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Microelectronic Pill

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***Abstract*: A microelectronic pill is basically a multi-channel sensor used for remote bio medical measurements using micro technology this has been developed for the internal study and detection of diseases and abnormalities in the gastro intestinal GI tract. This paper with the design of the microelectronic pill which mainly consists of an outer biocompatible capsule encasing 4 channel micro sensors a control chip, a discrete component radio transmitter and 2 silver oxide cells.**

***Keywords*: System description, Performance.**

1. Introduction

The invention of transistor enabled the first use of radiometry capsules, which used simple circuits for the internal study of the gastro-intestinal (GI) tract. They couldn't be used as they could transmit only from a single channel and also due to the size of the components. These technologies led to the formation of "microelectronic pill". This is used for the real-time measurement parameters such as temperature, pH, conductivity and dissolved oxygen. The sensors are fabricated using electron beam and photolithographic pattern integration and were controlled by an application specific integrated circuit (ASIC).

2. System description

The microelectronic pill consists of a machined biocompatible (non-cytotoxic), chemically resistant polyether-terketone (PEEK) capsule and a PCB chip carrier acting as a common platform for attachment of sensors, ASIC, transmitter & batteries. The fabricated sensors were each attached by wire bonding to a custom made chip carrier made from a 10-pin, 0.5-pitch polymide ribbon connector. The sensor chips are connected to both sides of the PCB by separate FCP sockets, with sensor chip 1 facing the top face, with the sensor chip 2 facing down. Thus, the oxygen sensor on chip 2 had to be connected to the top face by 3, 200 nm copper leads soldered onto the board. The transmitter was integrated in the PCB which also incorporated the power supply rails, the connection points to the sensors, as well as the transmitter & the ASIC & the supporting slots for the capsule in which the carrier is located. The capsule was machined as two separate screw-fitting compartments. The PCB chip carrier was attached to the front section of the capsule. The sensor chips were exposed to the ambient environment through access ports.

A. Temperature Channel Performance

The linear sensitivity was measured over a temp. range from 0˚C to 70˚C & found to be 15.4 mV/˚C. This amplified signal response was from the analog circuit, which was later implemented in the ASIC. The sensor once integrated in the pill, gave a linear regression of 11.9 bits/˚C, with a resolution limited by the noise band of 0.4 ˚C. The diode was forward biased with a constant current (15 µA) with the n-channel clamped to the ground, while p-channel was floating. Since the bias current supply circuit was clamped to the negative V rail, any change in the supply voltage potential would cause the temp. channel to drift. Thus, it was seen that o/p signal changed by 1.45 mV/mV change in supply expressed in mV, corresponding to a drift of – 41.7 mV/h in the pill from a supply voltage change of –14.5 mV/h.

3. pH Channel Performance

The linear performance from pH 1 to 13 corresponded to sensitivity of –41.7mV/pH unit at 23˚C. The pH ISFET sensor operated in a constant current mode (15 µA), with drain voltage clamped to positive supply rail & the source voltage floating with the gate potential. The Ag/AgCl reference electrode, representing the potential in which the floating gate was referred to, was connected to ground. The sensor performance, once integrated in the pill corresponded to 14.85 bits/pH which give a resolution of 0.07 pH/ data point. The sensor exhibits a larger responsivity in alkaline solutions. The sensor life time of 20h was limited by Ag\Agcl reference electrode made from electroplated silver.

The pH sensor exhibited a signal drift of –6 mV /h (0.14ph), of which –2.5mV/h was estimated to be due to the dissolution of Agcl from the reference electrode. The temperature sensitivity of the pH sensor was measured as 16.8mV/˚c. The changing of the pH of the solution at 40˚c from pH 6.8 to 2.3 and 11.6 demonstrated that the two channels were completely independent of each other and there was no signal interference from the temperature channel.

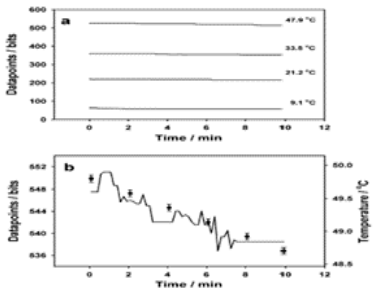

Fig. 1. Temperature channel performance

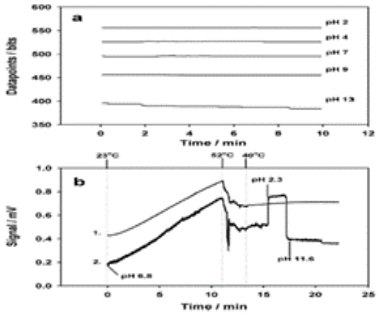

Fig. 2. pH channel performance

4. Conclusion

We have therefore described about the multichannel sensor, which has been implemented in remote biomedical using micro technology, the microelectronic pills, which is designed to perform real time measurements in the GI tract providing the best in vitro wireless transmitter, multi-channel recordings of analytical parameters. The generic nature of microelectronic pill makes it adaptable for use in corrosive environments related to environmental & industrial applications, such as the evaluation of water quality, pollution detection, fermentation process control & inspection of the pipelines. The integration of radiation sensors & the application of indirect imaging technologies such as ultrasound & impedance tomography, will improve the detection of tissue abnormalities & radiation treatment associated with cancer & chronic inflammation.

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