PACKAGING SYSTEM WITH OXYGEN SENSOR FOR LIMITED LIFE OPTICAL MEDIA

Inventors: William N. Schoen, Portland, ME (US); Robert F. Thompson, Kennebunk, ME (US)

Correspondence Address:
MORRIS MANNING & MARTIN LLP
1600 ATLANTA FINANCIAL CENTER
3343 PEACHTREE ROAD, NE
ATLANTA, GA 30326-1044 (US)

Assignee: Flexplay Technologies, Inc., Atlanta, GA

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Abstract

A packaging system and/or storage arrangement for limited life optical media that includes a provision to indicate the presence of oxygen and/or the amount of oxygen present. An oxygen-sensitive material is placed inside a sealable container. The oxygen-sensitive material will undergo a detectable change in the presence of oxygen and/or a detectable change occurs that will correspond to the amount of oxygen present in the sealable container. The detectable change provides an indication of the presence of oxygen and/or a measure of the amount of oxygen inside the sealable container.
Fig. 2.
PACKAGING SYSTEM WITH OXYGEN SENSOR FOR LIMITED LIFE OPTICAL MEDIA

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit under 35 U.S.C. § 119(e) of U.S. Provisional Patent Application Ser. No. 60/659,801 for “Packaging System With Oxygen Sensor For Limited Life Optical Media,” which was filed Mar. 9, 2005, and which is incorporated herein by reference in its entirety.

FIELD OF THE INVENTION

[0002] The present invention relates to the field of packaging of limited life optical media. More particularly, the present invention is directed to methods and arrangements for packaging limited life media whereby a change in an oxygen-sensitive material indicates the presence and/or the amount of oxygen inside the packaging and allows, for example, the remaining shelf life of the limited life optical media to be determined, a determination as to whether the package was sealed correctly and/or a determination as to whether an oxygen scavenger material was activated.

BACKGROUND OF THE INVENTION

[0003] In certain types of limited play optical media it is desirable to package the product in a controlled atmosphere or environment to ensure freshness or to promote proper chemical activity. In applications where a controlled atmosphere or environment is desirable, it may be beneficial to be able to determine the amount of oxygen in the controlled atmosphere or environment.

[0004] Currently, there are several types of oxygen, and oxidation, sensors designed to be used in packaging applications. See, for example, U.S. Pat. No. 4,526,752 to Perlman et al., U.S. Pat. No. 5,096,813 to Knmehr et al., U.S. Pat. No. 6,399,387 to Stenhom et al., and U.S. Pat. No. 6,325,974 to Ahvenainen et al., hereinafter incorporated by reference in their entirety.

SUMMARY OF THE INVENTION

[0005] In some embodiments, the present invention is directed toward a method and packaging system and/or storage arrangement including at least one limited play optical medium and an oxygen-sensitive material that is suitable for detecting the presence of oxygen and/or the amount of oxygen inside the package. In addition, at least some of the oxygen-sensitive materials of the present invention can be incorporated onto the limited play optical media itself. By using the oxygen-sensitive material as a component piece of a limited play optical medium, or other device, the device itself becomes an oxygen indicator, thereby removing any ambiguity regarding the contact of the device with the ambient atmosphere. In some embodiments, the oxygen-sensitive materials are activated in an oxygen-free environment. As used in this application, the term “activated” or “active” means that the oxygen-sensitive material will undergo a visual change when exposed to oxygen. Thus, the present invention creates an effective storage arrangement having means for detecting the presence of oxygen and/or the amount of oxygen, and ultimately for determining the remaining shelf life of a limited play optical media, quality check on whether the package was properly sealed, and/or a determination as to whether an oxygen scavenger material was activated.

[0006] In one embodiment of the present invention, a sealable container adapted to isolate the contents thereof from the ambient atmosphere and/or act as barrier layer to control the rate at which the outside atmosphere is introduced is provided with an oxygen-sensitive material located within the sealable container.

[0007] A container as used throughout the disclosure is inclusive of any and all package, bag, chamber, packet, pouch, receptacle, repository, sack, storage device, case, envelope, casing, cover, covering, enclosure, pocket, and/or wrapping. Sealable as used throughout the disclosure is inclusive of any and all mechanical and/or chemical mechanisms and/or methods of closing a container. The oxygen-sensitive material can be any material that undergoes a visual and/or detectable and/or observable change when in contact with oxygen.

[0008] In another embodiment of the present invention, in order to sense oxygen and/or determine the amount of oxygen within a package, an oxygen sensitive material is attached to the inside of the package. The material is illuminated with a pulsed blue light from an LED. The blue light is absorbed by the oxygen sensitive material and red light is emitted. The red light is detected by a photo-detector and the fluorescence lifetime is measured. Different lifetimes indicate different levels of oxygen within the package. The change in the emission intensity and lifetime is related to the oxygen partial pressure and can be calibrated to determine the oxygen concentration. The measurement is passive, totally reversible and no oxygen is consumed in the process. The fluorescence lifetime is reduced due to the presence of oxygen; this change can be calibrated to make a powerful sensor that has a large dynamic range. The oxygen measurement technique is based upon the fluorescence quenching of a metal organic fluorescent dye immobilized in a gas permeable hydrophobic polymer. The dye absorbs light in the blue region and fluoresces within the red region of the spectrum. The presence of oxygen quenches the fluorescent light from the dye as well as its lifetime. The quenching process is a purely collisional dynamic where the energy from the excited fluorescent dye is transferred to the oxygen molecule during a collision, hence, reducing the emission intensity as well as the fluorescent lifetime of the dye.

[0009] In a method according to the present invention, an oxygen-sensitive storage arrangement is produced by placing an oxygen-sensitive and/or oxygen measuring material inside a sealable container. The oxygen-sensitive and/or oxygen measuring material can be any material that undergoes a visual change with oxygen.

[0010] In an overlapping embodiment in accordance with the present invention a sealable container is disclosed, wherein the sealable container encloses an optical storage device that is configured to have a limited usable life for at least a portion of data stored on the optical storage device and an oxygen sensitive material.

[0011] In a further overlapping embodiment in accordance with the present invention the oxygen sensitive material resides on the optical storage device.
In another overlapping embodiment in accordance with the present invention the oxygen sensitive material resides on an internal surface of said container.

In yet another overlapping embodiment in accordance with the present invention the oxygen sensitive material is integral to said container.

In another overlapping embodiment in accordance with the present invention the oxygen sensitive material is in the shape of a small dot.

In another overlapping embodiment in accordance with the present invention the container is selected from one of a package, bag, chamber, packet, pouch, receptacle, repository, sack, storage device, case, envelop, casing, cover, covering, enclosure, pocket, or wrapping.

In a further overlapping embodiment in accordance with the present invention the sealable container is sealable by at least one mechanical and chemical mechanism.

In yet another overlapping embodiment in accordance with the present invention the sealable container is re-sealable after once being opened.

In another overlapping embodiment in accordance with the present invention the sealable container includes a window that allows observation of the oxygen sensitive material.

In another overlapping embodiment in accordance with the present invention the optical storage device is selected from at least one of CD-ROM, CD-WORM, CD-I, DVI, CD-ECD, OD3, ODD, Video Disk, IVD, Blu-ray, HD-DVD, DVD, DVD-R, DVD-Video, DVD-RAM, DVD-Audio, DVD-RAM, DVD-RW, DVD+RW, DVD+R, SACD, holographic versatile discs, and 3-D optical storage devices.

In an overlapping embodiment in accordance with the present invention a method is disclosed for observing the amount of oxygen in the sealable container. The method includes observation of at least one spectral property of the oxygen sensitive material and comparison of the observed spectral properties of the oxygen sensitive material to a set of known properties of the oxygen sensitive material.

In yet another overlapping embodiment in accordance with the present invention a method is disclosed for observing the amount of oxygen in the sealable container. The method includes observation of at least one spectral property of the oxygen sensitive material, comparison of the observed spectral properties of the oxygen sensitive material to a set of known properties of the oxygen sensitive material, illuminating said oxygen sensitive material with a pulsed blue light from an LED, detecting the amount of red light given off by the oxygen sensitive material using a photodetector, measuring the fluorescence lifetime, comparing the amount of red light given off by the oxygen sensitive material and the fluorescence lifetime to the set of known properties for the oxygen sensitive material, and determining the amount of oxygen in the sealable container.

BRIEF DESCRIPTION OF THE DRAWINGS

Other objects of the present invention and many of the attendant advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings, in which like reference numerals designate like parts throughout the figures thereof and wherein:

FIG. 1 is a schematic perspective view of one embodiment of a storage arrangement according to the present invention where a container and an oxygen-sensitive material are provided; and

FIG. 2 is a perspective view of one embodiment of a storage container of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

A container as used throughout the disclosure is inclusive of any and all package, bag, chamber, packet, pouch, receptacle, repository, sack, storage device, case, envelop, casing, cover, covering, enclosure, pocket, and/or wrapping. Sealable as used throughout the disclosure is inclusive of any and all mechanical and/or chemical mechanisms and/or methods of closing a container, which can be (but not required to be) resealable after the container is initially opened. The oxygen-sensitive material can be any material that undergoes a visual and/or detectable and/or observable change when in contact with oxygen.

In one embodiment of the present invention, a packaging system or storage arrangement is provided that comprises a sealable container adapted to isolate the contents of the sealable container from the ambient atmosphere. In this embodiment, an oxygen-sensitive material and/or oxygen measuring material is located inside the sealable container. The oxygen-sensitive material and/or oxygen measuring material can undergo a detectable change upon contact with oxygen. In one embodiment, the detectable change is a color change. In some embodiments, the detectable change is fluorescence. In some embodiments, the oxygen-sensitive material comprises a polycarbonate material. In one embodiment, the polycarbonate material comprises materials available from OxySense® with a location at 13111 N. Central Expressway, Suite 440, Dallas, Tex. 75243 USA. In some embodiments, the sealable container is substantially free of oxygen. In one embodiment, the sealable container is a foil pouch.

In another embodiment of the present invention, a limited life optical media is provided. The limited life optical media includes encoded information features that are readable by an optical media reading device. The limited life optical media further includes a read-inhibiting agent that prohibits the optical media reading device from reading at least some of the encoded information features after a predetermined time. Examples of such limited life optical media can be found at U.S. Pat. Nos. 6,434,109, 6,343,063, 6,011,772, and 5,815,484 and U.S. Patent Application Nos. 200301252019, 20030123379, 20030123302, 20030123370, 20030129408, 20030112737, and 20010046204, hereinafter incorporated by reference in their entirety. The limited life optical media is placed in a sealable container. An oxygen sensitive material and/or oxygen measuring material is placed inside the sealable container with the limited life optical media. In overlapping embodiment of the present invention, the oxygen sensitive material and/or oxygen measuring material is affixed to the limited life optical media in the form of a dot. In another overlapping embodiment of the present invention the oxygen sensitive material and/or
oxygen measuring material is affixed to the container. According to the present invention the sealable container does not have to be completely transparent. In one overlapping embodiment of the present invention a portion of the sealable container is transparent, wherein the portion of the sealable container that is transparent allows the oxygen sensitive material to be observed.

[0028] In another embodiment of the present invention, the oxygen sensitive material, once inside the sealable container, is illuminated with a pulsed blue light from an LED. The blue light is absorbed by the oxygen sensitive material and red light is emitted. The red light is detected by a photo-detector and the fluorescence lifetime is measured. Different lifetimes indicate different levels of oxygen within the package. The change in the emission intensity and lifetime is related to the oxygen partial pressure and can be calibrated to determine the oxygen concentration. The measurement is passive, totally reversible and no oxygen is consumed in the process. The fluorescence lifetime is reduced due to the presence of oxygen; this change can be calibrated to make a powerful sensor that has a large dynamic range. The oxygen measurement technique is based upon the fluorescence quenching of a metal organic fluorescent dye immobilized in a gas permeable hydrophobic polymer. The dye absorbs light in the blue region and fluoresces within the red region of the spectrum. The presence of oxygen quenches the fluorescent light from the dye as well as its lifetime. The quenching process is a purely collisional dynamic where the energy from the excited fluorescent dye is transferred to the oxygen molecule during a collision, hence, reducing the emission intensity as well as the fluorescence lifetime of the dye.

[0029] FIG. 1 shows schematically one embodiment of a packaging system or storage arrangement according to the present invention. As shown in FIG. 1, a sealable container 101 (depicted representatively) isolates a limited life optical media 103 (also depicted representatively) from the ambient atmosphere 104. An oxygen-sensitive material and/or oxygen measuring material 102 (illustrated representative) is located inside the sealable container. The oxygen-sensitive material and/or oxygen measuring material 102 can indicate the presence of oxygen inside the sealable container 101. In one embodiment, the visual indication of the presence of oxygen will be a change in color of the oxygen-sensitive material 102. In an overlapping embodiment of the present invention, the presence of oxygen is detected through the amount the oxygen sensitive material fluoresces. The oxygen-sensitive material 102 of the present invention can be any material that will provide a detectable indication of the presence of oxygen. A suitable choice for the oxygen-sensitive material 102 is available, for example, from OxySense®.

[0030] The oxygen-sensitive material and/or oxygen measuring material 102 as shown representatively in FIG. 1 can be formed into any desirable shape for use in the present invention. In one embodiment, the shape of the oxygen-sensitive material is a circular dot. The oxygen-sensitive material optionally can be attached to a background material to enhance the visibility of the visual change of the oxygen-sensitive material. The background material can be composed of metal, plastic, paper, or any other suitable material that will enhance the detectability of the change the oxygen sensitive material undergoes. Potential background materials could also have the word “exposed” written across (or other useful words such as “bad” and/or “expired”) the background material in a color such that upon contact with oxygen, the word “exposed” would become visible. As another option, the oxygen-sensitive material can be arranged to form at least one symbol that assists in interpreting the detectable change of the oxygen-sensitive material. Embodiments that employ a background material, the background material can be attached to the oxygen-sensitive material through the use of generally known adhesives or mechanical fasteners.

[0031] The sealable container of the present invention as shown representatively at 101 in FIG. 1 can be composed of any substance that will transmit radiation and that regulates the exchange of gas, especially oxygen. The sealable container can take any shape and any degree of rigidity spanning the range including completely non-rigid to completely rigid, including for example and not by way of limitation, a sealable sleeve or a thermoform package. In an overlapping embodiment of the present invention, the substance is semi-permeable to oxygen. In another overlapping embodiment of the present invention, the substance is formed, for example, of materials available from Cryvac®, a division of Sealed Air® Corporation, with a location at Park 80 East, Saddle Brook, N.J. 07663-5291. Examples of suitable materials for the container are metals, glass, gas-impermeable plastics, gas-impermeable thermosets and rubbers, and gas-impermeable foil pouches. In one embodiment, the sealable container is a foil pouch of multi-layer construction comprising a silicone oxide treated PET layer, a foil layer, a biaxially oriented nylon layer, and a polyethylene layer. Gas-impermeable plastic containers of the present invention can be either rigid or flexible. Suitable plastic materials for the gas-impermeable plastic containers include, but are not limited to, gas-impermeable polyethylene, polystyrenes, polycarbonates, nylons and polyethylene terphthalates. Potential thermoset and rubber materials for the sealable containers include gas-impermeable phenol formaldehyde, urea formaldehyde, natural rubbers and nitrile rubbers.

[0032] The sealable container 101 shown representatively in FIG. 1 can be sealed by any conventional means known to be used in the packaging industries including thermal seals, adhesive seals, or airtight mechanical closures such as caps or lids; and the sealable container can be a container that is resealable or a container that is not resealable. Another overlapping embodiment includes a sealable container which comprises a gas-impermeable foil pouch with a protective cardboard packaging. A further overlapping embodiment includes a resealable pouch with closure mechanism on at least one end of the resealable pouch that permits the resealable pouch to be optionally resealed. When the sealable container is a gas-impermeable foil pouch, a heat sealer can be used to heat plastic coatings located on the inside top and bottom of the foil pouch.

[0033] FIG. 2 shows one embodiment of the present invention with the oxygen sensitive material and/or oxygen measuring material 102 located on the optical media 103. FIG. 2 is not intended to convey the exact location of the oxygen sensitive material and/or oxygen measuring material 102 and is only shown by way of example.

[0034] The method for producing the storage arrangement of the present invention involves placing an oxygen-sensi-
tive material 102, inside a sealable container 101, along with at least one limited life optical media. In one embodiment, the sealable container is a foil pouch 105. As discussed above, the oxygen-sensitive material 102 can be any material that indicates the presence of oxygen. Furthermore, the oxygen-sensitive material 102 may be formed into any desired shape or size depending upon the application.

Before being placed inside the sealable container, the oxygen-sensitive material 102 optionally can be attached to a background material 110 to enhance the visibility of the visual change. In addition, the oxygen-sensitive material 102, and the optional background material 110, can be either fixed inside the container or can be free-moving inside the container. By fixed inside the sealable container 101, it is meant that the oxygen-sensitive material 102 is directly attached to the inside of the sealable container 101. In embodiments where the oxygen-sensitive material is fixed inside the sealable container 101, any conventional method of attachment, including adhesives and mechanical fasteners, may be used that does not interfere with the function of the oxygen-sensitive material 102. Conversely, the term “free-moving” is intended to describe embodiments of the present invention where the oxygen-sensitive material 102 is not attached directly to the inside of the sealable container 101.

The atmospheric contents of the sealable container 101 are then removed by either vacuum or by purging the sealable container 101 with an inert gas such as nitrogen, carbon dioxide, argon or helium. In one embodiment, a vacuum is used to remove the atmospheric contents because a higher percent of oxygen, or atmospheric gas, can be removed in a shorter period of time as compared to purging. If the atmospheric contents of the container are removed by a vacuum, the sealable container 101 may be subsequently filled with an inert gas. In some embodiments, the ability of the oxygen-sensitive materials 102 to visually indicate the presence of oxygen is not dependent upon the choice of inert gas used as the controlled environment. Furthermore, the oxygen-sensitive materials 102 of the present invention can also function in applications where the controlled environment is a vacuum.

Once the atmospheric contents have been removed from the sealable container 101, the sealable container 101 will be substantially free of oxygen. As described above, the sealable container 101 can be filled with a substantially oxygen-free gas. The substantially oxygen-free gas can be nitrogen, helium, argon, carbon dioxide or some other inert gas. In some embodiments, the sealable container 101 is not filled with a substantially oxygen-free gas, and in those embodiments the controlled inert environment is a vacuum. The sealable container 101 is then sealed to isolate the oxygen-sensitive material 102 from the ambient atmosphere. As noted above, the sealable container 101 may be sealed by any conventional means known in the packaging industry including, but not limited to, thermal, adhesive or mechanical closures. In embodiments where the sealable container is a foil pouch 105, a heat press can be used to seal the foil pouch. The choice of sealing means will generally be determined by the particular choice of container being employed in a specific application.

The embodiments are intended to be illustrative and not limiting. Additional embodiments are within the claims. Although the present invention has been described with reference to particular embodiments, workers skilled in the art will recognize that changes may be made in form and detail without departing from the spirit and the scope of the invention.

Applications of the various embodiments include, for example, determination of whether the sealable container has been properly sealed in the manufacturing process either in-line or by random sampling of the packaged product; determination of whether any additives to the package, such as for example, oxygen scavengers have been properly activated; means of quality control of the manufactured product; and determination of remaining product shelf life. For example, the oxygen measuring material will allow a determination to be made of the rate oxygen ingress into the package because it not only allows a determination as to whether oxygen is present in the package but also a determination as to the amount of oxygen. If measured at different time intervals the rate of oxygen ingress can be determined. If the rate rapidly increases over a short period of time, such an increase may indicate a problem in the manufacturing process or a defect in a material used in the manufacturing process. For example, an improperly form seal, a defect in the packaging material, and/or a failing of an oxygen scavenging material.

Various modifications can be made to the present invention without departing from the apparent scope thereof.

What is claimed is:

1. A sealable container comprising:

   an optical storage device, said optical storage device configured to have a limited usable life for at least a portion of data stored on the optical storage device;

   a container, said container encloses said optical storage device and said optical storage device resides therein;

   an oxygen sensitive material, said oxygen sensitive material resides within said container.

2. The sealable container of claim 1, wherein said oxygen sensitive material resides on the optical storage device.

3. The sealable container of claim 1, wherein said oxygen sensitive material resides on an internal surface of said container.

4. The sealable container of claim 1, wherein said oxygen sensitive material is integral to said container.

5. The sealable container of claim 1, wherein said oxygen sensitive material is in the shape of a small dot.

6. The sealable container of claim 1, wherein said container is selected from one of a package, bag, chamber, packet, pouch, receptacle, repository, sack, storage device, case, envelop, casing, cover, covering, enclosure, pocket, or wrapping.

7. The sealable container of claim 1, wherein said sealable container is sealable by at least one mechanical and chemical mechanism.

8. The sealable container of claim 7, wherein said sealable container is re-sealable after once being opened.

9. The sealable container of claim 1, further comprising a window in said container, said window allows observation of said oxygen sensitive material.
10. The sealable container of claim 1, wherein said optical storage device is selected from at least one of CD-ROM, CD-WORM, CD-I, DVI, CD-EMO, OD3, ODD, Video Disk, IVD, Blu-ray, HD-DVD, DVD, DVD-R, DVD-Video, DVD-RAM, DVD-Audio, DVD-RAM, DVD-RW, DVD+RW, DVD+R, SACD, holographic versatile discs, and 3-D optical storage devices.

11. A method for observing the amount of oxygen in the sealable container of claim 1 comprising:
   observing at least one spectral property of the oxygen sensitive material; and
   comparing the observed spectral properties of the oxygen sensitive material to a set of known properties of the oxygen sensitive material.

12. The method of claim 11, further comprising:
   illuminating said oxygen sensitive material with a pulsed blue light from an LED;
   detecting the amount of red light given off by the oxygen sensitive material using a photo-detector;
   measuring the fluorescence lifetime;
   comparing the amount of red light given off by the oxygen sensitive material and the fluorescence lifetime to the set of known properties for the oxygen sensitive material; and
   determining the amount of oxygen in said sealable container.

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