COMMUNICATION SYSTEM WITH ENHANCED PARTIAL POWER SOURCE AND METHOD OF MANUFACTURING SAME

CROSS-REFERENCE TO RELATED APPLICATIONS

[001] This application is a continuation-in-part of U.S. Patent Application No. 13/180,525 filed on July 11, 2011 and entitled "Communication System with Enhanced Partial Power Source and Method of Manufacturing the Same," published on May 10, 2012 as U.S. Publication No. US2012/0116188A1, which application is a continuation-in-part of U.S. Patent Application No. 12/564,017, filed on Sept 21, 2009 and entitled "Communication System with Partial Power Source", published on April 1, 2010 as U.S. Publication No. US2010-0081894A1, which is a continuation-in-part application of U.S. Patent Application No. 11/912,475 filed June 23, 2008 and entitled "Pharma-Informatics System", published on November 20, 2008 as U.S. Publication No. 2008-0284599A1 which application is a 371 application of PCT Application No. PCT/US06/16370 filed April 28, 2006 and entitled "Pharma-Informatics System"; published as WO Application No. WO 2006/116718, which application pursuant to 35 U.S.C. § 119 (e), claims priority to the filing dates of: United States Provisional Patent Application Serial No. 60/676,145 filed April 28, 2005 and entitled "Pharma-Informatics System"; United States Provisional Patent Application Serial No. 60/694,078, filed June 24, 2005, and entitled "Pharma-Informatics System"; United States Provisional Patent Application Serial No. 60/713,680 filed September 1, 2005 and entitled "Medical Diagnostic And Treatment Platform Using Near-Field Wireless Communication Of Information Within A Patient's Body"; and United States Provisional Patent Application Serial No. 60/790,335 filed April 7, 2006 and entitled "Pharma-Informatics System"; the disclosures of which are herein incorporated by reference.

[002] This application is related to the following US Applications filed on July 11, 2011, the disclosures of which are incorporated herein by reference: US Application Serial No. 13/180,516, filed July 11, 2011 entitled COMMUNICATION SYSTEM WITH REMOTE ACTIVATION, published on January 12, 2012 as U.S. Publication No. 2012/0007734A1; US Application Serial No. 13/180,498, filed July 11, 2011, entitled COMMUNICATION SYSTEM WITH MULTIPLE TYPES OF POWER, published on January 5, 2012 as U.S. Publication No. 2012/0004520A1;

US Application Serial No. 13/180,539, filed July 11, 2011, entitled COMMUNICATION SYSTEM USING AN IMPLANTABLE DEVICE, published on January 5, 2012 as U.S. Publication No. 2012/0004527A1; US Application Serial No. 13/180,538, filed July 11, 2011, entitled COMMUNICATION SYSTEM USING POLYPHARMACY CO-PACKAGED MEDICATION DOSING UNIT, published on February 2, 2012 as U.S. Publication No. 2012/0024889A1; and US Application Serial No. 13/180,507, filed July 11, 2011, entitled COMMUNICATION SYSTEM INCORPORATED IN AN INGESTIBLE PRODUCT, published on March 15, 2012 as U.S. Publication No. 2012/0062379A1.

FIELD

[003] The present invention is related to communication systems for detection of an event. More specifically, the present disclosure includes a system that includes a device with various power sources and communication schemes.

INTRODUCTION

[004] Ingestible devices that include electronic circuitry have been proposed for use in a variety of different medical applications, including both diagnostic and therapeutic applications. These devices typically require an internal power supply for operation. Examples of such ingestible devices are ingestible electronic capsules which collect data as they pass through the body, and transmit the data to an external receiver system. An example of this type of electronic capsule is an in-vivo video camera. The swallowable capsule includes a camera system and an optical system for imaging an area of interest onto the camera system. The transmitter transmits the video output of the camera system and the reception system receives the transmitted video output. Other examples include an ingestible imaging device, which has an internal and self-contained power source, which obtains images from within body lumens or cavities. The electronic circuit components of the device are enclosed by an inert indigestible housing (e.g. glass housing) that passes through the body internally. Other examples include an ingestible data recorder capsule medical device. The electronic circuits of the disclosed device (e.g. sensor, recorder, battery etc.) are housed in a capsule made of inert materials.

that may be included are: logic and/or memory elements; effectors; a signal transmission element; and a passive element, such as a resistor or inductor. The one or more components on the surface of the support may be laid out in any convenient configuration. Where two or more components are present on the surface of the solid support, interconnects may be provided. All of the components and the support of the ingestible circuitry are ingestible, and in certain instances digestible or partially digestible. Furthemore, the circuitry is manufactured according to a process to enhance adhesion of the materials.

[008a] According to a first aspect of the invention, a method of manufacturing a communication device including a partial power source, the method comprising the steps of: depositing a layer of adhesion material onto a first surface of a support structure, wherein the layer of adhesion material defines a plurality of holes; depositing a first material onto the layer of adhesion material, wherein the first material adheres to the layer of adhesion material; depositing a layer of transition metal on a second surface opposite the first surface of the support structure; and depositing a second material onto the layer of transition metal, wherein the first material and the second material represent a voltage potential difference when the first material and the second material come into contact with a conducting fluid.

[008b] According to a second aspect of the invention, a method of manufacturing a plurality of communication devices, wherein each device includes a non-conducting membrane and a partial power source device, the method comprising the steps of: cutting a plurality of openings into a sheet of non-conducting material to produce an assembly membrane sheet, wherein the shape of each opening corresponds to the shape of a framework of the device; and inserting one partial power source device selected from the plurality of partial power source devices into each opening of the assembly membrane to produce a loaded membrane sheet, wherein each partial power source device is prepared according to a process that includes the step of depositing a layer of transition metal on an opposite surface of a support structure from a surface having an adhesion material.

[008c] According to a third aspect of the invention, a device comprising a partial power source for communication, wherein the partial power source of the device is prepared by a process comprising the steps of: depositing a layer of adhesion material onto a first surface of a support

structure, wherein the layer of adhesion material defines a plurality of holes; depositing a first material onto the layer of adhesion material, wherein the first material adheres to the layer of adhesion material; depositing a layer of transition metal onto a second surface opposite the first surface of the support structure; depositing a second material onto the layer of transition metal, wherein the first material and the second material represent a voltage potential difference when the first material and the second material come into contact with a conducting fluid.

BRIEF DESCRIPTION OF THE FIGURES

[009] Fig. 1 shows a pharmaceutical product with an event indicator system according to the teaching of the present invention, wherein the product and the event indicator system combination are within the body.

[010] Fig. 2A shows the pharmaceutical product of Fig. 1 with the event indicator system on the exterior of the pharmaceutical product.

[011] Fig. 2B shows the pharmaceutical product of Fig. 1 with the event indicator system positioned inside the pharmaceutical product.

[012] Fig. 3 is a block diagram representation of one aspect of the event indicator system with dissimilar metals positioned on opposite ends.

[013] Fig. 4 is a block diagram representation of another aspect of the event indicator system with dissimilar metals positioned on the same end and separated by a non-conducting material.

[014] Fig. 5 shows ionic transfer or the current path through a conducting fluid when the event indicator system of Fig. 3 is in contact with conducting liquid and in an active state.

[015] Fig. 5A shows an exploded view of the surface of dissimilar materials of Fig. 5.

[016] Fig. 5B shows the event indicator system of Fig. 5 with a pH sensor unit.

[017] Fig. 5C shows the event indicator system in accordance with another aspect of the present invention.

[046] A variety of different materials may be employed as the materials that form the electrodes. In certain aspects, electrode materials are chosen to provide for a voltage upon contact with the target physiological site, e.g., the stomach, sufficient to drive the system of the identifier. In certain aspects, the voltage provided by the electrode materials upon contact of the metals of the power source with the target physiological site is 0.001 V or higher, including 0.01 V or higher, such as 0.1 V or higher, e.g., 0.3 V or higher, including 0.5 volts or higher, and including 1.0 volts or higher, where in certain aspects, the voltage ranges from about 0.001 to about 10 volts, such as from about 0.01 to about 10 V.

[047] Referring again to Fig. 3, the materials 34 and 36 provide the voltage potential to activate the control device 38. Once the control device 38 is activated or powered up, the control device 38 can alter conductance between the materials 34 and 36 in a unique manner. By altering the conductance between materials 34 and 36, the control device 38 is capable of controlling the magnitude of the current through the conducting liquid that surrounds the system 30. This produces a unique current signature that can be detected and measured by a receiver (not shown), which can be positioned internal or external to the body. Illustrative examples of receivers are shown in Figs. 12 to 17, as described hereinafter. In addition to controlling the magnitude of the current path between the materials, non-conducting materials, membrane, or "skirt" are used to increase the "length" of the current path and, hence, act to boost the conductance path, as disclosed in the U.S. Patent Application Serial No. 12/238,345 entitled, "In-Body Device with Virtual Dipole Signal Amplification" filed September 25, 2008, published on March 26, 2009 as U.S. Publication No. 2009/0082645A1, the entire content of which is incorporated herein by reference. Alternatively, throughout the disclosure herein, the terms "non-conducting material", "membrane", and "skirt" are used interchangeably with the term "current path extender" without impacting the scope or the present aspects and the claims herein. The skirt, shown in portion at 35 and 37, respectively, may be associated with, e.g., secured to, the framework 32. Various shapes and configurations for the skirt are contemplated as within the scope of the present invention. For example, the system 30 may be surrounded entirely or partially by the skirt and the skirt maybe positioned along a central axis of the system 30 or off-

center relative to a central axis. Thus, the scope of the present invention as claimed herein is not limited by the shape or size of the skirt. Furthermore, in other aspects, the materials 34 and 36 may be separated by one skirt that is positioned in any defined region between the materials 34 and 36.

[048] Referring now to Fig. 4, in another aspect, the systems 12 and 22 of Figs. 2A and 2B, respectively, are shown in more detail as system 40. The system 40 includes a framework 42. The framework 42 is similar to the framework 32 of Fig. 3. In this aspect of the system 40, a digestible or dissolvable material 44 is deposited on a portion of one side of the framework 42. At a different portion of the same side of the framework 42, another digestible material 46 is deposited, such that materials 44 and 46 are dissimilar. More specifically, material 44 and 46 are selected such that they form a voltage potential difference when in contact with a conducting liquid, such as body fluids. Thus, when the system 40 is in contact with and/or partially in contact with the conducting liquid, then a current path, an example is shown in Fig. 5, is formed through the conducting liquid between material 44 and 46. A control device 48 is secured to the framework 42 and electrically coupled to the materials 44 and 46. The control device 48 includes electronic circuitry that is capable of controlling part of the conductance path between the materials 44 and 46. The materials 44 and 46 are separated by a non-conducting skirt 49. Various examples of the skirt 49 are disclosed in US Provisional Application No. 61/173,511 filed on April 28, 2009 and entitled "HIGHLY RELIABLE INGESTIBLE EVENT MARKERS AND METHODS OF USING SAME" and US Provisional Application No. 61/173,564 filed on April 28, 2009 and entitled "INGESTIBLE EVENT MARKERS HAVING SIGNAL AMPLIFIERS THAT COMPRISE AN ACTIVE AGENT"; as well as U.S. Application No. 12/238,345 filed September 25, 2008 and entitled "IN-BODY DEVICE WITH VIRTUAL DIPOLE SIGNAL AMPLIFICATION", published on March 26, 2009 as U.S. Publication No. 2009/0082645A1; the entire disclosure of each is incorporated herein by reference.

[049] Once the control device 48 is activated or powered up, the control device 48 can alter conductance between the materials 44 and 46. Thus, the control device 48 is capable of controlling the magnitude of the current through the conducting liquid that surrounds the system 40. As indicated above with respect to system 30, a