

PORTABLE FUEL CELL SYSTEMS AND METHODS THEREFOR

5 PRIORITY OF INVENTION

This non-provisional application claims the benefit of priority under 35 U.S.C. § 119(e) to U.S. Provisional Patent Application Serial No. 60/757,750, filed January 9, 2006, which is herein incorporated by reference in its entirety.

10 TECHNICAL FIELD

This patent document pertains generally to fuel cells, and more particularly, but not by way of limitation, to a portable or micro-fuel cell system and methods therefor.

15 BACKGROUND

A fuel cell is an electrochemical energy conversion device that utilizes the reaction of fuel and oxygen to produce electricity. Fuel cells operate continuously as long as fuel is present. When hydrogen is used as the fuel, the only by-product is water vapor. The conversion reaction of the fuel cell occurs electrochemically and the energy is released as a combination of electrical energy and heat. The electrical energy can do useful work directly, while the heat can be dispersed.

Portable electrical devices, such as cellular phones and laptop computers (among others), demand a significant amount of electricity to operate. The primary and optionally secondary batteries that currently provide power to these devices are reaching performance limitations. As such, it is likely that battery sources may not be able to provide the necessary power to future portable devices, which will likely require even greater electrical power needs. Fuel cells are a viable alternative power source to traditional batteries, but are currently limited by their relatively large size, low energy density levels and insufficient power output. These drawbacks of current fuel cells are the result of, among other things, the awkward integration of current fuel cell components and positioning requirements in electrical devices.

It is with this recognition of the foregoing state of the technology that the present subject matter providing a portable fuel cell system that is able to maintain a high energy density and provide sufficient power output within an all-inclusive system has been conceived and is now set forth in the text and drawings associated with this patent document

SUMMARY

Embodiments of the present subject relate to a fuel cell system. According to one aspect of the present invention,, the fuel cell system includes at least one fuel cell or fuel cell layer including an anode, a cathode, and an electrolyte interposed therebetween, a fuel or a fuel storage material; a fuel reservoir including at least one surface positioned adjacent a first portion of the at least one fuel cell or fuel cell layer in which the fuel reservoir is configured to store the fuel or the fuel storage material; a current collecting circuit contacting a second portion of the at least one fuel cell or fuel cell layer in which the current collecting circuit is configured to receive and distribute current generated by the fuel cell or fuel cell layer, and a fuel plenum interposed between the at least one reservoir surface and the first portion of the at least one fuel cell or fuel cell layer.

According to another aspect, there is provided a fuel cell system comprising: a fuel reservoir configured to store a fuel therein; a system cover attachable with one or more portions of the fuel reservoir; an enclosed region formed by the attachment of the fuel reservoir with the system cover; and at least one fuel cell disposed in the enclosed region, each fuel cell including one or more flexible walls structurally arranged such that a reactant plenum is formed in a region between a portion of the fuel reservoir and at least one of the flexible walls; wherein the one or more flexible walls are supported by a portion of one or both of the fuel reservoir or the system cover.

According to yet another aspect, there is provided a method of fabricating a fuel cell system, the method comprising: forming a fuel reservoir configured to store fuel therein; forming a system cover having one or more air access ports; coupling the system cover with one or more portions of the fuel reservoir, including forming an enclosed region; and disposing at least one fuel cell in the enclosed region, including arranging one or more flexible fuel cell walls to form at least one reactant plenum in a region between a portion of the fuel reservoir and at least one of the flexible fuel cell walls; wherein forming the fuel reservoir and the system cover includes forming a support for the one or more flexible fuel cell walls.

According to still another aspect, there is provided a fuel cell system providing portable power, the system comprising a fuel cell assembly, including at least one fuel cell including an anode on a first surface, a cathode on a second surface, and an electrolyte interposed therebetween, a protective porous member positioned near the fuel cell second surface; a current collecting circuit configured to receive and distribute power generated by the at least one fuel cell; a hydrogen reservoir including a surface positioned adjacent the fuel cell

first surface, the hydrogen reservoir configured to store hydrogen fuel; a fuel plenum interposed between the hydrogen reservoir and the fuel cell first surface; and a system cover including at least one air access port, the system cover sized and shaped to house one or more of the protective porous member, the current collector circuit, the at least one fuel cell, the fuel plenum, or a portion of the hydrogen reservoir, wherein a fuel pressure in the plenum and a cover-generated pressure urge contact between the at least one fuel cell and the current collecting circuit.

In an example embodiment, the fuel cell system includes a fuel reservoir, a system cover, an enclosed region, and at least one fuel cell. The fuel reservoir is configured to store fuel or a fuel storage material. The system cover is configured to be attachable with the fuel reservoir, thereby forming an enclosed region therein. The at least one fuel cell includes one or more flexible walls comprising an anode or a cathode of the fuel cell. The flexible walls are structurally arranged to form a reactant plenum and are supported, when pressurized, by a portion of one or both of the fuel reservoir or the system cover.

Embodiments of the present subject matter also relate to methods of fabricating a fuel cell system. According to another aspect of the present invention, the method includes forming a fuel cell or a fuel cell layer, coupling a fuel reservoir with a first portion of the fuel cell or fuel cell layer such that a fuel plenum is formed therebetween, disposing a current collecting

circuit adjacent to a second portion of the fuel cell or fuel cell layer, disposing a system cover having at least one air access port over one or more of the current collecting circuit, the fuel cell or fuel cell layer, or a portion of the fuel reservoir, including positioning the at least one air access port near the second portion of the fuel cell or the fuel cell layer; and coupling the system cover with the fuel reservoir.

In an example embodiment, the method includes forming a fuel reservoir configured to store fuel therein; forming a system cover, coupling the system cover with a portion of the fuel reservoir including forming an enclosed region; and disposing at least one fuel cell in the enclosed region including arranging one or more flexible fuel cell walls to form at least one reactant plenum. In various examples, forming the fuel reservoir and system cover includes forming a support for the one or more flexible fuel cell walls.

These and other aspects, advantages, and features of the present systems and methods will become apparent from a consideration of the following description and associated drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In the drawings, which are not necessarily drawn to scale, like numerals describe similar components throughout the several views. Like numerals having different letter suffixes represent different instances of similar components. The drawings illustrate generally, by way of example, but not by way of limitation, various embodiments discussed in the present patent document.

FIG. 1 illustrates an exploded view of a fuel cell system, as constructed in accordance with at least one embodiment.

FIG. 2 illustrates a cross-sectional view of a fuel cell system, such as along line 2-2 of FIG. 1, as constructed in accordance with at least one embodiment.

FIGS. 3A-3D illustrate cross-sectional views of portions of a fuel cell system, including one or more fuel cells and a fuel reservoir, as constructed in accordance with various embodiments

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FIG. 4 illustrates a method of fabricating a fuel cell system, such as the fuel cell system illustrated in FIG. 1, as constructed in accordance with at least one embodiment.

5 FIGS. 5A-5B illustrate cross-sectional views of portions of a fuel cell system, including one or more fuel cells, a fuel reservoir, and a system cover, as constructed in accordance with various embodiments.

FIG. 6 illustrates a method of fabricating a fuel cell system, such as the fuel cell system illustrated in FIG. 5B, as constructed in
10 accordance with at least one embodiment.

DETAILED DESCRIPTION

The following detailed description includes references to the accompanying drawings, which form a part of the detailed description. The drawings show, by
15 way of illustration, specific embodiments in which the present systems and methods may be practiced. These embodiments, which are also referred to herein as “examples,” are described in enough detail to enable those skilled in the art to practice the present systems and methods. The embodiments may be combined, other embodiments may be utilized, or structural and logical changes may be made
20 without departing from the scope of the present systems and methods. The following detailed description is, therefore, not to be taken in a limiting sense, and the scope of the present systems and methods are defined by the appended claims and their equivalents.

In this document, the terms “a” or “an” are used to include one or more than
25 one, and the term “or” is used to refer to a nonexclusive or unless otherwise indicated. In addition, it is to be understood that the phraseology or terminology employed herein, and not otherwise defined, is for the purpose of description only and not of limitation.

If they are going to be used to power electrical devices, such as cellular
30 phones, satellite phones, laptop computers, computer accessories, displays, personal

audio or video players, medical devices, televisions, transmitters, receivers, lighting devices including outdoor lighting or flashlights, electronic toys, power tools or any device conventionally used with batteries, it is desirable and even necessary for fuel cell systems to occupy only a small volume of the overall electrical device volume, maintain high energy density, and provide sufficient power output. However, current fuel cell systems are either too large to be use in the electrical devices or fail to maintain the high energy density and provide the energy required to power the electrical devices for a sufficient period of time. Advantageously, the present subject matter provides a fuel cell system that is able to maintain a high energy density and provide sufficient power output, yet still occupy a relatively small volume of the overall electrical device volume. In addition, the present fuel cell systems may operate passively, requiring no pumps, valves or heaters, and may instantly startup without having to rely on any supplemental battery or other power source.

Referring now to the drawings, particularly to FIG. 1, there is illustrated a fuel cell system **100**, including, among other things, a fuel cell layer **102** and a fuel reservoir (e.g., a fuel tank) **104**. The fuel cell layer **102** includes one or more fuel cells each comprising an anode **107**, a cathode **108**, and an electrolyte **109** (e.g., an ion-exchange membrane) interposed therebetween. The fuel cell layer **102** utilized in the system **100** may be a planar fuel cell, such as an electrochemical cell structure having an electrical current-carrying structure which, at least in part, underlies an electrochemical reaction layer. In one such example, the cell includes an ion-exchange membrane with a catalyst layer on each side thereof. In another such example, the electrochemical cell structure includes a plurality of individual unit cells formed on a sheet of the ion-exchange membrane. In the fuel cell system **100**, the cathode **108** of each cell is supplied with an air containing oxygen as an oxidizing agent, and the anode **107** of each cell is supplied with a fuel, such as hydrogen.

Many structural options are available for the fuel reservoir **104**. For instance, in one example, the fuel reservoir **104** may comprise a cellular fuel tank in

which a first and a second cellular component are interconnected and arranged to substantially fill an available electrical device space. In such an example, one or more internal ports fluidly connect the first and second cellular components, while one or more end caps are coupled to the ends of the components. In another
5 example, the fuel reservoir 104 may comprise a structural filler and an outer enclosure wall conformably coupled to the structural filler. In yet another example, the fuel reservoir 104 may comprise an irregular shape (e.g., a non-circular, a non-rectangular, or a non-triangular shape), which substantially conforms to an available volume of an allotted space. The allotted space may be located in, among other
10 things, a cellular phone, a satellite phone, a laptop computer, a computer accessory, a display, a personal audio or video player, a medical device, a television, a transmitter, a receiver, a lighting device including an outdoor light or a flashlight, an electronic toy, or a power tool. In a further example, and as illustrated in FIG. 1, the fuel reservoir 104 may comprise a void 152 to house optional components, such as a
15 supplemental energy battery 122 or an electronic conditioning circuit 120.

In each of these structural examples, the fuel reservoir 104 encloses a fuel, such as hydrogen, or a fuel storage material, such as a hydrogen storage material. In one example, the fuel reservoir 104 encloses a composite hydrogen storage material comprising one or more active material particles and a binder, wherein the binder
20 immobilizes the active material particles sufficient to maintain a relative spatial relationship between the active material particles. In one such example, the hydrogen storage material includes a metal hydride. Among other techniques, the hydrogen storage material may store hydrogen using one or both of physisorption or chemisorption.

25 Power from the fuel cell layer 102 may be gathered by a current collecting circuit 106, which collects the current generated by the fuel cell layer 102 and routes it out of the system 100 via a power output connector 116 or alternatively into the conditioning electronics section 120 (e.g., an electronic conditioning circuit). In the example shown, but as may vary, the power output connector 116 is attached to both
30 the current collector circuit 106 and the optional conditioning electronics section

120. The current collecting circuit 106 may be flexible to conform to a shape or location of the fuel cell layer 102 or other fuel cell system component. In one example, the fuel cell system 100 provides a peak power output of up to about 4 Watts, while in other examples, the fuel cell system 100 may provide a peak power
5 output of about 2-3 Watts. In various examples, the average power output of the fuel cell system is between about 0.2-1.8 Watts, such about 0.5-1.5 Watts, about 0.75-1.25 Watts, or about 1 Watt. In various examples, the fuel cell system 100 provides an energy density of about 200-600 Watt-hr/L or more, such as about 250-350 Watt-hr/L or about 300 Watt-hr/L. In various examples, the fuel cell system
10 100 includes a size of about 25 cubic centimeters or less. In certain examples, the size of the fuel cell system 100 is about 10 cubic centimeter or less.

In various examples, the fuel reservoir 104 includes a refueling port 112 and a pressure regulator 110. The refueling port 112 may be a pressure activated valve that allows a flow of fluid, for example, fluid fuel, into the fuel reservoir 104. In
15 one example, the refueling port 112 includes a fuel inlet and at least one compressible member having a first sealing position and a second fueling position. In such an example, the at least one compressible member is sealingly coupled with the fuel inlet port when the at least one compressible member is in the first sealing position. In the example shown, the refueling valve 112 is coupled with a lower
20 wall 114 of the fuel reservoir 104.

The pressure regulator 110 may be designed to reduce a fuel reservoir pressure to a more constant, lower pressure that is acceptable to the fuel cell layer 102. In one example, the pressure regulator 110 is integrated with an upper wall 115 of the fuel reservoir 104 and includes a regulator body, a resilient member, a
25 diaphragm, a regulator valve, and a seal member. In such an example, the diaphragm and the regulator valve are movingly responsive to a pressure difference between a first chamber pressure and a second chamber pressure.

In example shown, a fuel plenum 212 (FIG. 2) is created by positioning the fuel cell layer 102 adjacent to at least one surface 150 of the fuel reservoir 104. A
30 perimeter of the fuel reservoir surface 150 adjacent the fuel cell layer 102 may be

sealed by a seal member 126, such as a compressive or elastic gasket or an adhesive, thereby forming the fuel plenum 212. In operation of this example, the fuel reservoir 104 is filled with fuel by pressurizing the refueling port 112. The pressure regulator 110 is then used to reduce or maintain the pressure in the fuel plenum 212 to a level sufficient for the operation and movement of the fuel cell layer 102. The pressure in the fuel plenum 212, in turn, urges or forces the fuel cell layer 102 against the current collecting circuit 106, providing contact between such components. In this way, the fuel cell system 100 can then be activated (i.e., the electrochemical reaction between, for example, hydrogen and oxygen can be initiated) simply by exposing the system 100 to ambient air. In an alternative example, the fuel cell layer 102 may be directly bonded to the current collecting circuit 106 such that current can be collected without pressure activation.

Optionally, the fuel cell system 100 may comprise a system cover 124 or a porous protective member 118. The system cover 124 may be utilized to assist the attachment of such things as the fuel cell layer 102 and the fuel reservoir 104. Among other things, the system cover 124 may be constructed of a rigid, but ductile material, including steel or aluminum. Other examples of suitable materials for the system cover 124 include rigid plastics, such as Ultem® (a registered trademark of General Electric Company) or polyethylene. In various examples, the system cover 124 includes one or more air access ports 206 (FIG. 2) that allow at least partial access of the fuel cell cathode 108 to ambient air. As shown, the system cover 124 is configured to surround the fuel cell layer 102 and may be attached to the fuel reservoir 104 by any physical or chemical means, such as by welding, soldering, brazing, crimping, gluing, thermal adhesive, pressure sensitive adhesive, or one or more mechanical structures (e.g., fasteners or protrusions). The mechanical structure may optionally be releasable.

The porous protective member 118 may provide protection to the fuel cell cathode 108 while still allowing air to flow thereto. In one example, the porous protective member 118 protects the cathode 108 from interferents in the ambient air. In certain examples, the porous protective member 118 may be disposed adjacent to

the fuel cell layer 102 on the anode side to provide protection to the anode 107 while still allowing fuel to flow therethrough.

FIG. 2 is a cross-sectional view, such as along line 2-2 of FIG. 1, of a fuel cell system 100 according to one example. In this example, a first fuel reservoir surface 150 contacts a first side of a seal member 126 on a perimeter thereof. A first side 250 of a fuel cell layer 102 contacts a second side of the seal member 126, such that a fuel plenum 212 is thereby created. A second side 252 of the fuel cell layer 102 contacts a current collecting circuit 106. A protective member 118 shields the fuel cell layer 102 and its components from interferences from the environment. A system cover 124 surrounds the fuel cell layer 102 and other components of the fuel cell system 100 (e.g., the protective porous member 118, the current collecting circuit 106, and the fuel plenum 212) and attaches to the fuel reservoir 104. The system cover 124 includes air access ports 206, which allow for ambient air to access the fuel cell layer 102 components, such as the cathode 108 (FIG. 1). Air flows in direction 208 through the air access ports 206 and the porous protective member 118 to provide oxygen to the cathode 108 of fuel cell layer 102.

In this example, as fuel (e.g., hydrogen) flows 210 from the fuel reservoir 104, through the pressure regulator 110, and into the fuel plenum 212, the fuel pressure 202 exerts a force on the fuel cell layer 102 in a direction toward the current collecting circuit 106, providing a contact therebetween. As shown, the mechanical binding of the system cover 124 to the fuel reservoir 104 exerts a cover pressure 204 on the current collecting circuit 106 toward the fuel cell layer 102 (i.e., in the opposite direction of fuel pressure 202), further providing efficient contact between the components of fuel cell system 100.

There are many options for the fuel cell system 100. For instance, in certain examples, the fuel plenum 212 includes a size less than about 1mm in width (wherein the width is the distance substantially perpendicular to the fuel reservoir 104 and extending from the fuel reservoir 104 to the fuel cell layer 102), while in other examples, the fuel plenum 212 includes a width greater than 1mm. In certain examples, the current collecting circuit 106 may be disposed underneath the fuel

cell layer 102, integrated with the fuel cell layer 102, or within the fuel plenum 212, rather than contacting a second side 252 of the fuel cell layer 102. In such examples, the connection between the fuel cell layer 102 and the current collecting circuit 106 may not be activated by the outward force 202 created through the fuel pressure, but rather through a more positive means of connection (e.g., a bonding process).

FIGS. 3A-3D illustrate cross-sectional views of portions of a fuel cell system 100, including, among other things, one or more fuel cell layers 102, a fuel reservoir 104, such as a hydrogen fuel reservoir, and one or more seal members 126. In FIG. 3A, one fuel cell layer 102 is disposed adjacent the fuel reservoir 104. In FIG. 3B, two fuel cell layers 102 are oppositely disposed around the fuel reservoir 104. In FIG. 3C, three fuel cell layers 102 are disposed on three separate surfaces of the fuel reservoir 104. In FIG. 3D, two fuel cell layers 102 are disposed on two separate surfaces of an irregularly-shaped (e.g., a non-square or non-rectangular shape) fuel reservoir 104. The fuel cell systems shown in FIGS. 1-2 can utilize the configurations shown in FIGS. 3A-3B, among others. As discussed in association with FIG. 2, one or more seal members 126 may be disposed between the fuel cell layer 102 and the fuel reservoir 104 thereby forming a fuel plenum 212 into which fuel may flow 210 from the reservoir 104.

FIG. 4 illustrates one method 400 of fabricating a fuel cell system, such as the portable fuel cell system 100 shown in FIG. 1. At 402, at least one fuel cell is formed. In various examples, multiple fuel cells are formed to create a fuel cell layer. Each fuel cell includes an anode, a cathode, and an electrolyte interposed therebetween. At 404, a fuel reservoir is coupled with a first portion of the at least one fuel cell, thereby forming a fuel plenum therebetween. In one example, the fuel reservoir is coupled with the first portion of the at least one fuel cell using a non-conductive adhesive. In another example, a seal member is disposed between the fuel reservoir and the first portion of the at least one fuel cell.

At 406, a current collecting circuit is disposed adjacent to a second portion of the at least one fuel cell. In one example, the current collecting circuit is

electrically coupled with a portable electronic device. In another example, the current collecting circuit is electrically coupled with an electronic conditioning circuit.

Further, at **408**, a system cover having at least one air access port is disposed over one or more of the current collecting circuit, the at least one fuel cell, or a portion of the fuel reservoir, in which the at least one air access port is positioned near the second portion of the at least one fuel cell. In one example, a protective porous member is disposed between the at least one air access port and the second portion of the at least one fuel cell. At **410**, the system cover is coupled with the fuel reservoir. In one example, the system cover is coupled to the fuel reservoir by welding, soldering, brazing, crimping, gluing, thermal adhesive, pressure sensitive adhesive, or one or more mechanical structures (e.g., fasteners or protrusions). The mechanical structure may optionally be releasable.

Referring now to FIGS. **5A-5B**, there is illustrated, in cross-section, a fuel cell system **100** including, among other things, a fuel cell layer **102** including one or more flexible walls **502**, a fuel reservoir **104** configured to store fuel or a fuel storage material, a system cover **124**, and an enclosed region **504**. The fuel cell layer **102** includes one or more fuel cells each comprising an anode **107**, a cathode **108**, an electrolyte (not expressly shown) interposed between anode **107** and cathode **108**, and a current collecting circuit **106**.

The system cover **124** is attachable with a portion of fuel reservoir **104** via, among other things, a weld, a solder, a braze, a crimp, the use of an adhesive, or one or more mechanical structures, thereby forming the enclosed region **504**, as shown. The one or more fuel cell layers **102** may be disposed in the enclosed region **504** such that their respective flexible walls **502** are structurally arranged to form at least one reactant plenum **506**. The one or more flexible walls **502** are supported by a portion of one or both of the fuel reservoir **104** or the system cover **124**. In the example shown, the cathode **108** may be accessible from an outside of the flexible wall **502** and exposed to ambient air via air access ports in the system cover **124**, while the anode **107** may be accessible from an inside of the flexible wall **502** and

exposed to a reactant, such as hydrogen fuel. The current collecting circuit **106** (integral with the fuel cell layer **102**) is configured to receive current generated by the fuel cell layer **102** and distribute such current to, for example, a portable electronic device.

In various examples, a plenum inlet **550** fluidly connects the reactant plenum **506** and the fuel reservoir **104** or ambient air. As reactant enters via the plenum inlet **550**, a reactant pressure pressurizes the fuel plenum **506**, thus urging the one or more flexible walls **502** of the fuel cell layer **102** toward the supporting portions of one or both of the fuel reservoir **104** or the system cover **124**.

FIG. 6 is a flow diagram illustrating one method **600** of fabricating a fuel cell system, such as the fuel cell system illustrated in FIG. **5B**. At **602**, a fuel reservoir configured to store fuel therein is formed. At **604**, a system cover is formed. At **606**, the system cover is coupled with a portion of the fuel reservoir such that an enclosed region is formed therein. In one example, the system cover is coupled with the fuel reservoir via welding, soldering, brazing, crimping, gluing, thermal adhesive, pressure sensitive adhesive, or one or more mechanical structures (e.g., fasteners or protrusions). The mechanical structure may optionally be releasable.

At **608**, at least one fuel cell including an anode, a cathode, and an electrolyte interposed therebetween is disposed in the enclosed region. In various examples, multiple fuel cells are formed to create a fuel cell layer. In one example, one or more flexible fuel cell walls comprise one or both of the fuel cell anode or the fuel cell cathode. Accordingly, in another example, disposing the at least one fuel cell into the enclosed region includes arranging the one or more flexible fuel cell walls to form at least one reactant plenum. In various examples, forming the fuel reservoir and the system cover includes forming a support for the one or more flexible fuel cell walls such that when a reactant enters a plenum inlet and pressurizes the reactant plenum, the fuel cell walls expand and conform to a shape of the one or more supports.

At 610, a current collecting circuit is integrated with the at least one fuel cell. In various examples, the current collecting circuit is configured to collect current from the at least one fuel cell and distribute such current to one or more electrical devices, such as portable electrical devices.

Fuel cell systems and methods for their manufacture are provided herein. Among other things, the present systems and methods provide for a fuel cell system providing sufficient power output and a high energy density, all within a relatively small amount of space. The fuel cell system can operate as a stand alone power source or be integrated into an electrical device. Further, the fuel cell system need not rely on pumps, valves or heaters for its operation, saving precious energy and electrical device volume.

It is to be understood that the above description is intended to be illustrative, and not restrictive. For example, the above-described embodiments (and/or aspects thereof) may be used in combination with each other. Many other embodiments will be apparent to those of skill in the art upon reviewing the above description. The scope of the invention should, therefore, be determined with reference to the appended claims, along with the full scope of equivalents to which such claims are entitled. In the appended claims, the terms "including" and "in which" are used as the plain-English equivalents of the respective terms "comprising" and "wherein." Also, in the following claims, the terms "including" and "comprising" are open-ended, that is, a system, device, article, or process that includes elements in addition to those listed after such a term in a claim are still deemed to fall within the scope of that claim. Moreover, in the following claims, the terms "first," "second," and "third," etc. are used merely as labels, and are not intended to impose numerical requirements on their objects.

The Abstract of the Disclosure is provided to comply with 37 C.F.R. §1.72(b), requiring an abstract that will allow the reader to quickly ascertain the nature of the technical disclosure. It is submitted with the understanding that it will not be used to interpret or limit the scope or meaning of the claims. In addition, in the foregoing Detailed Description, various features may be grouped together to

streamline the disclosure. This method of disclosure is not to be interpreted as reflecting an intention that the claimed embodiments require more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive subject matter may lie in less than all features of a single disclosed embodiment.

- 5 Thus the following claims are hereby incorporated into the Detailed Description, with each claim standing on its own as a separate embodiment.

AMENDED CLAIMS**received by the International Bureau on 22 June 2007 (22.06.2007)**

1. A fuel cell system comprising:
 - a fuel reservoir configured to store a fuel therein;
 - a system cover attachable with one or more portions of the fuel reservoir;
 - an enclosed region formed by the attachment of the fuel reservoir with the system cover; and
 - at least one fuel cell disposed in the enclosed region, each fuel cell including one or more flexible walls structurally arranged such that a reactant plenum is formed in a region between a portion of the fuel reservoir and at least one of the flexible walls; wherein the one or more flexible walls are supported by a portion of one or both of the fuel reservoir or the system cover.
2. The fuel cell system of claim 1, further comprising a current collecting circuit in contact with the at least one fuel cell, the current collecting circuit configured to receive and distribute current generated by the at least one fuel cell.
3. The fuel cell system of claim 2, wherein the current collecting circuit is integral with the at least one fuel cell.
4. The fuel cell system of claim 2, wherein the current collecting circuit is configured to distribute the fuel cell generated current to a portable electronic device.
5. The fuel cell system of claim 4, wherein the portable electronic device includes a cellular phone, a satellite phone, a laptop computer, a computer accessory, a display, a personal audio or video player, a medical device, a television, a transmitter, a receiver, a lighting device, an electronic toy, or a power tool.

6. The fuel cell system of any of claims 1-5, further comprising an inlet fluidly connecting the reactant plenum and the fuel reservoir.

7. The fuel cell system of claim 6, wherein a pressure regulator is disposed within the inlet.
8. The fuel cell system of any of claims 1-7, further comprising a protective porous member disposed adjacent the at least one fuel cell.
9. The fuel cell system of any of claims 1-8, wherein a reactant pressure urges the one or more flexible walls towards the supporting portions of one or both of the fuel reservoir or the system cover.
10. The fuel cell system of any of claims 1-9, wherein the attachment of the system cover and the fuel reservoir includes a weld, a solder, a braze, a crimp, the use of an adhesive, or a mechanical structure.
11. The fuel cell system of any of claims 1-10, wherein the fuel reservoir comprises a refueling port.
12. A method of fabricating a fuel cell system, the method comprising:
 - forming a fuel reservoir configured to store fuel therein;
 - forming a system cover having one or more air access ports;
 - coupling the system cover with one or more portions of the fuel reservoir, including forming an enclosed region; and
 - disposing at least one fuel cell in the enclosed region, including arranging one or more flexible fuel cell walls to form at least one reactant plenum in a region between a portion of the fuel reservoir and at least one of the flexible fuel cell walls;wherein forming the fuel reservoir and the system cover includes forming a support for the one or more flexible fuel cell walls.
13. The method of claim 12, further comprising contacting a current collecting circuit with the at least one fuel cell.

14. The method of claims 12 or 13, further comprising disposing a protective porous member adjacent the at least one fuel cell.

15. The method of any of claims 12-14, wherein coupling the system cover with the fuel reservoir includes welding, soldering, brazing, crimping, gluing, thermal adhesive, pressure sensitive adhesive, or one or more mechanical structures.

16. A fuel cell system comprising:

- at least one fuel cell including an anode, a cathode, and an electrolyte interposed therebetween;

- a fuel or fuel storage material;

- a fuel reservoir including at least one surface positioned adjacent a first portion of the at least one fuel cell, the fuel reservoir configured to store the fuel or the fuel storage material;

- a current collecting circuit in contact with a second portion of the at least one fuel cell, the current collecting circuit configured to receive and distribute power generated by the fuel cell; and

- a fuel plenum interposed between the at least one fuel reservoir surface and the first portion of the at least one fuel cell.

17. The fuel cell system of claim 16, wherein a pressure in the fuel plenum urges the second portion of the at least one fuel cell against a portion of the current collecting circuit.

18. The fuel cell system of claims 16 or 17, wherein the fuel plenum is at least partially surrounded by a seal member, the seal member providing a seal between the at least one fuel reservoir surface and the first portion of the at least one fuel cell.

19. The fuel cell system of any of claims 16-18, wherein the at least one fuel reservoir surface and the first portion of the at least one fuel cell are coupled using an adhesive.
20. The fuel cell system of any of claims 16-19, further comprising a protective porous member positioned adjacent the at least one fuel cell.
21. The fuel cell system of any of claims 16-20, further comprising a system cover including at least one air access port, the system cover attachable to one or more portions of the fuel reservoir.
22. The fuel cell system of claim 21, wherein a connection between the system cover and the fuel reservoir includes a weld, a solder, a braze, a crimp, an adhesive, or one or more mechanical structures.
23. The fuel cell system of claim 21, wherein the system cover houses one or more of the protective porous member, the current collecting circuit, the at least one fuel cell, the fuel plenum, or a portion of the fuel reservoir.
24. The fuel cell system of claim 21, wherein the system cover comprises steel, aluminum, or a rigid plastic.
25. The fuel cell system of any claims 16-24, wherein the current collecting circuit is configured to distribute the power generated by the at least one fuel cell to a portable electronic device.
26. The fuel cell system of claim 25, wherein the current collecting circuit comprises a connection member attachable with the portable electronic device.

27. The fuel cell system of any of claims 16-26, further comprising an electronic conditioning circuit; and
wherein the current collecting circuit is configured to distribute the power generated by the at least one fuel cell to the electronic conditioning circuit.
28. The fuel cell system of claim 27, wherein the electronic conditioning circuit is disposed in a void of the fuel reservoir.
29. The fuel cell system of any of claims 16-28, further comprising a supplemental energy battery; and
wherein the supplemental energy battery is disposed, at least in part, in the void of the fuel reservoir.
30. The fuel cell system of any of claims 16-29, wherein the fuel comprises hydrogen.
31. The fuel cell system of any of claims 16-30, wherein the fuel storage material comprises a hydrogen storage material.
32. The fuel cell system of claim 31, wherein the hydrogen storage material stores hydrogen by physisorption.
33. The fuel cell system of claim 31, wherein the hydrogen storage material stores hydrogen by chemisorption.
34. The fuel system of any of claims 16-33, wherein the fuel storage material comprises a metal hydride.
35. The fuel cell system of any of claim 16-34, wherein the fuel reservoir includes a first cellular component interconnected with at least a second cellular

component, the interconnected cellular components arranged to substantially fill an allotted space.

36. The fuel cell system of claim 35, wherein the allotted space is located in a portion of a cell phone, a personal digital assistant, a laptop computer, a digital camera, a game device, a portable television, or a flashlight.

37. The fuel cell system of any of claims 16-36, wherein the fuel reservoir comprises a structural filler and an outer enclosure wall conformably coupled to the structural filler.

38. The fuel cell system of any of claims 16-37, wherein the fuel reservoir includes one or both of a pressure regulator or a refueling port.

39. The fuel cell system of any of claims 16-38, wherein the fuel reservoir and the at least one fuel cell comprise a combined volume of about 25 cubic centimeters or less.

40. The fuel cell system of any of claims 16-39, wherein the at least one fuel cell is configured to generate an average electrical power of about 1 Watt or more and a peak power of about 3 Watts or more.

41. The fuel cell system of any of claims 16-40, wherein a system energy density comprises about 500 Watt-hours/liter.

42. A fuel cell system providing portable power, the system comprising:
a fuel cell assembly, including at least one fuel cell including an anode on a first surface, a cathode on a second surface, and an electrolyte interposed therebetween;
a protective porous member positioned near the fuel cell second surface;

a current collecting circuit configured to receive and distribute power generated by the at least one fuel cell;

a hydrogen reservoir including a surface positioned adjacent the fuel cell first surface, the hydrogen reservoir configured to store hydrogen fuel;

a fuel plenum interposed between the hydrogen reservoir and the fuel cell first surface; and

a system cover including at least one air access port, the system cover sized and shaped to house one or more of the protective porous member, the current collector circuit, the at least one fuel cell, the fuel plenum, or a portion of the hydrogen reservoir;

wherein a fuel pressure in the plenum and a cover-generated pressure urge contact between the at least one fuel cell and the current collecting circuit.

43. The fuel cell system of claim 42, wherein the current collecting circuit distributes the power generated by the at least one fuel cell to a portable electronic device.

44. A method of fabricating a portable fuel cell system, the method comprising:
forming a fuel cell;

coupling a fuel reservoir with a first portion of the fuel cell, including forming a fuel plenum therebetween;

disposing a current collecting circuit adjacent a second portion of the fuel cell;

disposing a system cover having at least one air access port over one or more of the current collecting circuit, the fuel cell, or a portion of the fuel reservoir, including positioning the at least one air access port near the second portion of the fuel cell; and

coupling the system cover with the fuel reservoir.

45. The method of claim 44, wherein coupling the fuel reservoir with the first portion of the fuel cell includes using an adhesive.
46. The method of claims 44 or 45, wherein coupling the system cover with the fuel reservoir includes welding, soldering, brazing, crimping, gluing, thermal adhesive, pressure sensitive adhesive, or one or more mechanical structures.
47. The method of any of claims 44-46, further comprising disposing a seal member between the fuel reservoir and the first portion of the fuel cell.
48. The method of any of claims 44-47, further comprising disposing a protective porous member between the at least one air access port and the second portion of the fuel cell.
49. The method of any of claims 44-48, further comprising electrically coupling the current collecting circuit with a portable electronic device.
50. The method of any of claims 44-49, further comprising electrically coupling the current collecting circuit with an electronic conditioning circuit.