devices such as catheters, drain bags, etc., to monitor entry and exit sites for complications.

In particular embodiments, the sensing device 101 as a whole, or the just the modulator 103, are configured for attachment to a surgical suture. The device may be attached to the suture by threading the suture through fixtures in the device. Alternatively, or additionally, the device could also be attached to the suture by clamping or with a suitable adhesive.

In such embodiments, the sensing device 101 may be configured to monitor for an event related to the wound and/or surgical suture. For example, the sensing device 101 itself may monitor for the occurrence of at least one event, such as bleeding, dehiscence, infection, leakage or, in more positive aspects, healing.

The sensing device 101 (or modulator 103, as appropriate), may be attached after placement of the suture for example by clamping to the suture or with an adhesive, for example surgical glue or strips. In other embodiments, the sensing device 101 or modulator 103, as appropriate, may be incorporated into the suture or attached in advance of placement of the suture, for example by stitching or threading the suture through fixtures on the device. Moreover, more than one device 101 or modulator 103 may be attached to a single suture, such that each sensing device (for the case of plural devices) or each modulator (for the case of multiple modulators for one sensing device) monitors one of many different conditions.

Devices according to embodiments may be produced using conventional techniques for producing printed circuit boards (PCBs), such as chemical etching of copper foil laminated to an insulating substrate with one or more components mounted in electrical connection with the copper on the surface of the PCB. In an embodiment, the capacitor is a printed interdigital capacitor.

In an embodiment, the system may be configured to output the characteristics of the signal determined by the spectrum analyzer 4515 to an external device, such as user device 4517 for processing in order to determine of a condition at the site, as described above.

It will be appreciated that determination of a condition at the site of interest from the received backscatter signal could be performed in a number of ways in addition to those described above.

One or more of the components shown in Figure 17 may be omitted or other components added, in accordance with embodiments.

Figure 18 shows a schematic diagram of reader 109 according to another embodiment for providing an interrogation signal 111 to a sensing device 101 according to embodiments and receiving a response signal 113. In an embodiment the reader 109 is a handheld device for ease of application.

The reader comprises a processor 1203 configured to process data relating to signals received from sensing devices 101 according to embodiments and display data on the display 1231. The device may comprise a battery 1227 and/or USB port 1229 for supplying power to the device. The device comprises a first signal generator 1205 configured to generate radiofrequency signals at the unaffected resonance frequency of the modulating circuit when the antenna (e.g. suture) is intact as indicated by 1207. The signal generator 1205 is connected to amplifier 1209 and antenna 1211 for transmitting the signal produced by signal generator 1205.

The reader further comprises a second signal generator 1211 which acts as a reference for receiving power and also for boosting frequency and/or power.

The reader comprises an antenna 1215 for receiving signals from the sensing device according to embodiments connected to amplifier 1217. The reader may

rectifying module 5401. In this example, the voltage multiplying circuit comprises capacitors 5311, 5313, 5315 and two diodes 5317, 5319. It will be appreciated that other designs of rectifying circuits could be employed. Electrodes 5321 and 5323 are connected to the rectifying circuit either side of the capacitor 5315 via connectors 5325 and 5327, respectively. In this embodiment, at least one of the electrodes 5321, 5323, and preferably both of the electrodes, is formed form an electrically conductive suture.

As described above in relation to Figure 5, in a preferred embodiment, the suture comprises two conductive portions separated by an insulating portion, thereby enabling its use as both electrodes in the embodiment of Figures 20 and 21.

As in the case of the embodiments described above, the device 5301 may be produced using conventional techniques for producing printed circuit boards (PCBs), such as chemical etching of copper foil laminated to an insulating substrate with one or more components mounted in electrical connection with the copper on the surface of the PCB or by employing printed components, as appropriate.

In an embodiment, device 5301, or a portion of the device, may be encapsulated by biocompatible material such as a biocompatible silicone polymer in order to prevent unwanted side-effects inside the human or animal body. In an embodiment, the device comprises a PCB coated with the encapsulation material to the desired thickness. Preferably, the biocompatible material is selected from PDMS, silicone, parylene-C, and polyurethane. The antenna 105 may comprise a separate component or components or may be integrated into the same component as that forming the RLC 5303 and/or voltage multiplying circuit 5309, for example, both circuits and the antenna may be printed onto a PCB.

CLAIMS

1. A wirelessly triggered device for implantation in vivo comprising:
an electrically conductive suture configured as an antenna for receiving a wireless triggering signal; and
an electronic circuit coated with a biocompatible encapsulating material and communicatively coupled to the electrically conductive suture, wherein the electronic circuit is arranged to convert the wireless triggering signal into an electrical signal for passing through the electrically conductive suture.

2. A wirelessly triggered device according to claim 1, the electrically conductive suture comprising a first conductive portion; a second conductive portion; and an insulating portion between the first and second conductive portions, the electronic circuit being communicatively coupled to the first and second conductive portions and arranged to pass the electrical signal through the first and second conductive portions.

3. A wirelessly triggered device according to claim 1 or 2, wherein the electrically conductive suture comprises electrically conductive surgical thread, wherein the electrically conductive surgical thread comprises an inner surgical thread; an electrically conductive coating on the inner surgical thread, and wherein the electrically conductive coating comprises a bio-compatible conductive polymer; and a bio-compatible protective coating on the electrically conductive coating.

4. A wirelessly triggered device according to any one of claims 1 to 3, wherein the wirelessly triggered device is a passive electronic device, and/or wherein the biocompatible encapsulating material is selected from PDMS, silicone, parylene-C, and polyurethane.

5. A wirelessly triggered device according to any one of claims 1 to 4, wherein the electronic circuit includes a modulating circuit operable to modulate the wireless triggering signal to produce a backscatter response signal having a specific harmonic as the electrical signal for passing through the electrically conductive suture.

6. A wirelessly triggered device according to claim 5, wherein the wirelessly triggered device is a sensing device for monitoring conditions at a site, further comprising a detector operable to detect a predetermined condition at the site, and wherein the modulator is operable to modulate the backscatter signal based on the detected predetermined condition, wherein the detector optionally comprises a passive component of the modulating circuit, and wherein the passive component optionally is a capacitor or inductor.

7. A wirelessly triggered device according to any of claims 1 to 6, wherein the electronic circuit includes a rectifier operable to rectify the wireless triggering signal to produce an electrical current as the electrical signal for passing through the electrically conductive suture.

8. A wirelessly triggered device according to claim 7, wherein the wirelessly triggered device is configured to stimulate a nerve by passing the electrical current through the electrically conductive suture, or wherein the electrically conductive suture is in electrical connection with an electronic device and configured to supply power to the electronic device.

9. A wirelessly triggered device according to claim 6, wherein the predetermined condition comprises one or more adverse physiopathological states, wherein the one or more adverse physiopathological states optionally comprises one or more of bleeding, bacterial infection, gastric juice leakage and anastomotic leakage.

10. A wirelessly triggered device according to claim 6 or 9, wherein the modulating circuit is an RLC circuit and a resonance frequency of the RLC circuit varies based on the detected predetermined condition.

11. A wirelessly triggered device according to any one of claims6, 9, and 10, further comprising a support member for supporting a layer of responsive material which is susceptible to undergo a change in the predetermined condition, the support member configured to support the responsive material over the passive component, wherein the responsive material optionally is a hydrogel.

12. A wirelessly triggered device according to claim 11, wherein the support member comprises a plurality of relief structures projecting from the modulating circuit and defining a cavity for receiving the responsive material, wherein the responsive material optionally is a hydrogel.

13. A wirelessly triggered device according to any one of claims 6, and 9 to 12, further comprising a responsive material which is susceptible to undergo a change in the predetermined condition, the responsive material being coated over the passive component, wherein the responsive material optionally is a hydrogel.

14. A wirelessly triggered device of any one of claims 11 to 13, wherein the predetermined condition includes bacterial infection and the responsive material is a DNA hydrogel susceptible to degradation in the presence of nuclease secreted by bacteria, or wherein the predetermined condition includes gastric juice leakage and the responsive material is a peptide hydrogel susceptible to degradation in the presence of pepsin.

15. A reader for use with a wirelessly triggered device of any one of claims 6 and 9 to 14 the reader comprising:

a transmitter configured to transmit a plurality of interrogation signals configured to stimulate a backscatter response signal from the wirelessly triggered device;

a receiver configured to receive the backscatter response signal from the wirelessly triggered device; and

a processor configured to determine a condition at the site based on the backscatter response signal.

16. The reader of claim 15, wherein the condition at the site includes one or more of healing, bleeding, infection, bacterial growth, dehiscence, suture breakage, heart rate and respiration rate.

17. A system comprising the wirelessly triggered device of any one of claims 6 and 9 to 14 and the reader of claim 15 or 16.

18. A method of monitoring conditions at a site in vivo,
the method comprising:
implanting a wirelessly triggered device according to any one of claims 6 and 9 to 14 into the site;
transmitting a plurality of interrogation signals configured to stimulate a backscatter response signal from the wirelessly triggered device;
receiving the backscatter response signal from the wirelessly triggered device; and
determining a condition at the site based on the backscatter response signal.

19. A method according to claim 18, wherein the condition comprises one or more physiopathological conditions, or wherein the condition includes one or more of healing, bleeding, infection, dehiscence, suture breakage, heart rate and respiration rate.

20. A method according to claim 18 or 19, comprising implanting a wirelessly triggered device according to claim 6, wherein implanting the wirelessly triggered device comprises suturing at least a portion of a wound with the electrically conductive suture.