbonates mixtures and Yttria stabilised Zirconia. The type of electrolyte selected for use in a fuel cell typically classifies the fuel cell type.

Generally, there are several fuel cell types such as alkaline fuel cells, molten carbonic fuel cells, solid-polymer fuel cells and direct methanol fuel cells. Despite the presence of various fuel cell types, the principle of operation of each fuel cell is similar. Generally, the principle of operation of fuel cells involves oxidation of fuel at the anode for generating electrons and protons, and reduction of an oxidant at the cathode for receiving the generated electrons and protons. However, the generated electrons and protons have different paths of travel from the anode the cathode. The protons pass through the electrolyte whereas the electrons typically travel from the anode to the cathode via an external circuit. Travel of electrons through the external circuit facilitates generation of electrical energy.

Typical fuel and oxidant used in the fuel cell is hydrogen and oxygen respectively. Hydrogen is supplied at the anode while oxygen is supplied at the cathode. When hydrogen comes into contact with the anode, it dissociates into hydrogen ions and electrons. The hydrogen ions pass through the electrolyte while the electrons travel

through the external circuit. Through a chemical or catalytic reaction, the hydrogen ions and electrons combine with oxygen at the cathode to form water as a by-product.

Each unit cell, which comprises the pair of electrodes and the electrolyte disposed
5 between the pair of bipolar plates, as previously mentioned, generally generates a relatively small voltage of about 0.7 to 1.0 volts after accounting for resistance losses. This small voltage is probably only enough for lighting up a light bulb. Hence, the fuel cell typically comprises multiple unit cells stacked together for generating a higher voltage. The number of unit cells needed in a fuel cell varies according to the
10 voltage required. The operating voltage of the fuel cell is a result of the voltage from one unit cell multiplied by the number of unit cells stacked together.

The current produced by each unit cell is approximately a linear function of the cross sectional area of the electrodes. However, the size of the electrodes cannot be
15 increased infinitely so as to increase the current being produced due to manufacturing and transportation constraints. The efficiency of a fuel cell, depending on its type and design, typically ranges from 40 percent to 60 percent. The fuel cell seems to be more efficient as compared to conventional power generation technologies such as gas turbines, internal combustion engines and steam turbines, which generate power at a
20 maximum efficiency of approximately 33 percent to 35 percent.

Despite fuel cells being substantially more efficient as compared to gas turbines, internal combustion engines and steam turbines, they are rarely used to replace these conventional power generation systems in the stationary power market or the
25 automotive sector. This is largely due to the high capital cost of fuel cells. Hence, cost reductions are vital to the implementation of fuel cells in society as the public will generally not easily accept and use technologies that are not economically advantageous.

30 The bipolar plates constitute a significant percentage of the capital cost of the fuel cell. Therefore advance in the development of bipolar plates is critical. The function of bipolar plates is to mainly to supply fuel or oxidant to the electrodes through reaction flow channels that are formed within the bipolar plates. The bipolar plates

are typically made of metals such as titanium and stainless steel, or carbon/graphite composites.

5 One method to reduce the cost of bipolar plates is through exploration of alternative materials that are of a lower cost as compared to present materials used. A method to increase cost efficiency of bipolar plates is to improve the efficiency of the bipolar plates, which increases the overall efficiency of fuel cells and thereby decreases the cost per kilowatt of a fuel cell system.

10 Presently, there are deficiencies in the structure of bipolar plates that reduces the overall efficiency of the fuel cell. For example, when hydrogen and oxygen are supplied to the anode and cathode respectively through the reaction flow channels, voids are inevitably created in the reaction flow channels during the oxidation of hydrogen and reduction of oxygen at the anode and the cathode respectively. Due to
15 the structure of existing bipolar plates, there is a difficulty in removing the voids created and therefore efficiency of the fuel cell is reduced as the voids reduce the total area that the gases (for example, hydrogen and oxygen) come into contact with the electrodes (for example, anode and cathode).

20 There is therefore a need for an improved bipolar plate structure for improving flow of fluid through channels formed therein for improving efficiency of fuel cells.

Summary

In accordance with a first aspect of the invention, a bipolar plate comprising a body
25 and a plurality of pillars is disclosed. Each of the plurality of pillars extends from the body and terminates at a free end. The plurality of pillars is inter-disposed and inter-configured for forming a plurality of channels, and each of the plurality of channels is defined by adjacently inter-disposed at least two of the plurality of pillars. The plurality of channels is inter-coupled such that a first at least two of the plurality of
30 channels is for communicating fluid between a second at least two of the plurality of channels. The free end of each of the plurality of pillars is abutable to a surface of an electrolyte electrode assembly to thereby dispose the plurality of pillars between the body and the electrolyte electrode assembly, and enclose and further define at least a

portion of the plurality of channels. When a fluid is introduced into at least a portion of the plurality of channels for contacting at least a portion of the surface of the electrolyte electrode assembly, a reaction occurs for one of generating charged particles and combining at least a portion of the charged particles. Furthermore, at least a portion of the plurality of pillars is for electrically conveying at least a portion of the charged particles between the body and the electrolyte electrode assembly.

In accordance with a second aspect of the invention, a fuel cell comprising an electrolyte electrode assembly and a pair of bipolar plates is disclosed. The electrolyte electrode assembly is disposed between the pair of bipolar plates. Furthermore, each of the bipolar plates comprises a body and a plurality of pillars. Each of the plurality of pillars extends from the body and terminates at a free end. The plurality of pillars is inter-disposed and inter-configured for forming a plurality of channels, and each of the plurality of channels is defined by adjacently inter-disposed at least two of the plurality of pillars. The plurality of channels is inter-coupled such that a first at least two of the plurality of channels is for communicating fluid between a second at least two of the plurality of channels. The free end of each of the plurality of pillars is abutable to a surface of the electrolyte electrode assembly to thereby dispose the plurality of pillars between the body and the electrolyte assembly, and enclose and further define at least a portion of the plurality of channels. When a fluid is introduced into at least a portion of the plurality of channels for contacting at least a portion of the surface of the electrolyte electrode assembly, a reaction occurs for one of generating charged particles and combining at least a portion of the charged particles. Furthermore, at least a portion of the plurality of pillars is for electrically conveying at least a portion of the charged particles between the body and the electrolyte electrode assembly.

In accordance with a third aspect of the invention, a bipolar plate comprising a body and a plurality of pillars is disclosed. The body comprises two outwardly opposing plate faces. The plurality of pillars extends from and corresponds to each of the two plate faces and each of the plurality of pillars terminates at a free end. The plurality of pillars is inter-disposed and inter-configured for forming a plurality of channels along each of the two plate faces. Further, each of the plurality of channels is defined by

adjacently inter-disposed at least two of the plurality of pillars, and the plurality of channels is inter-coupled such that a first at least two of the plurality of channels is for communicating fluid between a second at least two of the plurality of the channels. The bipolar plate is disposable between a first electrolyte electrode assembly and a second electrolyte electrode assembly for abutting the free end of each of the plurality of pillars with one of the first electrolyte electrode assembly and the second electrolyte electrode assembly, and enclose and further define at least a portion of the plurality of channels. When fluid is introduced into at least a portion of the plurality of channels for contacting at least one surface of at least one of the first electrolyte electrode assembly and the second electrolyte electrode assembly, the fluid reacts with the at least one surface for one of generating charged particles and combining at least a portion of the charged particles. Furthermore, at least a portion of the plurality of pillars is for electrically conveying at least a portion of the charged particles between the body and at least one of the first electrolyte electrode assembly and the second electrolyte electrode assembly.

Brief Description Of The Drawings

An embodiment of the invention is described hereinafter with reference to the following drawings, in which:

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FIG. 1 shows a partial front elevation of a bipolar plate according to embodiments of the present invention;

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FIG. 2 shows a partial front elevation of a second bipolar plate according to embodiments of the present invention;

FIG. 3 shows a partial front elevation of a hydrogen plate face of a bipolar plate according to embodiments of the present invention;

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FIG. 4 shows an isometric view of the hydrogen plate face of FIG. 3;

FIG. 5 shows an isometric view of pillars extending from the hydrogen plate face according to view "A" of FIG. 4;

FIG. 6 shows a partial front elevation of an oxygen plate face of the bipolar plate of FIG. 3;

FIG. 7 shows an isometric view of the oxygen plate face of FIG. 6; and

FIG. 8 shows an isometric view of pillars extending from the oxygen plate face according to view “B” of FIG. 7.

Detailed Description

10 Bipolar plates are typically used in fuel cells for creating channels through which hydrogen gas and oxygen gas are supplied to anodes and cathodes respectively. Chemical reactions occurring between the hydrogen gas and the anode, as well as between the oxygen gas and the cathode, typically create voids within the channels. Presence of voids within the channels reduces surface area for contact and reaction
15 between the gases and their respective electrodes. This reduction in surface area consequently reduces efficiency of a typical fuel cell. Therefore, it is apparent that improvements to structure of bipolar plates, and channels created thereby, are needed for reducing or even eliminating the creation of voids within the channels.

20 For purposes of brevity and clarity, the description of the invention is limited hereinafter to applications relating to bipolar plates used in fuel cells. This however does not preclude various embodiments of the invention from other applications where fundamental principals prevalent among the various embodiments of the invention such as operational, functional or performance characteristics are required.

25 Exemplary embodiments of the present invention are described hereinafter with reference to FIG 1 to FIG. 8, in which like elements are numbered with like reference numerals.

30 A bipolar plate structure (hereinafter known as a bipolar plate 10), as shown in FIG. 1, is provided in a first exemplary embodiment of the present invention. The bipolar plate 10 is preferably made of graphite composites. Bipolar plates 10 made from graphite composites are preferably substantially corrosion resistant. Alternatively, the

bipolar plate 10 is made of other materials including metals such as titanium and metal alloys.

5 The bipolar plate 10 comprises a body 12 and a number of pillars 14 extending from a plate face 16. The body 12 is preferably planar. The plate face 16 preferably comprises a central portion 18 that is substantially surrounded by a border 20. Preferably, the pillars 14 extend from the central portion 18 of the plate face 16. The border 20 is shaped and structured for locating a seal (not shown) thereto.

10 Each pillar 14 extending from the plate face 16 preferably terminates at a free end 22. Each pillar 14 further comprises a base 24, which is connected to the plate face 16, and a stem 26 for interconnecting the base 24 with the free end 22. Preferably, the cross-sectional area of the base 24 is larger than the cross-sectional areas of each of the stem 26 and the free end 22. The larger cross-sectional area of the base 24 is
15 preferably for securing or reinforcing the pillar 14 to the body 12 of the bipolar plate 10.

Preferably, the cross-sectional shape of the stem 26 is circular. Alternatively the cross-sectional shape of the stem 26 is rectilinear. Further alternatively, the cross-
20 section of the stem 26 has a different geometric shape. An end face is defined at the free end 22 of each pillar 14. Preferably, the end face is planar. Further preferably, the end face is substantially parallel the plate face 16. The end face can have a smooth surface. Alternatively, the surface of the end face is coarse or uneven.

25 The cross-sectional shape of the stem 26 preferably defines the shape and structure of the pillars 14. Therefore, the pillar 14 preferably has a truncated conical structure. Alternatively, the pillar 14 has a truncated pyramidal structure. Further alternatively, the pillar 14 has a different geometric structure.

30 The pillars 14 are inter-disposed and inter-configured for forming channels 28 through which fluid or air is able to flow. Each channel 28 is defined by at least two pillars 14 that are adjacently inter-disposed. Preferably, the shape and structure of the pillars 14 influences structure of the channels 28 defined thereby. The channels 28 are

preferably inter-coupled and inter-disposed for forming a grid. The channels 28 comprise an intake portion 30 and an exhaust portion 32, through which the fluid enters and leaves the channels 28 respectively.

- 5 The bipolar plate 10 further comprises a pair of conduits, namely an inlet conduit 34 and an outlet conduit 36, defined at the border 20 of the body 12. The inlet conduit 34 facilitates introduction of the fluid into the channels 28 via the intake portion 30 and the outlet conduit 36 facilitates exit of the fluid from the channels 28 via the exhaust portion 32. Preferably, the inlet conduit 34 is positioned for introducing fluid at an
10 angle to the grid of channels 28. Introduction of fluid at an angle to the grid of channels 28 preferably increases turbulence of the fluid as the fluid flows through the channels 28.

- The use of the pillars 14 for forming the channels 28 enables the fluid flowing
15 between the intake portion 30 and the exhaust portion 32 to travel between channels 28. This ability, coupled with the configuration of the pillars 14, result in the fluid travelling substantially about at least a portion of each of the pillars 14 that the fluid comes into contact with. Therefore, non-laminar flow characteristic is exhibited by the fluid when travelling along or across channels 28 and about the respective pillars 14,
20 resulting in the formation of vortices along the way. The vortices increase the flow rate across the surface of the pillars 14 to thereby improve heat transfer from the bipolar plate 10 to the fluid and consequently improve heat dissipation of the bipolar plate 10.

- 25 In a second exemplary embodiment of the present invention, a pair of bipolar plates, namely the bipolar plate 10 as described above and a second bipolar plate 50 as shown in FIG. 2, are provided. The bipolar plate 10 and the second bipolar plate 50 are used within a fuel cell, and are each connected to an electrolyte electrode assembly (EEA) (not shown). The bipolar plate 10, the second bipolar plate 50 and one EEA are
30 collectively known as a unit cell. Preferably, the EEA is disposed between the bipolar plate 10 and the second bipolar plate 50. The second bipolar plate 50 preferably has equivalent structural and functional features and configuration to those of the bipolar plate 10 of the first exemplary embodiment.

The EEA preferably comprises an anode, a cathode and an electrolyte. The electrolyte is disposed between the anode and the cathode. The anode and the cathode are preferably coated with a catalyst that includes, but is not limited to, platinum. The
 5 EEA further comprises a first carbon sheet and a second carbon sheet (both not shown). The first carbon sheet is disposed between the electrolyte and the cathode and the second carbon sheet is disposed between the electrolyte and the anode.

The electrolyte is preferably a static electrolyte. Alternatively, the electrolyte is a
 10 mobile electrolyte. A static electrolyte is one where the electrolyte is held in a matrix material and does not circulate, whereas a mobile electrolyte is one where the electrolyte is not held in a matrix material and is pumped around an external circuit. The electrolyte is preferably an ion exchange membrane. More preferably, the electrolyte or ion exchange membrane only allows positive ions to pass therethrough.

15 The free ends 22 of the pillars 14 of the bipolar plate 10 preferably abut the anode. Therefore, the pillars 14 of the bipolar plate 10, and the channels 28 formed thereby, are disposed between the body 12 of bipolar plate 10 and the anode. In a similar manner, free ends 52 of pillars 54 of the second bipolar plate 50 preferably abut the
 20 cathode. Therefore, the pillars 54 of the second bipolar plate 50, and channels 56 formed thereby, are disposed between the body 58 of the second bipolar plate 50 and the cathode.

Preferably, a gasket (not shown) extends along the border 20 of the bipolar plate 10
 25 for forming a fluid seal between the anode and the body 12 of the bipolar plate 10. Correspondingly, the gasket preferably extends along a border 60 of the second bipolar plate 50 for forming a fluid seal between the cathode and the body 58 of the second bipolar plate 50.

30 Preferably, the bipolar plate 10 is connected to the second bipolar plate 50 by means of an external circuit (not shown). The external circuit preferably comprises a load. Generally, the principle of operation of fuel cells involves oxidation of fuel (typically hydrogen gas) at the anode for generating negatively charged electrons and positively

charged protons, and reduction of an oxidant at the cathode for utilizing the generated electrons and protons. The fuel can also be air comprising hydrogen gas, hydrocarbons or alcohols. The electrons and protons generated at the anode take different paths of travel from the anode to the cathode. The generated protons pass
 5 through the electrolyte whereas the electrons travel through the external circuit and are harvestable for generating electrical energy.

Preferably, hydrogen gas is introduced into the intake portion 30 of the bipolar plate 10 via the input conduit 34. The hydrogen gas then flows within the channels 28
 10 formed by the pillars 14 of the bipolar plate 10. Direction of flow of the hydrogen gas within the channels 28 is determined by the inter-configuration or alignment of pillars 14 of the bipolar plate 10. In other words, the direction of flow of the hydrogen gas is determined by the grid pattern of the channels 28 of the bipolar plate 10.

15 When the hydrogen gas comes into contact with the anode, it dissociates into hydrogen ions (H^+) and electrons through a chemical reaction, also known as a catalytic reaction or an oxidation reaction (i.e. $H_2 \rightarrow 2H^+ + 2e^-$). The hydrogen ions (H^+) pass through the electrolyte to reach the cathode while the electrons travel through the external circuit to reach the cathode. The pillars 14 of the bipolar plate 10
 20 electrically convey the electrons generated at the anode to the body 12 of the bipolar plate 10 for further transmission through the external circuit.

Preferably, the pillars 14 of the bipolar plate 10 allow close placement thereof adjacent the anode. The close placement of adjacent pillars 14 substantially reduces
 25 travel distance of the electrons, which are generated at the anode, to the pillars 14. In addition, the close spacing of adjacent pillars 14 preferably increases surface area of contact between the free ends 22 and the anode. Further preferably, the close spacing of adjacent pillars 14 enhances heat dissipation.

30 Hydrogen gas that has not been dissociated (i.e. residual or unreacted hydrogen gas) exits the channels 28 of the bipolar plate 10 through the output conduit 36 via the exhaust portion 32.

The oxidant is introduced into an intake portion 62 of the second bipolar plate 50 via an input conduit 64. The oxidant is preferably air comprising oxygen gas. Alternatively, the oxidant is oxygen gas. The air flows within the channels 56 formed by the pillars 54 of the second bipolar plate 50. Direction of flow of the air within the channels 56 is determined by the inter-configuration or alignment of pillars 54 of the second bipolar plate 50. In other words, the direction of flow of the air within the channels 56 is determined by the grid pattern of the channels 56 of the second bipolar plate 50.

When air comes into contact with the cathode, another catalytic reaction, also known as a reduction reaction, occurs. The oxidant, preferably the oxygen gas within the air, combines with the electrons and the protons at the cathode to form a waste product. Preferably, the overall reaction equation for the reaction or combination of oxygen gas with hydrogen ions (H^+) and electrons is $2H^+ + 2e^- + 1/2O_2 \rightarrow H_2O$. Oxygen gas that does not combine with the hydrogen ions (H^+) and electrons (i.e. residual air with oxygen gas) exits the channels 56 of the second bipolar plate 50 through the output conduit 66 via an exhaust portion 68 of the second bipolar plate 50. The water that is formed through the catalytic or reduction reaction also exits the channels 56 of the second bipolar plate 50 through the output conduit 66 via the exhaust portion 68 of the second bipolar plate 50.

To reiterate, at the anode, hydrogen gas dissociates into hydrogen ions (H^+) and electrons. The hydrogen ions (H^+) pass through the electrolyte to reach the cathode while the electrons travel through the external circuit to reach the cathode. The hydrogen ions (H^+) and electrons then combine with the oxygen gas, which is supplied to the cathode, to form water as the waste product. Continuous dissociation of the hydrogen gas at the anode and continuous combination of the oxygen gas with hydrogen ions and electrons at the cathode result in a continuous flow of electrons from the anode to the cathode through the external circuit. The continuous flow of electrons through the external circuit enables production and harvesting of electrical energy.

In a typical fuel cell presently used, voids are often inevitably created within channels of conventional bipolar plates. The voids are typically created during both the dissociation of hydrogen gas at anode and the combination of oxygen gas with hydrogen ions (H^+) and electrons at the cathode. This creation and presence of voids within the channels of the conventional bipolar plates reduces the total surface area available for contact and reaction between the gases and their respective electrodes. Consequently, the reduction in the total surface area significantly reduces the efficiency of the typical fuel cell.

10 The bipolar plate 10 of the present invention improves the efficiency of fuel cells in so far as it decreases, or even eliminates, the formation of voids within the channels 28. More specifically, the shape and structure of the pillars 14 as well as the inter-configuration of the pillars 14 facilitate a continuous flow of fluid or gas through the channels 28 formed by the pillars 14. Likewise, the pillars 54 of the second bipolar
15 plate 50 are shaped and inter-configured for facilitating continuous flow of fluid or gas through the channels 56 formed thereby. The continuous flow of fluid or gas inhibits the creation of voids within the channels 28 and 56, thereby maximizing total surface area available for contact between the hydrogen gas and the anode, as well as between the oxygen gas and the cathode. Therefore, the bipolar plate 10 and the
20 second bipolar plate 50 of the present invention are able to significantly improve the efficiency of fuel cells.

Electrical energy generated by a single unit cell is typically relatively small. Therefore, fuel cells typically comprise multiple unit cells stacked together and used
25 in combination for generating an increased quantity of electrical energy.

In a third exemplary embodiment of the present invention, a bipolar plate 80 comprising two outwardly opposing plate faces as illustrated in FIG. 3 to FIG. 8 is provided. The two opposing plate faces are namely a hydrogen plate face 82a and an
30 oxygen plate face 82b. Each of the hydrogen plate face 82a and the oxygen plate face 82b share similar structural and functional characteristics to the plate face 16 of the bipolar plate 10 as previously described.

The bipolar plate 80 is disposed between two EEAs, namely a first EEA and a second EEA. Each EEA share similar structural and functional characteristics as previously described. Multiple bipolar plates 80, each disposed between two EEAs, are used in fuel cells for generating a required quantity of electrical energy.

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Pillars 84a extending from the hydrogen plate face 82a are preferably directly opposing pillars 84b extending from the oxygen plate face 82b. Further preferably, stems 86a of pillars 84a extending from the hydrogen plate face 82a and stems 86b of pillars 84b extending from the oxygen plate face 82b share a common cross-sectional shape. Alternatively, the stems 86a of pillars 84a extending from the hydrogen plate face 82a and the stems 86b of pillars 84b extending from the oxygen plate face 82b have different cross-sectional shapes. The cross-sectional shape of the stems 86a and 86b can be one of a circular, a rectilinear and an alternative geometrical shape.

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Preferably, the free ends 88a of the pillars 84a of the hydrogen plate face 82a abut with the anode of the first EEA and the free ends 88b of the pillars 84b of the oxygen plate face 82b abut with the cathode of the second EEA. The pillars 84a of the hydrogen plate face 82a forms channels 90a through which hydrogen gas flows. The pillars 84b of the oxygen plate face 82b forms channels 90b through which oxygen gas flows.

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Preferably, the pillars 84b extending from the oxygen plate face 90b has a longer stem 86b as compared to the pillars 84a extending from the hydrogen plate face 82a. The longer stem 86b of the pillars 84b extending from the oxygen plate face 82b increases surface area of contact and reaction between the oxygen gas and the cathode. The increased surface area also facilitates enhanced heat dissipation.

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Preferably the multiple bipolar plates 80 and EEAs are stacked in series and compressed. Hydrogen gas is introduced into the channels 90a formed by the pillars 84a extending from the hydrogen plate face 82a, and oxygen gas is introduced into the channels 90b formed by the pillars 84b extending from the oxygen plate face 82b. The introduction of hydrogen gas and oxygen gas into their appropriate channels (i.e. 90a and 90b respectively) is preferably effected simultaneously.

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As mentioned above, multiple bipolar plates 80, each disposed between two EEAs are used in fuel cells for generating electrical energy. Generally, increasing the number of bipolar plates 80 increases the quantity of electrical energy generated. This is because
5 increasing the number of bipolar plates 80 increases the number of channels 90a and 90b for flow of hydrogen gas and oxygen gas, and correspondingly the rate and quantity of chemical reactions between the hydrogen gas and the anode, as well as between the oxygen gas and the cathode as previously described.

10 In the foregoing manner, exemplary embodiments of a bipolar plate for facilitating continuous fluid flow within channels formed thereby are described with reference to the drawings. The bipolar plate can be used within fuel cells for enhancing the efficiency thereof. Although only exemplary embodiments of the invention are disclosed, the invention is not to be limited to specific forms or arrangements of parts
15 so described. It will be apparent to one skilled in the art in view of this disclosure that numerous changes and/or modification can be made without departing from the scope and spirit of the invention.

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Claims

1. A bipolar plate comprising:

a body; and

a plurality of pillars, each of the plurality of pillars extending from the body and terminating at a free end, the plurality of pillars being inter-disposed and inter-configured for forming a plurality of channels, each of the plurality of channels being defined by adjacently inter-disposed at least two of the plurality of pillars, the plurality of channels being inter-coupled such that a first at least two of the plurality of channels is for communicating fluid between a second at least two of the plurality of the channels, the free end of each of the plurality of pillars being abutable to a surface of an electrolyte electrode assembly to thereby dispose the plurality of pillars between the body and the electrolyte electrode assembly and enclose and further define at least a portion of the plurality of channels,

wherein when a fluid is introduced into at least a portion of the plurality of channels for contacting at least a portion of the surface of the electrolyte electrode assembly, a reaction occurs for one of generating charged particles and combining at least a portion of the charged particles, at least a portion of the plurality of pillars for electrically conveying at least a portion of the charged particles between the body and the electrolyte electrode assembly.

2. The bipolar plate as in claim 1, wherein the body comprises a plate face having a centre portion and a border bounding the centre portion, the plurality of pillars extending from the centre portion.

3. The bipolar plate as in claim 1, each of the plurality of pillars comprising:

a stem; and

a base being interposed between the stem and the body,

wherein the cross-sectional area of the base is larger than the cross-sectional area of the free end.

4. The bipolar plate as in claim 3, wherein the shape of the cross-section of the stem is at least one of circular and rectilinear.

5. The bipolar plate as in claim 3, wherein the stem tapers towards the free end.
6. The bipolar plate as in claim 1, wherein the free end comprises an end face being one of smooth and coarse.
- 5 7. The bipolar plate as in claim 1, wherein the plurality of channels is arranged in a grid fashion.
- 10 8. The bipolar plate as in claim 2, further comprising a plurality of conduits formed on the border portion of the body, each of the plurality of conduits being one of an inlet for introducing the fluid to at least one of the plurality of channels and an outlet for discharging at least a portion of the fluid from at least one of the plurality of channels.
- 15 9. The bipolar plate as in claim 2, wherein the border portion of the body is shaped for locating a gasket thereto, the gasket extending along the border portion for forming a fluid seal between the electrolyte electrode assembly and the body when disposed therebetween.
- 20 10. The bipolar plate as in claim 1, wherein the electrolyte electrode assembly comprises a cathode, an anode and an electrolyte, the electrolyte being disposed between the cathode and the anode.
- 25 11. The bipolar plate as in claim 10, wherein the electrolyte is one of a static electrolyte and a mobile electrolyte.
12. The bipolar plate as in claim 10, wherein the electrolyte is an ion exchange membrane.
- 30 13. The bipolar plate as in claim 10, wherein the electrolyte electrode assembly further comprises at least one carbon sheet being disposed between the electrolyte and each of the cathode and the anode.
14. A fuel cell comprising:

an electrolyte electrode assembly; and

a pair of bipolar plates, the electrolyte electrode assembly being disposed between the pair of bipolar plates, each of the bipolar plates comprising:

5 a body; and

a plurality of pillars, each of the plurality of pillars extending from the body and terminating at a free end, the plurality of pillars being inter-disposed and inter-configured for forming a plurality of channels, each of the plurality of channels being defined by adjacently inter-disposed at least two of the plurality of pillars, the plurality of channels being inter-coupled such that a first at least two of the plurality of channels is for communicating fluid between a second at least two of the plurality of the channels, the free end of each of the plurality of pillars being abutable to a surface of the electrolyte electrode assembly to thereby dispose the plurality of pillars between the body and the electrolyte electrode assembly and enclose and further define at least a portion of the plurality of channels,

wherein when a fluid is introduced into at least a portion of the plurality of channels for contacting at least a portion of the surface of the electrolyte electrode assembly, a reaction occurs for one of generating charged particles and combining at least a portion of the charged particles, at least a portion of the plurality of pillars for electrically conveying at least a portion of the charged particles between the body and the electrolyte electrode assembly.

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15. The fuel cell as in claim 14, wherein the body comprises a plate face having a centre portion and a border bounding the centre portion, the plurality of pillars extending from the centre portion.

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16. The fuel cell as in claim 14, each of the plurality of pillars comprising:
a stem; and
a base being interposed between the stem and the body,

wherein the cross-sectional area of the base is larger than the cross-sectional area of the free end.

17. The fuel cell as in claim 16, wherein the shape of the cross-section of the stem is at least one of circular and rectilinear.
18. The fuel cell as in claim 16, wherein the stem tapers towards the free end.
19. The fuel cell as in claim 14, wherein the free end comprises an end face being one of smooth and coarse.
20. The fuel cell as in claim 14, wherein the plurality of channels is arranged in a grid fashion.
21. The fuel cell as in claim 15, further comprising a plurality of conduits formed on the border portion of the body, each of the plurality of conduits being one of an inlet for introducing the fluid to at least one of the plurality of channels and an outlet for discharging at least a portion of the fluid from at least one of the plurality of channels.
22. The fuel cell as in claim 21, wherein the plurality of conduits on one of the pair of bipolar plates is aligned with the plurality of conduits on the other of the pair of bipolar plates to form a common manifold for fluid communication.
23. The fuel cell as in claim 15, wherein the border portion of the body is shaped for locating a gasket thereto, the gasket extending along the border portion for forming a fluid seal between the electrolyte electrode assembly and the body when disposed therebetween.
24. The fuel cell as in claim 14, wherein the electrolyte electrode assembly comprises a cathode, an anode and an electrolyte, the electrolyte being disposed between the cathode and the anode.

25. The fuel cell as in claim 24, wherein the electrolyte is one of a static electrolyte and a mobile electrolyte.

5 26. The fuel cell as in claim 24, wherein the electrolyte is an ion exchange membrane.

27. The fuel cell as in claim 24, wherein the electrolyte electrode assembly further comprises at least one carbon sheet being disposed between the electrolyte and each of the cathode and the anode.

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28. A bipolar plate comprising:

a body comprising two outwardly opposing plate faces; and

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a plurality of pillars extending from and corresponding to each of the two plate faces, each of the plurality of pillars terminates at a free end, the plurality of pillars being inter-disposed and inter-configured for forming a plurality of channels along each of the two plate faces, each of the plurality of channels being defined by adjacently inter-disposed at least two of the plurality of pillars, the plurality of channels being inter-coupled such that a first at least two of the plurality of channels is for communicating fluid between a second at least two of the plurality of the channels, the bipolar plate disposable between a first electrolyte electrode assembly and a second electrolyte electrode assembly for abutting the free end of each of the plurality of pillars with one of the first electrolyte electrode assembly and the second electrolyte electrode assembly to thereby dispose each of the plurality of pillars between the body and one of the first electrolyte electrode assembly and the second electrolyte electrode assembly and enclose and further define at least a portion of the plurality of channels,

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wherein when fluid is introduced into at least a portion of the plurality of channels for contacting at least one surface of at least one of the first electrolyte electrode assembly and the second electrolyte electrode assembly, the fluid reacts with the at least one surface for one of generating charged particles and combining at least a portion of the charged particles, at least a portion of the plurality of pillars for electrically conveying at least a portion of

the charged particles between the body and at least one of the first electrolyte electrode assembly and the second electrolyte electrode assembly.

29. The bipolar plate as in claim 28, each of the plate faces comprising:
5 a centre portion; and
 a border bounding the centre portion,
 wherein the plurality of pillars extends from the centre portion.
30. The bipolar plate as in claim 28, each of the plurality of pillars comprising:
10 a stem; and
 a base being interposed between the stem and the body,
 wherein the cross-sectional area of the base is larger than the cross-sectional area of the free end.
31. The bipolar plate as in claim 30, wherein the shape of the cross-section of the
15 stem is at least one of circular and rectilinear.
32. The bipolar plate as in claim 30, wherein the stem tapers towards the free end.
33. The bipolar plate as in claim 28, wherein the free end comprises an end face
20 being one of smooth and coarse.
34. The bipolar plate as in claim 28, wherein the plurality of channels is arranged
 in a grid fashion.
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35. The bipolar plate as in claim 29, further comprising a plurality of conduits
 formed on the border portion of the first and second face, each of the plurality
 of conduits being one of an inlet for introducing the fluid to at least one of the
 plurality of channels and an outlet for discharging at least a portion of the fluid
30 from at least one of the plurality of channels.
36. The bipolar plate as in claim 29, wherein the border portion of the first and
 second face is shaped for locating a gasket thereto, the gasket extending along

the border portion for forming a fluid seal between one of the first electrolyte electrode assembly and the first face and the second electrolyte electrode assembly and the second face when disposed therebetween.

5 37. The bipolar plate as in claim 28, wherein the electrolyte electrode assembly comprises a cathode, an anode and an electrolyte, the electrolyte being disposed between the cathode and the anode.

10 38. The bipolar plate as in claim 37, wherein the electrolyte is one of a static electrolyte and a mobile electrolyte.

39. The bipolar plate as in claim 37, wherein the electrolyte is an ion exchange membrane.

15 40. The bipolar plate as in claim 37, wherein the electrolyte electrode assembly further comprises at least one carbon sheet being disposed between the electrolyte and each of the cathode and the anode.

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