US 20100293892A1

(19) **United States**

(12) **Patent Application Publication**

(10) **Pub. No.: US 2010/0293892 A1**

(43) **Pub. Date: Nov. 25, 2010**

**Curry et al.**

(54) **METHOD OF PACKAGING AND PACKAGE FOR SENSORS**

(75) Inventors: **Kenneth Curry**, Oceanside, CA (US); **Todd Fjield**, Laguna Hills, CA (US); **Michael J. Higgins**, Huntington Beach, CA (US); **Patrick Carlin**, Dana Point, CA (US); **Gregory J. Carlin**, Irvine, CA (US)

Correspondence Address:
**EDWARDS LIFESCIENCES CORPORATION LEGAL DEPARTMENT, ONE EDWARDS WAY IRVINE, CA 92614 (US)**

(73) Assignee: **Edwards Lifesciences Corporation**, Irvine, CA (US)

(21) Appl. No.: **12/624,717**

(22) Filed: **Nov. 24, 2009**

**Related U.S. Application Data**

(60) Provisional application No. 61/122,246, filed on Dec. 12, 2008.

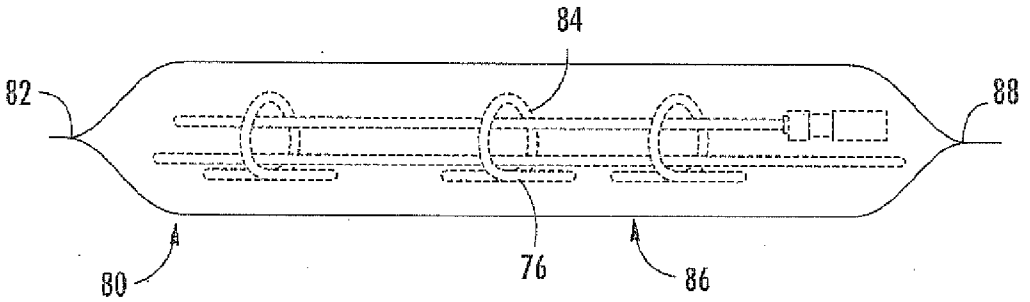
**Publication Classification**

(51) **Int. Cl.**
***B65B 31/00*** (2006.01)
***B65D 85/38*** (2006.01)

(52) **U.S. Cl.** ..... **53/403**; 206/305

(57) **ABSTRACT**

There are provided methods of packaging and packages that prevent damage of the package contents while maintaining sterility and that limit the negative effects of sterilization on sensors such as enzyme sensors. A method of packaging an enzyme sensor includes providing an enzyme sensor such as a glucose oxidase sensor in a gas impermeable package comprising one or more of oxygen and water, removing a significant portion of the oxygen and water present in the package, and sealing the package. The resulting package comprises the enzyme sensor in an atmosphere that is substantially free of oxygen and water. The package can also include a pressure indicator that indicates when the package has exceeded a predetermined pressure.



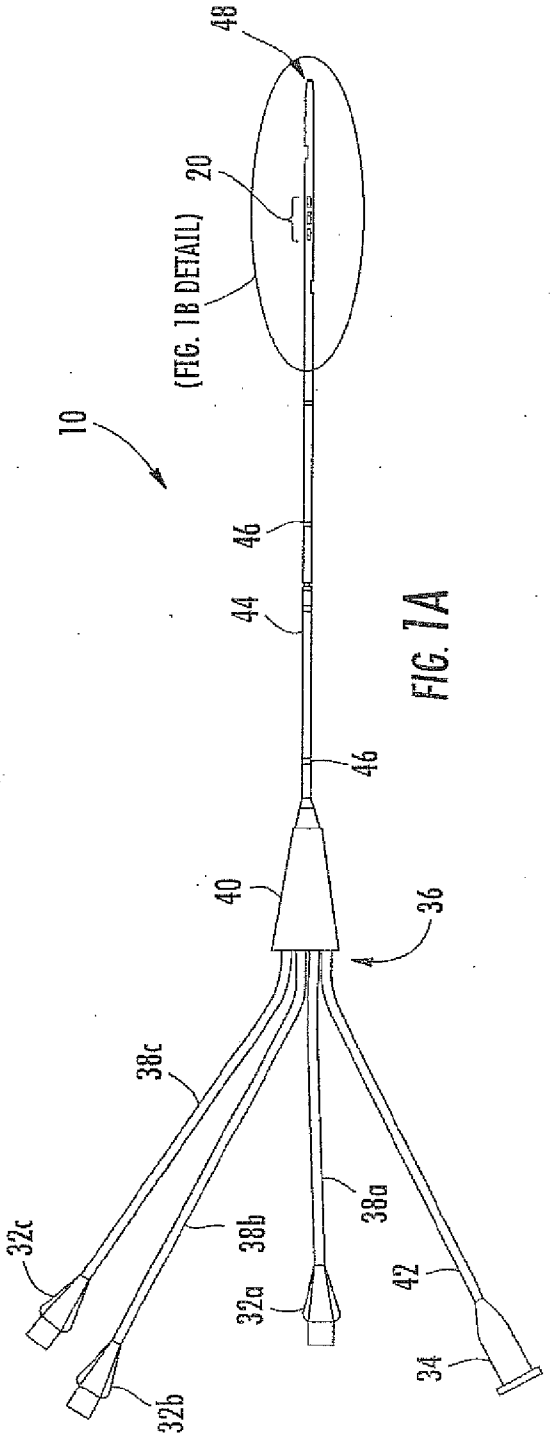

48
20
(FIG. 1B DETAIL)
10
46
44
46
40
36
38c
38b
38a
32c
32a
32b
42
34

FIG. 1A

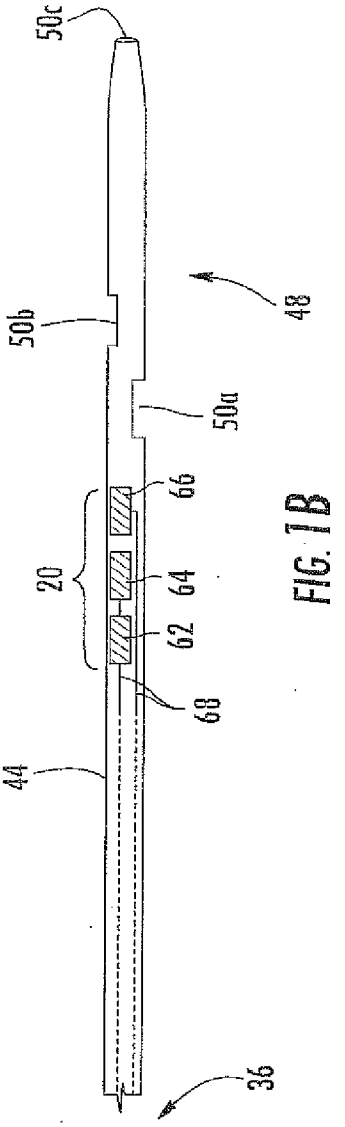

50c
50b
48
50a
66
20
64
62
68
44
36

FIG. 1B

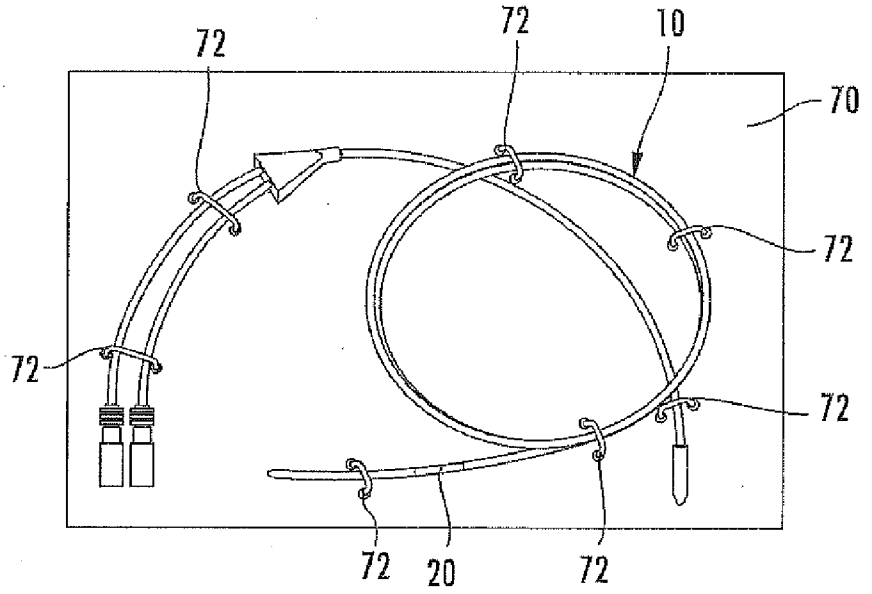



FIG. 2

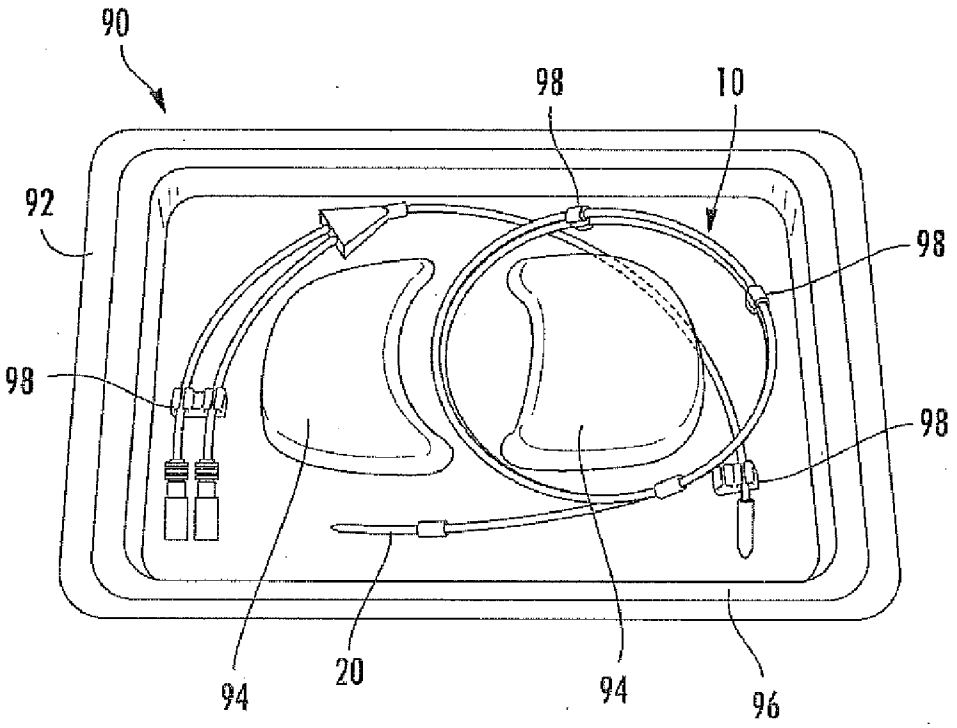



FIG. 5

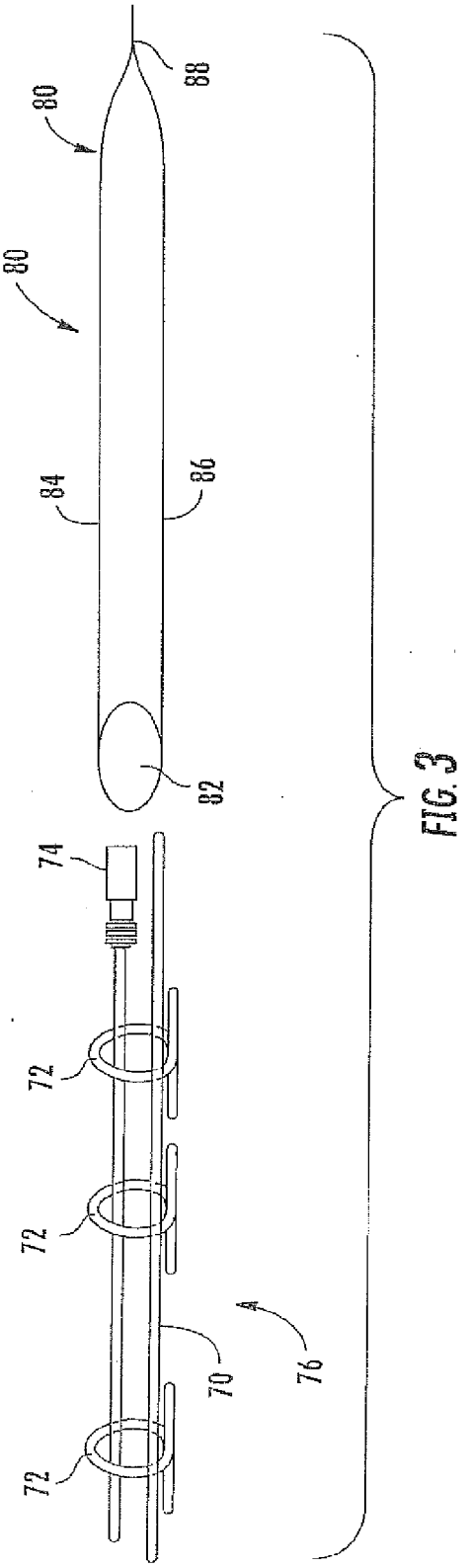



FIG. 3

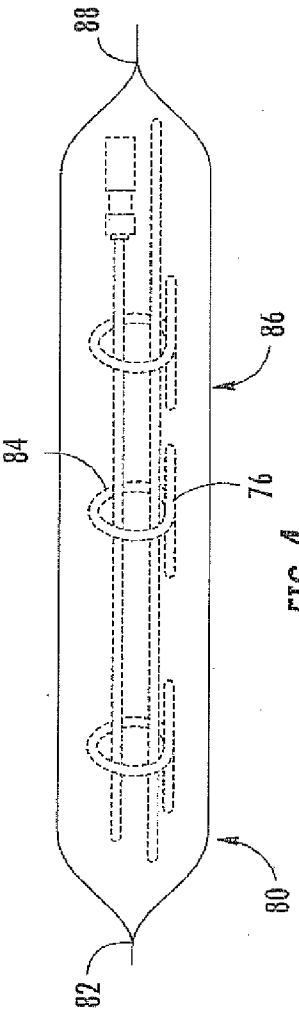



FIG. 4

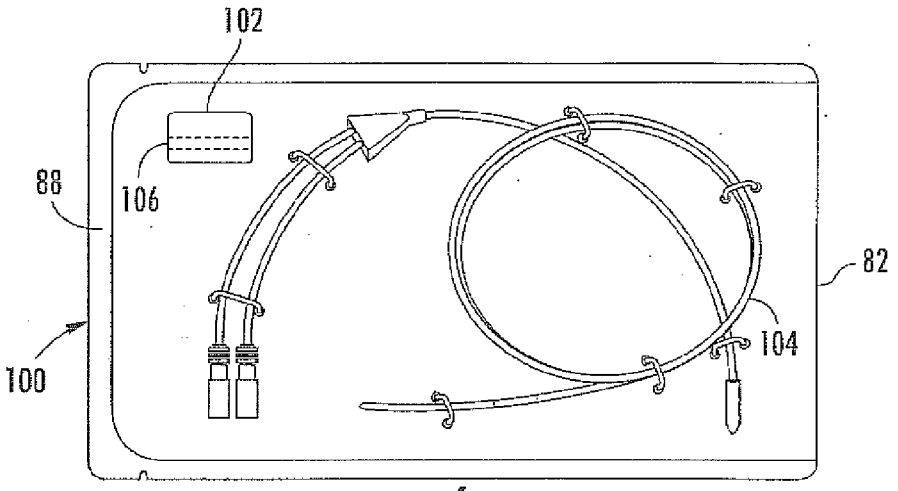



FIG. 6

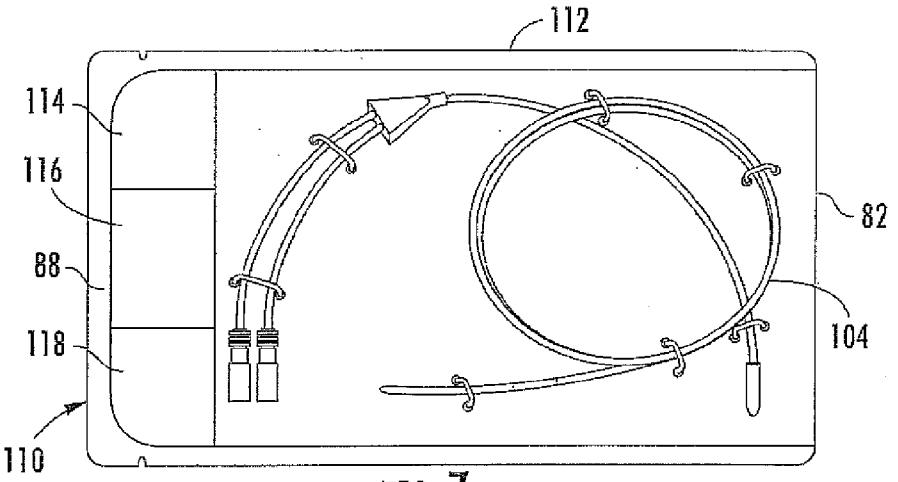



FIG. 7

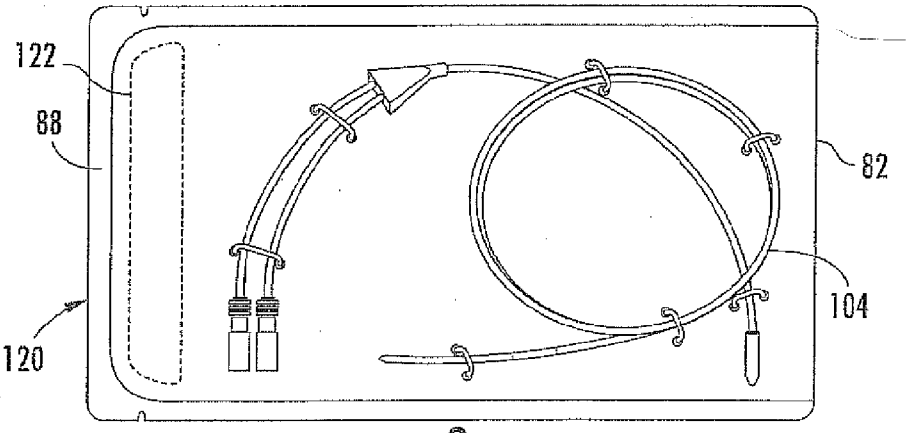



FIG. 8

# METHOD OF PACKAGING AND PACKAGE FOR SENSORS

## CLAIM OF PRIORITY UNDER 35 U.S.C. §119

**[0001]** The application claims the benefit of U.S. Provisional Application No. 61/122,246 filed Dec. 12, 2008, entitled "Method of Packaging and Package for Sensors" and assigned to the assignee hereof and hereby incorporated by reference in its entirety.

## FIELD AND BACKGROUND

**[0002]** The present invention relates to methods of packaging and packages for sensors such as enzyme sensors that prevent damage to the sensor and that maintain sterility of the sensor.

**[0003]** Sensors are known in the medical industry for use in analyzing fluids such as blood. These sensors generally have to be sterilized for use in the medical environment; however, known sterilization methods can result in degradation of sensor performance and a reduction in the sensor's shelf life. In addition, packaging delicate medical devices such as sensors requires that particular care be taken such that damage to either the sensor or the package itself does not occur. In particular, damage to the sensor can compromise performance of the device and damage to the package can compromise sterilization of the sensor.

**[0004]** One type of sensor used in the medical industry is an enzyme sensor. Glucose oxidase (GOx)-based enzyme sensors, for example, are used to measure blood glucose concentration. An enzyme sensor includes an enzyme that is immobilized using a membrane at the surface of an electrode. The membrane limits diffusion to the enzyme layer. Typically, these sensors are sterilized using radiation. However, radiation has been shown to denature the enzymes used in the sensor and to modify the polymer structure of the membranes thereby increasing the permeability of the membranes. Therefore, the amount of radiation used to sterilize enzyme sensors is preferably limited. Alternatively, steps must be taken to limit the effect sterilization has on the enzyme sensors.

**[0005]** The maintenance of low bioburden levels is necessary during manufacturing to minimize the radiation dose required to ensure the sterilization of enzyme sensors. Typically, lower bioburden levels are accomplished by limiting human contact with the sensor during production. However, maintaining low bioburden levels has the negative effect of increasing production time by requiring additional cleaning steps, increasing production cost by requiring replacement of gowns, gloves and other equipment used to maintain a sterile environment, and reduced yield resulting from the rejection of products not having the desired bioburden levels. This becomes particularly problematic for more complex devices where the bioburden levels are generally higher or at least much more difficult to minimize.

**[0006]** Furthermore, if the enzyme sensor is exposed to moisture and oxygen during sterilization, it can further reduce the shelf life of the enzyme sensor. In particular, the formation of ozone by subjecting oxygen and water to sterilization can result in denaturing enzymes. A reduction of ozone formation is typically accomplished by using lower radiation doses by controlling bioburden levels thereby limiting the amount of ozone formed by radiation. However, maintaining low bioburden levels has its own issues as discussed above.

## BRIEF SUMMARY

**[0007]** There are provided methods of packaging and packages that prevent damage of the sensors while maintaining sterility and that limit the negative effects of sterilization on sensors. A method of packaging a sensor such as an enzyme sensor includes providing an enzyme sensor such as a glucose oxidase sensor in a gas impermeable package comprising one or more of oxygen and water, removing a significant portion of the oxygen and water present in the package, and sealing the package. The resulting package comprises the enzyme sensor in an atmosphere that is substantially free of oxygen and water, e.g., having an oxygen content of no more than 1 mm Hg.

**[0008]** In some embodiments, a method of packaging an enzyme sensor includes providing an enzyme sensor in a gas impermeable package, wherein the package is inflatable and sealable, and comprises one or more of oxygen and water. The package can be a flexible material. A significant portion of the oxygen and water present in the package is removed by flushing the package with an inert gas such as nitrogen. The package is then inflated with excess pressure of the inert gas and sealed, such that the packaged material including the enzyme sensor cannot touch more than one non-adjacent surface of the package at a time. Typically, the packaged material includes a catheter onto which the enzyme sensor is situated and can further include a tray or sheet such as a cardboard sheet onto which the catheter can be mounted or fixed. The sealed package can be exposed to radiation such as e-beam or gamma radiation, or other known means for medical use.

**[0009]** In some embodiments, a method of packaging an enzyme sensor includes providing an enzyme sensor in a gas impermeable package, wherein at least a portion of the package is a rigid or semi-rigid material and the package comprises one or more of oxygen and water. A significant portion of the oxygen and water present in the package can be removed by drawing a vacuum on the package and sealing the package. For example, the package can be a thermoformed tray and the method can, include heat sealing a film layer onto the thermoformed tray to seal the package. The sealed package can be exposed to radiation such as e-beam or gamma radiation, or other known means for medical use.

**[0010]** The removal of a significant amount of the oxygen and water present in the package results in a sensor package that is substantially free of oxygen and water. Thus, when radiation such as e-beam or gamma radiation is used to sterilize the package contents, it can be used at higher doses than those presently used for sterilizing enzyme sensors. This is because the removal of oxygen results in a reduction in the production of free radicals and thus the production of ozone in the package in the sterilization process.

**[0011]** The packaging methods allow enzyme sensors to be produced more quickly and more cheaply than by prior art methods wherein the effects of sterilization are mitigated by controlling bioburden alone. Furthermore, as there are many attributes of sensors that are difficult to control individually at design time, it is possible to design a sensor for the best performance without the need to focus on the effects of sterilization and the methods that must be used to mitigate the effects of sterilization. In addition, the packaging methods allow for a simple but reliable way to package the sensor without increasing mass, which is costly to ship and which

can create mask areas during sterilization. These mask areas can make sterilization less predictable and can require higher doses of radiation, thereby possibly further degrading sensor performance.

**[0012]** In some embodiments, a sensor package comprises a pouch including a sensor and a pressure indicator that indicates when a particular pressure is reached adjacent the pressure indicator. The pouch can include the pressure indicator and/or the pressure indicator can be provided elsewhere in the package such as in one or more isolated chambers. In some embodiments, the pressure indicator can include a burst point that avulses when the pressure indicator reaches a predetermined pressure, a color indicator that becomes activated when the pressure indicator reaches a predetermined pressure, and/or an audible sound when the pressure indicator reaches a predetermined pressure. The pouch can, in some embodiments, include an inner pouch and the inner pouch can include a burst point as a pressure indicator when the inner pouch reaches a predetermined pressure. The inner pouch can further include an aqueous electrolytic solution and/or a sterilizing agent.

**[0013]** These and other features and advantages will become more readily apparent to those skilled in the art upon consideration of the following detailed description and accompanying figures.

## BRIEF DESCRIPTION OF THE FIGURES

**[0014]** FIG. **1**A is a side view of a multilumen catheter assembly.

**[0015]** FIG. **1**B is a magnified detail of the distal end of the multilumen catheter of FIG. **1**A including an enzyme sensor.

**[0016]** FIG. **2** is a top view of a catheter including an enzyme sensor and a package prior to insertion of the catheter into the package.

**[0017]** FIG. **3** is a side view of a package including a catheter that includes an enzyme sensor.

**[0018]** FIG. **4** is a perspective view of the sealed and inflated package comprising a catheter that includes an enzyme sensor.

**[0019]** FIG. **5** is a top view of a catheter that includes an enzyme sensor provided in tray.

**[0020]** FIG. **6** is a top view of a pouch that includes a pressure indicator in the form of a burst point.

**[0021]** FIG. **7** is a top view of a package that includes a pouch and one or more compartments that include pressure indicators.

**[0022]** FIG. **8** is a top view of a pouch that includes a inner compartment that can include a liquid that enters the pouch at a particular pressure.

## DETAILED DESCRIPTION

**[0023]** As used in the specification, and in the appended claims, the singular forms "a", "an", "the", include plural referents unless the context clearly dictates otherwise. The term "comprising" and variations thereof as used herein is used synonymously with the term "including" and variations thereof and are open, non-limiting terms.

**[0024]** Methods of limiting possible damage to the sensor or the packaging material during shipping comprise providing an enzyme sensor such as a glucose oxidase sensor in a gas impermeable package. The methods can also limit the negative effects of sterilization on enzyme sensors.

**[0025]** In the normal process for producing a package and providing the sensor within the package, the package can include one or more of oxygen and water. Furthermore, regardless of the process used to produce the package and the desire to minimize the bioburden, microorganisms will generally exist in the package. In the packaging methods, a significant portion of the oxygen and water present in the package is removed using an inert process, i.e., a process that does not have an appreciable effect on the microorganisms present in the package. For example, the inert process would kill less than 50%, generally less than 25% and typically less than 10% of the microorganisms present in the package. The removal of a significant amount of the oxygen and water present in the package results in a sensor package that is substantially free of oxygen and water, e.g., having less than 1 mm Hg of oxygen prior to sterilization.

**[0026]** In some embodiments, the sensor can be provided on a catheter. For example, FIG. **1**A illustrates a multilumen catheter assembly **10** in which a sensor **20** is integrated into the catheter. The catheter assembly **10** can include multiple infusion ports **32***a*, **32***b*, and **32***c* (collectively referred to as reference number **32**) and one or more electrical connectors **34** disposed adjacent to a proximal end **36** of the catheter assembly **10**. One or more lumens **38***a*, **38***b*, and **38***c* (collectively referred to as reference number **38**) can connect each infusion port **32***a*, **32***b*, and **32***c*, respectively, to a junction **40**. Similarly, a conduit **42** can connect an electrical connector **34** to the junction **40**, and can terminate at junction **40**, or at one of the lumens **38***a*-**38***c* (as shown). Although the particular embodiment shown in FIG. **1**A is a multilumen catheter having three fluid lumens and one electrical lumen, other embodiments having other combinations of lumens and connectors can be used, including a single lumen catheter, a catheter having multiple electrical connectors, etc. In some embodiments, one of the lumens and the electrical connector can be reserved for a probe or other sensing element mounting device, or one of the lumens can be open at its proximal end and designated for insertion of the probe or biosensor mounting device.

**[0027]** The junction **40** connects the lumens **38***a*-**38***c* and the conduit **42** to a narrow elongated tube **44** that forms an insertion portion of the catheter assembly **10**. The tube **44** is typically cylindrical, having a circular or somewhat oval cross section defining a longitudinal axis extending therethrough. The tube **44** can be formed from any material, including synthetic materials such as silicone, polyurethane, polyethylene, and the like. Through the junction **40**, each of the lumens **38***a*-**38***c* extend in separate parallel paths for some distance into the distal end of tube **44**. One or more support structures **46** within the tube **44** can be disposed along the length of the catheter to provide rigidity.

**[0028]** The distal end **48** of the catheter assembly **10** is shown in greater detail in FIG. **1**B. At one or more intermediate locations along the distal end, the tube **44** can include one or more recesses formed in an outer wall of the tube. In some embodiments, the recess can define an opening in the outer wall of the tube through which a body fluid can flow into a lumen that is in communication with the opening. In some embodiments, the recess can define a port formed in the outer wall of the tube that defines an opening through which a bodily fluid can flow through the port and into the lumen, and vice versa. In the illustrated embodiment, the ports include the intermediate ports **50***a* and **50***b*, and an end port **50***c* (collectively referred to as reference number **50**) that can be

formed towards the distal tip of tube **44**. Each port **50***a*-**50***c* can correspond respectively to one of the lumens **38***a*-**38***c* or conduit **42**. That is, each lumen can define an independent channel extending from one of the infusion ports **32***a*-**32***c* and conduit **42** to one of the ports **50***a*-**50***c* located towards the distal end of the tube **44**.

**[0029]** As shown in FIGS. **1**A and **1**B, the catheter **10** can include the sensor **20** proximate to the distal end **48** of the catheter for monitoring one or more analytes. The enzyme sensor can include one or more electrodes **62**, **64**, **66** created on a surface of a flexible substrate and associated with the catheter **10**. The sensor **20** can communicate with the lumen **38** in the catheter **10** such that an active portion, e.g., a portion containing an electrode, can be exposed to space outside the tube **44**. Electrical wires **68** coupled to electrodes **64** and **66** can extend from the sensor **20** through the lumen **38** to provide a conductive path through the lumen **38** and the conduit **42** that can terminate at the electrical connector **34**. The electrical wires **68** can be attached to the sensor elements with a weld, solder, conductive adhesive, such as a conductive epoxy, and the like. In some embodiments, the electrical wires **68** can be bonded to the sensor **20**. Although the electrical wires **68** are drawn such that they terminate within the tube **44**, the electrical wires will typically extend and communicate with an electrical connector, e.g., electrical connector **34**.

**[0030]** The sensor provided on a catheter can be mounted or affixed to an insert tray or sheet **70**. For example, in FIG. **2**, the sensor **20** is provided on catheter **10** and the catheter **10** is mounted onto the tray or sheet **70**. The tray or sheet **70** can be made of a suitable material such as a cardboard. The catheter **10** can be further affixed to the cardboard sheet using plastic clips, plastic ties or plastic coated metal ties **72**. As shown in the side view of the catheter **10** and the tray or sheet **70** illustrated in FIG. **3**, portions of the catheter **74** and the ties **72** can provide high points or rough points in the material to be packaged **76**.

**[0031]** As shown in FIG. **3**, the material to be packaged **76** can be inserted into a gas impermeable package **80** that can be sealed and inflated. For example, a heat-sealable foil pouch made from a polyester outer layer, a polyethylene inner layer, and an aluminum lining layer can be used as the package **80**. The material to be packaged **76** can be inserted through an open end **82** of a package **80** including two separate faces **84** and **86**, and a closed end **88**.

**[0032]** Once the material to be packaged **76** is placed in the package **80**, oxygen and water from the package can be removed by flushing the package with an inert gas. For example, nitrogen, a noble gas, or a combination thereof can be used to flush the package contents. These gases are provided in dry form, with a moisture content of less than 1%, more preferably less than 0.1%. This can be accomplished prior to sealing the package by using an opening in the package (such as open end **82**) for entry of the inert gas and driving out any gases present in the package such as oxygen and water using the inert gas. The package can then be inflated with excess pressure of the inert gas and sealed, such that the packaged material including the enzyme sensor cannot touch more than one non-adjacent surface of the package at a time, e.g., cannot touch both interior faces **84** and **86** of a metal foil-lined pouch. The open end of the package **82** can then be sealed via known means such as heat sealing resulting in a sealed package such as the package **80** shown in FIG. **4**.

**[0033]** By having the package **80** is at least partially inflated with an inert gas, the interior components of the package (the packaged material **76**) are protected from damage upon external pressure. In particular, as pressure is applied, the trapped gases push back on the pouch increasing resistance. This pressure will match the external pressure and negate it, thus preventing damage to the contained sensors. For example, when the inflated packaged is further packaged (e.g. in a box), the movement from shipping will not cause adjacent packages in the box to damage each other and will not cause friction to wear a hole in the package. In addition, when the packaged material cannot simultaneously touch both horizontal faces of the pouch, the packaged material will not puncture the pouch during vibration of transportation, which will ensure sterility of the sensor until time of use.

**[0034]** In some embodiments, the sensor can be provided in a rigid or semi-rigid package that has enough rigidity that it does not significantly collapse when the vacuum is drawn on the package. For example, the sensor can be provided in a thermoformed tray. In some embodiments, the sensor can be provided on a catheter and the catheter provided in a tray. For example, as shown in FIG. **5**, a sensor **20** can be provided on a catheter **10** in a thermoformed tray **90**. The thermoformed tray can include inset portions that prevent the catheter **10** from extending above the upper surface **92** of the tray. The thermoformed tray **90** can include protrusions **94** and/or plastic clips **98** that hold the catheter **10** in place within the tray.

**[0035]** The sensor **20** and/or catheter **10** provided in the insert tray **90** can be placed in a vacuum chamber wherein the removal of oxygen and water can be accomplished by drawing a vacuum on the package. This can be accomplished by removing any gases from the package using a vacuum process and then sealing the package. For example, a film (not shown) can be heat sealed along an outer edge **96** of the package. The package can also be flushed with an inert gas prior to drawing a vacuum on the package and sealing the package.

**[0036]** The interior of the package produced by the above methods can be substantially free of oxygen and water. The environment in the package typically has an oxygen content of less than 1 mm Hg. By using appropriate techniques of vacuum cycling with inert gas, then sealing in vacua, the partial pressure of oxygen can be a small fraction of the total pressure in the sealed package, which can be 1 to 10 mm Hg. Likewise, the partial pressure of water in the sealed package will be a small fraction of the total pressure as stated previously. Thus, the amount of oxygen can be less than 0.5 mm Hg or even less than 0.1 mm Hg in the sealed package. Furthermore, the amount of water can be less than 1 mm Hg, less than 0.5 mm Hg, or even less than 0.1 mm Hg in the sealed package.

**[0037]** The sealed package produced by any of the above methods can be exposed to radiation or any other known means to sterilize the contents therein. Preferably, e-beam or gamma radiation is used to sterilize the package contents although other forms of radiation can alternatively be used. The radiation can be used at higher doses and/or the sensor package can be at higher bioburden levels than those presently used for sterilizing enzyme sensors because of the reduction in the production of free radicals and thus the production of ozone in the package resulting from the sterilization process. In particular, in present systems, the required e-beam dose is in the order of about 19 kGy and requires a bioburden level to be below about 19.7 CFU's. Using the method of the present invention, the bioburden level can be

greater than 25 CFU's, greater than 50 CFU's, greater than 75 CFU's, greater than 100 CFU's, greater than 125 CFU's and even greater than 150 CFU's and still provide a sufficiently sterilized enzyme sensor. Alternatively, much higher does of radiation at these bioburden values can be used in the order of 25 kGy or greater, 30 kGy or greater, 35 kGy or greater, or even 40 kGy or greater, for e-beam radiation levels.

**[0038]** A system for producing a package for a sensor can include means for inserting a sensor (or packaged material including a sensor) into the package; means for one of flushing the sensor with an inert gas or drawing a vacuum on the package; optionally means for inflating the package, and means for sealing the package. The system can also include means for forming the package includes thermoforming or trimming a sheet of plastic, or by other means known in the art. The sensor is typically inserted into the open package by a conveyor, by hand or by other means known in the art. The open sensor package can be flushed with an inert gas by inserting a nozzle into the open end of the pouch and by closing the bars on an impulse sealer at such a time as to leave the pouch partially inflated. The resulting package can be sterilized by subjecting the package to radiation using e-beam or gamma radiation or another process known in the art.

**[0039]** As an alternative to or in addition to including means for flushing with an inert gas, the package can include means of drawing a vacuum and sealing the package while it is subjected to the vacuum and suitable means are known in the art. For example, a vacuum can be drawn on a rigid package by using a pump to pull air and other gases from the open package by placing the package in a vacuum chamber and then sealing said package, or by other means known in the art. The open package can be sealed using a heat sealing process or another process known in the art.

**[0040]** The sensors packaged according to the invention are particularly useful in systems where enzyme sensors are typically used. For example, the sensors can be used for real-time measurement of redox active chemical species in a bodily fluid by taking in vivo measurements; however, the membranes and electrodes are also useful otherwise. For example, the sensors can be used for continuous measurement in a laboratory setting. In certain embodiments, the sensors can be used with automated testing equipment.

**[0041]** The sensor can be provided within a probe or catheter for intravenous insertion into a patient. When the sensors and methods of the invention find use for in vivo testing in a live subject, placement of the sensor can be by any useful method known in the art using known devices, such as catheters. In these settings, the sensor can function as an amperometric sensor while immersed in a patient's bloodstream. In certain embodiments, catheters such as a multilumen catheter, a central venous catheter (CVC), a pulmonary artery catheter (PAC), a peripherally inserted central catheter (PICC), or other commonly used peripheral intravenous (IV) lines can provide a suitable platform for effective intravenous positioning of the sensor. For example, the sensor can be positioned in the patient's bloodstream by inserting a probe including the sensor through a CVC or PAC or through a peripheral IV catheter or by using an introducer. One advantage of using a CVC or PAC for installing an intravenous sensor is its ability to reach the largest blood vessels of the body where a sensor can be exposed to an abundant flow of blood. Further, certain embodiments of the invention can be economically employed for use with multilumen catheters. Alternately, the sensor can be attached to a venous arterial blood management protection (VAMP) system by drawing a blood sample from the intravascular space and exposed to the sensor ex vivo.

**[0042]** Specifically, in one embodiment, a sensor according to the invention can be described as being in association with a catheter. In such embodiments, "association" comprises any method of combining a sensor and a catheter allowing for in vivo sensing using the sensor. For example, association can refer to direct attachment of the sensor to a surface of the catheter subject to ambient conditions. Association can also refer to a combination of the sensor and a catheter such that the sensor is directly adjacent the catheter (i.e., in a working proximity thereto) but not attached thereto. Still further, association can encompass placement of the sensor within a lumen of the catheter. Thus, association means that the sensor and the catheter are sufficiently related such that placement of the catheter in vivo likewise results in placement of the sensor in vivo.

**[0043]** In embodiments where a pouch or bag is used, the pouch or bag can include an indicator that shows when the pouch or bag has exceeded a maximum pressure. For example, as shown in FIG. **6**, a pouch **100** including the sensor (or a catheter including the sensor **104**) can have a weakened location or burst point **102** that avulses when the pressure exceeds a maximum value. The burst point **102** can be provided by providing a portion of the pouch **100** with a thinner film layer or by roughening the surface of the pouch at the location of the burst point without creating a hole in the pouch. The burst point **102** can have a color indicator **106** (e.g. a bright red indicator) that is readily apparent on the pouch **100** and that can further include a warning not to use the sensor. The color indicator **106** can be provided on the interior side of the film forming the pouch **100** and can become colored, e.g., upon exposure to oxygen. The pouch **100** can be inflated to a predetermined pressure at a predetermined temperature (e.g. at room temperature) and a predetermined volume (e.g. the fully inflated volume of the pouch). Based on the ideal gas law (PV=nRT), a maximum pressure could be determined that would cause the burst point **102** to avulse. Accordingly, if the pouch **100** were to burst at the burst point **102**, the end user would know that the pouch exceeded the maximum pressure.

**[0044]** In some embodiments, the burst point **102** could alternatively or additionally provide a sound such as a "pop" that would indicate to a person involved in the delivery or storage of the sensors provided in the pouches that the pouches need to be moved to a higher pressure and/or lower temperature environment to preserve the sterility of the other sensors provided in the pouches.

**[0045]** In some embodiments as shown in FIG. **7**, a package **110** can include a pouch **112** including the sensor and one or more isolated chambers (e.g. **114**, **116** and **118**) on the package of different sensitivities that burst progressively based on the pressures the package is subjected to. For example, the isolated chambers **114**, **116** and **118** could have burst points that would burst at 90%, 95% and 100% of what would be the maximum pressure for the pouch **112**. Alternatively, if the pouch **112** also includes a burst point provided at 100% of the maximum pressure, the isolated chambers **114**, **116** and **118** could have burst points at 85%, 90% and 95% of the maximum pressure. The isolated chambers **114**, **116** and **118** can help to preserve the sterility of the sensor for pressures below a maximum pressure.

**[0046]** In some embodiments as shown in FIG. **8**, a pouch **120** can include an inner compartment **122** that includes a burst point that is set to avulse at a particular pressure. The inner compartment **122** can include a liquid (e.g. an aqueous electrolytic solution) that can wet the sensor or a sterilizing agent that can provide sterility to the sensor and extend its life. In the event a liquid is used pre-wet the sensor, the liquid can be used to reduce run-in time for the sensor.

**[0047]** The method of the present invention allows enzyme sensors to be produced more quickly and more cheaply than by prior art methods wherein the effects of sterilization are mitigated by controlling bioburden alone. Furthermore, as there are many attributes of sensors that are difficult to control individually at design time, it is possible to design a sensor for the best performance without the need to focus on the effects of sterilization and the methods that must be used to mitigate the effects of sterilization.

That which is claimed:

**1**. A method of packaging an enzyme sensor, comprising:
providing an enzyme sensor in a gas impermeable package, said package being inflatable and sealable, and comprising one or more of oxygen and water;
removing a significant portion of the oxygen and water present in the package by flushing the package with an inert gas;
inflating the package with excess pressure of said inert gas, and
sealing the package,
wherein the package is inflated such that the packaged material including the enzyme sensor cannot touch more than one non-adjacent surface of the package at a time.

**2**. The method according to claim **1**, wherein said inert gas is nitrogen.

**3**. The method according to claim **1**, further comprising the step of exposing the sealed package to radiation.

**4**. The method according to claim **3**, wherein the radiation is e-beam radiation.

**5**. The method according to claim **3**, wherein the radiation is gamma radiation.

**6**. The method according to claim **1**, wherein the package is a metal foil-lined pouch.

**7**. The method according to claim **1**, wherein the enzyme sensor is a glucose oxidase sensor.

**8**. The method according to claim **1**, wherein the enzyme sensor is provided on a catheter.

**9**. The method according to claim **8**, wherein the catheter is provided on a sheet or tray and affixed thereto.

**10**. The method according to claim **1**, wherein the gas impermeable package is a flexible material.

**11**. A sensor package, comprising:
an enzyme sensor stored in a sealed gas impermeable package, said package being inflated with an inert gas such that the packaged material including the enzyme sensor cannot touch more than one non-adjacent surface of the package at a time.

**12**. The package according to claim **11**, wherein the package is substantially free of oxygen and water.

**13**. The package according to claim **11**, wherein the package includes no more than 1 mm Hg oxygen.

**14**. The package according to claim **11**, wherein the enzyme sensor is a glucose oxidase sensor.

**15**. The package according to claim **11**, wherein said inert gas is nitrogen.

**16**. The package according to claim **11**, wherein the package is a metal foil-lined pouch.

**17**. The package according to claim **11**, wherein the enzyme sensor is provided on a catheter.

**18**. The package according to claim **17**, wherein the catheter is provided on a sheet or tray and affixed thereto.

**19**. The package according to claim **11**, wherein the gas impermeable package is a flexible material.

**20**. A method of packaging an enzyme sensor, comprising:
providing an enzyme sensor in a gas impermeable package, wherein at least a portion of the package is a rigid or semi-rigid material and the package comprises one or more of oxygen and water;
removing a significant portion of the oxygen and water present in the package by drawing a vacuum on the package; and
sealing the package.

**21**. The method according to claim **20**, further comprising the step of exposing the sealed package to radiation.

**22**. The method according to claim **21**, wherein the radiation is e-beam radiation.

**23**. The method according to claim **21**, wherein the radiation is gamma radiation.

**24**. The method according to claim **21**, wherein the package comprises a tray.

**25**. The method according to claim **24**, wherein the tray is thermoformed.

**26**. The method according to claim **25**, wherein said sealing step comprises heat sealing a film layer onto said thermoformed tray.

**27**. The method according to claim **21**, wherein the enzyme sensor is a glucose oxidase sensor.

**28**. The method according to claim **21**, wherein the enzyme sensor is provided on a catheter.

**29**. A sensor package, comprising:
an enzyme sensor stored in a sealed gas impermeable package, said package being vacuum sealed and being substantially free of oxygen and water.

**30**. The package according to claim **29**, wherein the package includes no more than 1 mm Hg oxygen.

**31**. The package according to claim **29**, wherein the enzyme sensor is a glucose oxidase sensor.

**32**. The package according to claim **29**, wherein at least a portion of the package is a rigid or semi-rigid material.

**33**. The package according to claim **32**, comprising a thermoformed tray.

**34**. The package according to claim **33**, further comprising a film layer heat sealed to said thermoformed tray.

**35**. The package according to claim **29**, wherein the enzyme sensor is provided on a catheter.

**36**. A sensor package comprising:
a pouch including a sensor; and
a pressure indicator that indicates when a particular pressure is reached adjacent the pressure indicator.

**37**. The package according to claim **36**, wherein the pouch includes the pressure indicator.

**38**. The package according to claim **36**, wherein the pressure indicator includes a burst point that avulses when the pressure indicator reaches a predetermined pressure.

**39**. The package according to claim **36**, wherein the pressure indicator includes a color indicator that becomes activated when the pressure indicator reaches a predetermined pressure.

**40**. The package according to claim **36**, wherein the pressure indicator provides an audible sound when the pressure indicator reaches a predetermined pressure.

**41**. The package according to claim **36**, further comprising one or more isolated chambers wherein the isolated chambers include the pressure indicator.

**42**. The package according to claim **41**, wherein the pouch also includes a pressure indicator.

**43**. The package according to claim **36**, wherein the pouch includes an inner pouch and the inner pouch includes a burst point as a pressure indicator when the inner pouch reaches a predetermined pressure.

**44**. The package according to claim **43**, wherein the inner pouch includes an aqueous electrolytic solution and/or a sterilizing agent.

* * * * *