FUEL CELL PROTECTIVE CONTAINERS

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Abstract

A protective container for containing a material and protecting against adverse exposure to the material, which is particularly adapted for use with fuel cells, can include a durable outer casing and an inner casing. The inner casing is less durable than the outer casing. At least one layer of a preventative agent is disposed between the inner and outer casings that is configured to disable at least a portion of the material upon failure of the inner casing.

Related U.S. Application Data
Continuation-in-part of application No. 09/960,180, filed on Sep. 20, 2001, now abandoned.

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FUEL CELL PROTECTIVE CONTAINERS
CROSS-REFERENCE TO RELATED APPLICATION

[0001] The present application is a continuation-in-part of co-pending U.S. application Ser. No. 09/960,180, filed Sep. 20, 2001, which is incorporated herein by reference.

FIELD OF THE INVENTION

[0002] The present invention relates generally to containers for materials. More particularly, the present invention relates to containers which reduce the danger of adverse exposure to contents of the container, and such containers that are particularly adapted for use for storing fuel cells and/or reactant storage containers associated with fuel cells.

BACKGROUND OF THE INVENTION

[0003] Systems designed to contain materials rank among the oldest of human inventions. A wide variety of container types ranging from clay pots to refrigerated semi-tractor trailer tanks have been used to hold, dispense, and transport nearly every type of material imaginable. During the recent past, many materials that require a relatively high degree of care in handling have been developed and used with greater frequency. In one example, fuel cell technology has developed to the point that fuel cells can be used in vehicles, appliances, and other devices that are found among or used by the general public.

[0004] The materials, or reactants, used in fuel cells are generally highly reactive and/or flammable, presenting challenges for safely using and/or transporting cell technology. In general, increasing the use of such materials increases the use of such materials, problems inherent in providing, storing, and transporting the materials used in the fuel cells can greatly increase the cost of such systems, and can further increase the amount of regulatory oversight required for such systems.

[0005] Various containers and packaging for containers are designed to protect contents during shipping or transport from inadvertent exposure. One common design has been to create an impact resistant outer shell which cushions the materials inside the container. Other containers may have impact resistant layers and/or spacing between outer and inner layers to decrease the risk of leakage of materials or puncture of the container. Foam and other padding materials having advantageous deformation characteristics have also been used as a measure of protection against various impact forces.

[0006] Another approach to protecting materials in a container during transport is through the use of various packaging materials. Such packaging materials are often used in absorbent layers or agents which absorb any material discharged from a ruptured container. These types of packaging layers form a physical barrier to prevent the fluid from leaking outside of the package. Such layers may also act as a cushion to reduce the chances of a container breach. Other packaging materials may contain compounds that interact with the container contents to minimize the consequences of accidental discharge.

[0007] While containers employing a durable shell or cushioning material may reduce the incidence of ruptures, such containers provide no protection from exposure to the container's contents when a rupture occurs. Additionally, the rupture of such a container generally ruins the container and results in a loss of the entire contents thereof.

SUMMARY OF THE INVENTION

[0008] It has been recognized that it would be advantageous to develop a container with improved protection characteristics, including protection that remains in place during use of the container, and protection that allows the contents of the container to be salvaged. In addition, it has been recognized that it would be advantageous to develop a container suitable for use with fuel cell technology to enable fuel cells to be utilized in commonly accessible devices.

[0009] In accordance with this, a protective container containing a fuel cell can comprise a durable outer casing, an inner casing coupled within the outer casing, and at least one layer of a preventative agent disposed between the inner and outer casings that is sufficient to disable at least a portion of the fuel cell reactant material upon failure of the inner casing. The inner casing can be less durable than the outer casing and can be operable to provide a non-reactive barrier to a fuel cell reactant material. Further, at least one fuel cell can be disposed at least partially within the inner casing.

[0010] In another embodiment, a protective container containing at least one component of a fuel cell assembly can comprise a durable outer casing, an inner casing coupled within the outer casing, and at least one layer of a preventative agent disposed between the inner and outer casings that is sufficient to disable at least a portion of the fuel cell reactant material upon failure of the inner casing. The inner casing can be less durable than the outer casing and can be operable to provide a non-reactive barrier to a fuel cell reactant material. Further, at least one component of a fuel cell assembly can be disposed at least partially within the inner casing.

[0011] In still another embodiment, a fuel cell assembly can comprise a fuel cell coupled to at least one reactant storage tank. The reactant storage tank can comprise a durable outer casing, an inner casing disposed within the outer casing, and at least one layer of a preventative agent disposed between the inner and outer casings that is sufficient to disable at least a portion of the fuel cell reactant material upon failure of the inner casing. The inner casing can be less durable than the outer casing and can be operable to provide a non-reactive barrier to a fuel cell reactant material when present within the inner casing.

[0012] Additional features and advantages of the invention will be apparent from the detailed description which follows, taken in conjunction with the accompanying drawings, which together illustrate, by way of example, features of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] FIG. 1 is a cross sectional view of a protective container, or more specifically, a fuel cell reactant material storage tank for use with a fuel cell assembly, in accordance with an embodiment of the present invention.

[0014] FIG. 2 is a cross sectional view of a protective container similar to that of FIG. 1, more specifically showing an embodiment where at least a portion of a fuel cell assembly is disposed therein.
DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT(S)

[0015] Before particular embodiments of the present invention are disclosed and described, it is to be understood that this invention is not limited to the particular process and materials disclosed herein as such may vary to some degree. It is also to be understood that the terminology used herein is used for the purpose of describing particular embodiments only and is not intended to be limiting, as the scope of the present invention will be defined only by the appended claims and equivalents thereof.

[0016] In describing and claiming the present invention, the following terminology will be used:

[0017] The singular forms “a,” “an,” and “the” include plural references unless the context clearly dictates otherwise.

[0018] As used herein, the terms “material” and “contained material” may be used interchangeably, and refer to a material held in a container, the inadvertent exposure of which would be undesirable or adverse. A number of reasons may be presented as to why inadvertent exposure of the material may be undesirable or adverse, including potential hazard to the health of individuals, potential damage to the surrounding environment including degradation or discoloration, or a reduction or loss of material volume inside the container. More specifically, in the context of fuel cells, typically, the material will be a “reactant material,” such as oxygen, hydrogen, acids such as phosphoric acid, methanol, etc. Further, the reactant material also includes precursor reactant materials which are used to form the reactants that will actually be used in the fuel cells. An example of this is sodium or aluminum borohydride, which is used to generate hydrogen for use in fuel cells.

[0019] As used herein, the term “preventative agent” is to be understood to refer to an agent which is capable of physically or chemically reacting with a material in a manner which disables at least a portion of the material when contacted therewith. A wide range of physically and chemically reactive agents are known and must be individually selected by one of ordinary skill in the art to disable a specific material. Examples of preventative agents include, without limitation, absorbents, adsorbents, gelling agents, foaming agents, chemical antidotes, polymer forming agents, fire retardants, etc.

[0020] As used herein, the term “physically reacting” is to be understood to refer to a physical interaction between a preventative agent and a material which physically disables the material, such as entrapping, adsorbing, absorbing, suspending or otherwise arresting the material.

[0021] As used herein, the term “chemically reacting” is to be understood to refer to a reaction between a preventative agent and a material which chemically disables the material by changing the chemical structure and/or nature thereof, such as by neutralizing the material, forming a salt, etc.

[0022] As used herein, the term “disable” is to be understood to refer to the chemical or physical deactivation of a material by a preventative agent, such that adverse or undesirable circumstances resulting from exposure of the material are ameliorated or eliminated.

[0023] As used herein, the term “outer casing” is to be understood to refer to a barrier between the contents of a container and the outside of the container that forms an exterior surface of the container.

[0024] As used herein, the terms “inner casing” and “container lining” may be used interchangeably and are to be understood to refer to a barrier in direct contact with the contents of a container, which is placed between the contents of the container and an outer casing of the container.

[0025] As used herein, the term “barrier” is to be understood to refer to a layer or layers that are at least substantially impermeable (and can be fully impermeable) to the passing of material, external environment gases or liquids, and/or preventative agent, etc., unless the barrier is breached or otherwise broken. The term “barrier” can also refer to a layer or layers that are substantially unreactive with a material.

[0026] As used herein, the term “chemical antidote” is to be understood to refer to any composition which chemically reacts with the contained material in a manner so as to chemically alter the material and render it substantially disabled. It is of particular note that in the use of the present invention, specific chemical antidotes will be selected by one of ordinary skill in the art and employed based on the particular type of materials to be contained in the container.

[0027] As used herein, the term “polymer forming agent” is to be understood to refer to an agent which polymerizes upon contact with a material contained in the container and forms a polymer therewith.

[0028] As used herein, the terms “hazardous” and “toxic” may be used interchangeably and are to be understood to refer to a material or combination of materials, that because of its or their quantity, concentration, or physical, chemical or infectious characteristics, may pose a substantial present or future risk to the health, safety, or welfare of an animal (including humans), or to the quality of the environment when exposed thereto.

[0029] A used herein, the term “explosive material” is to be understood to refer to a material or combination of materials which causes a sudden, almost instantaneous release of pressure, gas, and/or heat when subjected to sudden shock, pressure, spark, or high temperature. In one aspect, the term “explosive material” includes highly reactive materials which react violently when combined with various other substances. For example, the metal hydrides used as hydrogen source react violently with water, metal peroxides, persulfates, or nitrates used as oxygen sources form flammable materials and mixtures, such as when in contact with fabric.

[0030] As used herein, the term “durable” is to be understood to refer to the ability of a material to resist rupturing under various stress conditions, such as various temperature, pressure, and impact conditions. It is to be noted that durability is not only assessed by the degree of hardness, but also by other characteristics which aid in resisting rupture, such as elasticity or flexibility, thermal conductivity, various chemical properties, etc.

[0031] As used herein, in context of the contained material, the term “use” is to be understood to refer to any suitable, appropriate, or designed employment of the material as dictated by its specific physical or chemical properties which is recognized by one of ordinary skill in the relevant art. Such use is also considered to encompass preparatory
actions or steps which are required in order to place the material in a suitable posture for its intended use, such as dispensing the material from one-container to another. By way of example, a “use” of a fuel cell reactant material may include transferring the material from a storage tank to a fuel cell.

[0032] As used herein, in context of the container, the term “use” is to be understood to refer to any suitable, appropriate, or designed employment of the container, including storing, dispensing, heating, cooling, transporting, mixing, and reacting materials.

[0033] As used herein, the term “inseparably coupled” is to be understood to refer to a condition in which two or more structures or compositions are bonded, molded, attached, or otherwise joined to one another in such a manner that they cannot be separated from one another without causing structural damage to at least one of the two or more structures or compositions. The term “inseparably coupled” does not apply, for example, to two or more materials that are merely held one within another and are capable of being separated during normal usage of a device comprised of the materials.

[0034] When referring to “fuel cells,” typically, a fuel cell includes two electrodes sandwiched around an electrolyte. These fuel cells can be stacked to provide additional energy. One type of reactant material can pass over one electrode, while another type of reactant material can pass over the other, generating electricity and typically byproducts. If the fuel cell utilizes oxygen and hydrogen, the byproducts are typically water and heat. Other fuel cell types can be utilized in accordance with the present invention. Exemplary fuel cell types that can be used include Phosphoric Acid (PAFC); Proton Exchange Membrane (PEM); Molten Carbonate (MCTC); Solid Oxide (SOFC); Alkaline; Direct Methanol Fuel Cells (DMFC); Regenerative Fuel Cells; Zinc-Air Fuel Cells (ZFC); Protonic Ceramic Fuel Cell (PCFC), etc. Further, fuel cells that produce reactant material in situ are also included. For example, sodium borohydride or aluminum borohydride are examples of fuels which are fuels that can be used to form hydrogen in situ, and the hydrogen is the actual fuel that is introduced into the fuel cell for reaction.

[0035] It is to be understood that the various features shown in the attached figures are for the purposes of illustration and do not in any manner limit the present invention. In particular, most of the technical features of the present invention are shown schematically in the figures and are not drawn to scale, nor are components necessarily scaled proportionally to one another.

[0036] Reference will now be made to the exemplary embodiments illustrated in the drawings, and specific language will be used herein to describe the same. It will nevertheless be understood that no limitation of the scope of the invention is thereby intended. Alterations and further modifications of the inventive features illustrated herein, and additional applications of the principles of the inventions as illustrated herein, which would occur to one skilled in the relevant art and having possession of this disclosure, are to be considered within the scope of the invention.

[0037] The present invention provides a container designed to prevent or ameliorate inadvertent or adverse exposure of a material contained therein. This container is particularly useful in the context of use as a component of, or for containing, fuel cells. As shown in cross section in FIG. 1, a protective container 10 in accordance with an embodiment of the invention includes a durable outer casing 15, an inner casing 25, which can be less durable than the outer casing, and at least a layer of a preventative agent 20 disposed therebetween. The container is designed to hold a material 30, such as a fuel cell reactant material, and can be configured in a variety of shapes or sizes, as desired, to enable a specific use or accommodate a specific material. Though the material is not shown as completely filling the inner casing, in one embodiment, the material can substantially fully fill the container.

[0038] The durable outer casing 15 of the container 10 can be constructed from a range of materials including polymers or metals, and can be made to durability specifications as needed to meet the requirements of a particular use. Such specifications may generally be determined by one of ordinary skill in the art on a case-by-case basis without undue experimentation. In one aspect, the outer casing may be made of a hard material which is moderately to highly impact resistant, such as a metal or a rigid polymeric material like plastic, etc. In another aspect, the outer casing may be made of flexible material which allows the container to conform to a shape dictated by its surroundings, such as a flexible polymer material.

[0039] The outer casing should be sufficiently durable to protect the contained material 30 from minimal impacts, as well as other stresses, and the external environment. The outer casing is typically a barrier material with respect to the surrounding environment, in that the outer casing can be from substantially to completely impermeable to external gases, liquids, and/or solids. Thus, in one embodiment, a permeable cloth, such as a burlap sack, would not be considered to be a barrier in accordance with embodiments of the present invention. However, a fabric that is gas impermeable might be considered to be a barrier.

[0040] The inner casing 25 is designed and constructed to be less durable (i.e. more easily ruptured or compromised) than the outer casing 15. The purpose of constructing the inner casing in such a manner is to allow a breach of containment by the inner casing before the outer casing becomes compromised when the container is subjected to various stresses or environmental conditions. The choice of relative durabilities for the inner and outer casings will be governed by the type of material 30 which is contained, and the intended use of the container, as can be determined by those skilled in the art. Further, the specific materials selected for the inner casing will be dictated in part by the contents which the container is to contain. Specifically, since the inner casing is in direct contact with the contents of the container over a large surface area, the inner casing is generally formed of a material which is reactive with the contents of the container, which typically includes the fuel cell reactant material.

[0041] Further, the inner casing should be configured such that it does not become degraded or weakened by contact with the material. Examples of suitable materials for the inner casing may include without limitation, polymeric materials including plastics, metals, glass, etc. In embodiments where the inner casing acts as a barrier, the barrier material selected for use should be capable of preventing the
material and preventative agent from contacting, physically reacting, or chemically reacting with one another until breach of the inner casing. Thus, the term barrier in this context can be composition specific. However, the barrier can also be configured to be from substantially to completely impermeable to gases, liquids, and/or solids in general.

[0042] A layer of preventative agent 20 can be disposed between the inner casing 25 and the outer casing 15, the layer of preventative agent being generally designed to disable at least a portion of the contained material 30 upon contact therewith. In an alternative embodiment shown schematically in FIG. 1, a plurality of preventative agent layers, 20, 22, and 24 can alternatively be used (rather than a single layer of preventative agent as shown elsewhere in FIG. 1). The preventative agent layer may be made of any suitable agent that is capable of disabling the contained material or a portion thereof. Such a disabling effect may be achieved by either physical or chemical reactions, or both, between the preventative agent and the contained material. Because the purpose of the preventative agent is to disable the contents of the container, the specific preventative agent used will most often be selected based on its ability to physically or chemically react with a specific material to be contained in the container. The determination of an appropriate combination of contents and preventative agent layer may be readily made using the knowledge and skill of one of ordinary skill in the art without undue experimentation.

[0043] In use, the design of the inner casing 25 to be less durable than the outer casing 15 allows the preventative agent time to disable the material 30 before the material is allowed to escape from the container 10. Further, if physically disabled by the preventative agent, the material may be partially or wholly prevented from escaping from the container. In some aspects, the barrier presented by the outer casing may aid in distributing the contained material throughout the layer(s) of preventative agent and increase the disabling action. The present invention is therefore designed such that any actual exposure to the contained materials will be dramatically reduced or the nature of the material so changed that such exposure is less adverse than to the original contained material.

[0044] In accordance with one aspect of the present invention, the container 10 may be designed in a manner which allows the preventative agent layer 20 to remain in place while the contents 30 of the container are in use. In such a case, the outer casing 15 and the inner casing 25 are coupled together in some manner, allowing the container to be an integrated device. As discussed in more detail below, one advantage for which the container is particularly well adapted is in the containment or storage of fuel cells and/or various components of fuel cell assemblies.

[0045] In yet another aspect of the present invention, the preventative agent layer 20 may disable a portion of the contained material 30 without disabling all of the contained material, thus allowing a portion thereof to remain enabled and useful. As such, when a container 10 becomes damaged, a portion of the contents may still be salvaged and used.

[0046] As noted above, a wide variety of materials, in nearly all known physical forms, such as solid, semi-solid, liquid, and vapor, may be used in connection with the fuel cells of the present invention. In short, any material useable in a fuel cell may benefit from the containers of the present invention. In one aspect of the present invention, the contained materials may include, but are not limited to, materials which are flammable, combustible, acidic, etc.

[0047] As recited above, the preventative agent used in the present invention includes substances and/or mechanisms which disable or otherwise make less harmful the contained fuel cell reactant material. As such, the preventative agent may present physical and/or chemical characteristics which act to disable the contained material. A wide variety of preventative agents may be used in the container of the present invention, several of which may be in its separate layer and containment in a given package, and as noted above, the specific preventative agent may be selected based upon the material which the container is to hold. Such a selection may be readily made using the knowledge of one ordinarily skilled in the art without being required to engage in undue experimentation.

[0048] Referring again to FIG. 1, the preventative agent layer 20 may be made of a single preventative agent, or the layer may include a mixture of preventative agents. Alternatively, multiple preventative agent layers 20, 22, and 24 may each be made of a single preventative agent material (different from one another or the same as one another), a mixture of preventative agents, alternating layers of certain types of preventative agents, etc. The specific preventative agent, or mixture of agents contained in each layer may be customized in order to achieve a particularly desired result. Likewise, the combination of different layers may be customized to achieve a specific result. In short, the number of possible preventative agents and mixtures thereof, as well as different layer combinations which are capable of being used in the present invention, is only limited by the number and types of materials which the container may contain.

[0049] Because of the wide variety of preventative agents which may be used in connection with the present invention, reference will only be made to a few specific classes and species which are representative of the much larger group of preventative agent which is contemplated to be within the scope of the present invention. Accordingly, in one aspect of the present invention, the preventative agent may be a foaming agent. A wide variety of foaming agents may be used with the container of the present invention. However, specific examples of foaming agents which may be used include without limitation, carbonates such as sodium bicarbonate and ammonium bicarbonate, polyolefin foams, and other alkali metal carbonates, or surfactants.

[0050] In another aspect of the present invention, the preventative agent may be a polymer forming material. Generally, such a material will be selected to form a hard polymer with the contained material, upon contact therewith to provide a sealant that forms a barrier which is essentially impermeable to the contained material. Initiation of polymerization may be accomplished through either the contained material or an initiator included within the preventative agent. Specific examples of polymeric agents include without limitation, cyanoacrylates as well as other polymerizable compounds. Further, cyanoacrylate monomers include α-cyanoacrylate esters and corresponding initiators which may include amines, sodium hydroxide, sodium carbonate, and other compatible Lewis bases. Self-initiation may also occur via free radicals.

[0051] In yet another aspect of the present invention, the preventative agent may be a fire retardant. Specific examples
of fire retardants include without limitation, bromides such as brominated polystyrenes, bromine chloride, and phosphines such as phosphate salts, phosphate esters, nitrogen-containing phosphorous derivatives, phosphoric acid derivatives, phosphinates, phosphites, phosphonites, phosphinates, and phosphines. Other compounds which have found use as fire-retardants include inorganic compounds such as antimony compounds like antimony trioxide, antimony pentoxide, and sodium antimonite, boron compounds such as zinc borate, boric acid and sodium borate, alumina trihydrate and molybdenum oxides, halogenated compounds such as including decabromodiphenyl oxide, chloroformic acid, tetra-bromophthalic anhydride, and similarly halogenated compounds. The halogenated compounds, especially chlorinated compounds, are often combined with inorganic compounds, especially antimony-, iron-, cobalt-, nickel-, molybdenum-, and other metal-containing compounds, to produce fire-retarding effects.

[0052] In a further aspect of the invention, the preventative agent may be a chemical antioxidant. As recited above, a chemical antioxidant is any composition which chemically reacts with the contained material in a manner so as to chemically alter the material and render it substantially disabled. Generally, chemical antioxidants include chemical compounds known to react with the contained material to produce products which are less harmful, (i.e. reacting a basic compound with a contained acid, etc.).

[0053] In an additional aspect of the present invention, the preventative agent may be a gelling agent. A wide variety of gelling agents may be used in connection with the present invention and may be determined in part by the specific material being contained. Specific examples of gelling agents include without limitation, alginate, polycrylate salt, surfactants such as laurel glutamic butyramid, carboxymethyl cellulose, cellulose ether, polyvinylpyrrolidone, starch, dextrin, gelatin, stearate and stearate salts, lamellae and liposome or vesicle forming surfactants, lecithin, pectin, coagulants such as sulfate salts, and fluid thickeners such as substituted sebacic acids or polyoxyalkylene reaction products, may be included such that upon contact with the contained material a gel is formed which substantially immobilizes the contained material.

[0054] In accordance with yet another aspect of the present invention, the preventative agent may be an absorbent agent. Absorbents generally physically disable a contained material when placed in contact therewith. A wide variety of absorbents may be used in connection with the container of the present invention, and the specific choice of absorbent may be based in part on the material contained in the container. Such choices are deemed to be well within the capacity of one skilled in the art without requiring undue experimentation. Specific examples of absorbent agents include without limitation, vermiculite, high porosity clay, polyurethane foams, fibrous cellulose, fibrous polycrylates, fibrous acrylic polymers, fibrous thermoplastics, plastic microspheres, glass microspheres, and ceramics which absorb and immobilize the contained material and prevent evaporation and/or uncontrolled release. Despite the use of the term “absorbent,” any material which is absorbent is also included in the scope of the present invention, and several of the listed components may be more correctly referred to as absorbent.

[0055] In keeping with the present invention, the container 10 is so designed such that if a portion of the material 30 is disabled after failure of the inner casing 25, a portion of the material remaining unaffected may be used as originally intended. For example, a fuel cell storage tank according to the present invention can have an adsorbent preventative agent layer. Upon a breach of the inner casing, a portion of the contained fuel cell reactant material would be adsorbed, and a remaining portion of the reactant material could still be dispensed and used as intended without detrimental effects in performance.

[0056] In accordance with another aspect of the invention, the preventative agent remains in a position capable of disabling the material 30 during use thereof. Thus, the preventative agent is integrated into the container 10 and is situated to disable the material upon failure of the inner casing 25. In this respect, the preventative agent layer(s) is not designed to be removable from the container or from contact with the inner and outer casings. Thus, in this, and other embodiments of the invention, one or more of the inner casing, outer casing, preventative agent, etc., are inseparably coupled as an integrated container. This inseparability can be by structural integration between the inner and outer casings, such as by a connecting member 28, and/or by adhesion between the inner casing, the preventative agent layer(s), and the outer casing. In either of these aspects, or other examples where inseparability can be achieved, the container is configured such that the various casings and layers cannot be separated from one another without damaging one or more of the layers.

[0057] Thus, in one embodiment, an integrated container 10 is presented that allows storage of the material 30 without requiring that the material be disposed within some other container prior to storing the other container within the present container. In this manner, someone working with the material would not be able to separate the various components of the container one from another. This is in contrast to many prior art containers that generally provide a protective, outer bag, cushion or other assembly into which a container, such as a glass or plastic container, is simply placed or stored. In this type of container, an individual might easily remove the glass or plastic container from the protective portions of the prior art container, risking exposure of a material contained in the prior art container.

[0058] Turning now to FIG. 2, in one aspect of the invention, a container 10a can include all of the features and advantages of the container 10 discussed in relation to FIG. 1. In addition, however, a fuel cell 32 can be contained within the container. The fuel cell can be of a variety of types known to those of ordinary skill in the art, and is generally operable by the provision of reactants, such as hydrogen and oxygen, or other known fuel cell reactants, to the fuel cell.

[0059] As is well known in the art, fuel cells are generally electrochemical energy conversion devices that, for example, convert the chemicals hydrogen and oxygen into water, and in the process produce a DC current. In general, fuel cells typically require a substantially constant supply of hydrogen and oxygen through one or more of a variety of electrolytes. One example of a fuel cell capable of use in the present invention is the proton exchange membrane (PEM) fuel cell. Other exemplary fuel cell types that can be used include Phosphoric Acid (PAFC); Molten Carbonate
Some of these components are illustrated schematically in FIG. 2, where fuel cell 32 is provided with two reactants (not apparent from the figure), such as hydrogen and oxygen, via supply conduits 34 and 36, respectively. Electrical leads 38 and 40 can be operably coupled to the fuel cell to allow for the discharge of useful electricity from the fuel cell.

In the embodiment shown, the fuel cell 32, and at least portions of the supply conduits 34, 36, are at least partially contained within the container 10z. It will be appreciated that the supply conduits will, in operation, be fluidly coupled to storage tanks (not shown) that store and protect the reactants used by the fuel cell. The storage tank can be any storage tank known in the art, or can be a storage tank similar to the container shown in FIG. 1.

The containers of the present invention can be used to contain and protect one or more components, including fuel cells and fuel cell stacks, fuel cell supply conduits, and reactant storage tanks. In this manner, inadvertent exposure of the reactants, e.g., hydrogen or oxygen, can be provided for all, or nearly all, components of a typical fuel cell assembly. The containers of the present invention can be configured to individually and separately contain each one of these components, or one or more components can be contained within a single container of the present invention.

Furthermore, it is to be understood that a “container” in accordance with the present invention can be integrally incorporated with another component of the fuel cell system. For example, the supply conduits can be contained within a container of the present invention, or the supply conduits can be formed from the layers of the present container. In this manner, the inside surface of a conduit, for example, can be the inner casing of the container. Alternatively, the container may not just hold the fuel cell component, but a container of the present invention can alternatively act as the fuel cell component per se, e.g., storage tanks, conduit etc.

It is to be expressly understood that one or more of the above-recited preventative agents may be used in combination with one or more of the above-recited contained materials. Such combinations, as well as combinations with preventative agents or contained materials not specifically recited may be made using the knowledge of one skilled in the art without the necessity of engaging in undue experimentation. The following examples should not be considered as limitations of the present invention, but merely teach exemplary methods of the present invention.

**EXAMPLE**

A protective container for protecting a fuel cell component or for use as a fuel cell reactant material storage container is constructed as follows. A high density polyethylene (HDPE) of a thickness of about 200 mils is used to form a durable outer casing. Glass having a thickness of about 30 mils is used to form an inner casing. A layer of oxidized cellulose is disposed between the durable outer casing and the inner casing, and has a thickness of about 100 mils. Optionally, the entire container (three layers) can be inseparably coupled as described herein. This protective container is useful for containing sodium borohydride or aluminum borohydride, which are fuels that can be used to form hydrogen in situ. Upon failure of the inner casing, the oxidized cellulose reacts with the borohydride material to form alcohols and alkoxides, which are innocuous.

It is to be understood that the above-referenced arrangements are illustrative of the application for the principles of the present invention. Numerous modifications and alternative arrangements can be devised without departing from the spirit and scope of the present invention while the present invention has been shown in the drawings and described above in connection with the exemplary embodiments of the invention. It will be apparent to those of ordinary skill in the art that numerous modifications can be made without departing from the principles and concepts of the invention as set forth in the claims.

What is claimed is:

1. A protective container containing a fuel cell, comprising:
   a) a durable outer casing;
   b) an inner casing coupled within the outer casing, the inner casing being less durable than the outer casing and being operable to provide a non-reactive barrier to a fuel cell reactant material;
   c) at least one layer of a preventative agent disposed between the inner and outer casings that is sufficient to disable at least a portion of the fuel cell reactant material upon failure of the inner casing; and
   d) at least one fuel cell disposed at least partially within the inner casing.

2. The protective container of claim 1, wherein the at least one layer is a plurality of preventative agents.

3. The protective container of claim 1, wherein a first portion of the fuel cell reactant material remains functional after a second portion of the fuel cell reactant material has been disabled by the preventative agent.

4. The protective container of claim 1, further comprising a plurality of fuel cells combined in a fuel cell stack, the fuel cell stack being disposed at least partially within the inner casing.

5. The protective container of claim 1, wherein the fuel cell reactant material is hydrogen or oxygen.

6. The protective container of claim 1, wherein the at least one fuel cell contains the fuel cell reactant material.

7. The protective container of claim 6, wherein the at least one fuel cell further contains a second fuel cell reactant material.

8. A protective container containing at least one component of a fuel cell assembly, comprising:
   a) a durable outer casing;
   b) an inner casing coupled within the outer casing, the inner casing being less durable than the outer casing.
and being operable to provide a non-reactive barrier to a fuel cell reactant material once disposed therein;

c) at least one layer of a preventative agent disposed between the inner and outer casings that is sufficient to disable at least a portion of the fuel cell reactant material upon failure of the inner casing; and

d) at least one component of a fuel cell assembly disposed at least partially within the inner casing.

9. The protective container of claim 8, wherein the at least one component of the fuel cell assembly comprises a reactant storage tank.

10. The protective container of claim 8, wherein the at least one component of the fuel cell assembly comprises a fuel cell stack.

11. The protective container of claim 8, wherein the at least one component of the fuel cell assembly comprises a delivery conduit for a reactant of a fuel cell.

12. The protective container of claim 8, wherein the at least one layer is a plurality of preventative agent layers.

13. The protective container of claim 8, wherein a first portion of the fuel cell reactant material remain functional after a second portion of the fuel cell reactant material has been disabled by the preventative agent.

14. The protective container of claim 8, wherein the fuel cell reactant material is hydrogen or oxygen.

15. The protective container of claim 8, wherein at least a portion of the fuel cell reactant material is present within the at least one component of the fuel cell assembly.

16. A fuel cell assembly, comprising a fuel cell coupled to at least one fuel cell reactant material storage tank, said reactant storage tank comprising:

   a) a durable outer casing;

   b) an inner casing disposed within the outer casing, the inner casing being less durable than the outer casing and being operable to provide a non-reactive barrier to a fuel cell reactant material when present within the inner casing;

   c) at least one layer of a preventative agent disposed between the inner and outer casings that is sufficient to disable at least a portion of the fuel cell reactant material upon failure of the inner casing.

17. The fuel cell assembly of claim 16, wherein the at least one layer is a plurality of preventative agent layers.

18. The fuel cell assembly of claim 16, wherein a first portion of the fuel cell reactant material remain functional after a second portion of the fuel cell reactant material has been disabled by the preventative agent.

19. The fuel cell assembly of claim 16, wherein the fuel cell reactant material is present within the inner casing.

20. The fuel cell assembly of claim 16, wherein the fuel cell reactant material is hydrogen or oxygen.

21. The fuel cell assembly of claim 16, wherein the fuel cell reactant material is a precursor reactant material.

22. The protective container of claim 21, wherein the precursor reactant material is sodium borohydride or aluminum borohydride.

23. The fuel cell assembly of claim 16, further comprising a second fuel cell reactant material tank operably coupled to the fuel cell stack, said second reactant material tank containing a second fuel cell reactant material that is reactive with the fuel cell reactant material.

24. The fuel cell assembly of claim 23, wherein the second fuel cell reactant material tank includes:

   a) a second durable outer casing;

   b) a second inner casing disposed within the second outer casing, the second inner casing being less durable than the second outer casing and being operable to provide a non-reactive barrier to the second fuel cell reactant material;

   c) at least one layer of a second preventative agent disposed between the second inner and second outer casings that is sufficient to disable at least a portion of the second fuel cell reactant material upon failure of the second inner casing.