Wireless Pressure Sensor for Continuous Monitoring of Ventricular pressure.

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ABSTRACT

This work reports the novel design of a capacitive pressure sensor (TMCPS) system with a wireless aproach for full-range continuous monitoring of ventricular pressure. The system consists de two modules: an flexible implantable set and an external reading device. The two modules are designed for making a resonant circuit for to accomplish practical, accurate and real-time wireless pressure sensing.

INTRODUCTION

Blood pressure problems are a kind of disease that chronically damages the blood vessels, organs and tissue of the human body, with the high blood pressure beign the main cause of morbidity and mortality in the world.

ARTERIAL PRESSURE MEASUREMENT SYSTEMS

External

1. The measurements lacks pressure and stability.
2. Not provide measurements in real-time.
3. Intermittent measurements and far from irrigation site.

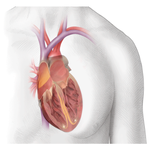
Internal

1. Very precise method.
2. Measurements at the irrigation site.
3. Unsafe for long-term use.
4. Risk of infection and hemorrhage.

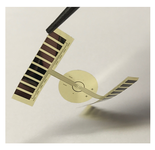
Implantable

1. Provides continuous, accurate and real-time measurements.
2. Measurements at the irrigation site.
3. Safe
4. without connection

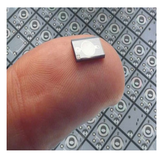
The development of a implantable pressure sensor that the following characteristics could would new diagnostic and therapeutic possibilities, mainly in cardiac pathologies.



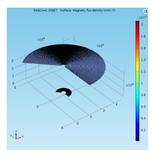
Dinamic and full pressure range.



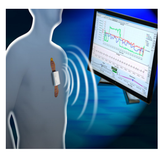
Mechanical flexibility.



Small dimension.



3.5cm mutal coupling.

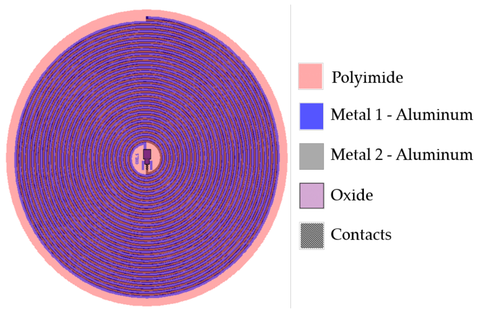


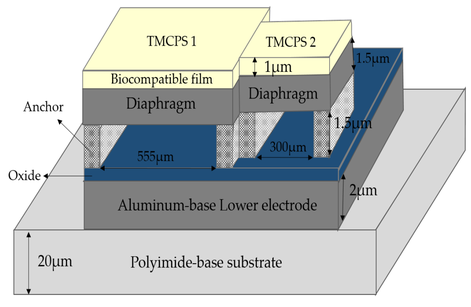
Appropiate bandwich.

Biocompatibility.

METHODOLOGY

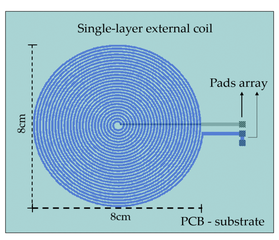
The implantable sensor set, restricted to 2x2cm^2 area, consist of 2 TMCPS parallel array connected to a planar dual-layer coil. The desing and modeled consider a thin-film monolithic approach and the small deflexion analysis regimen.

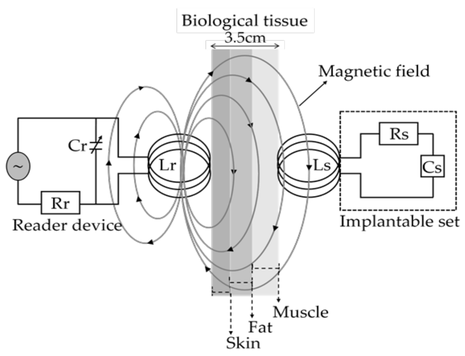


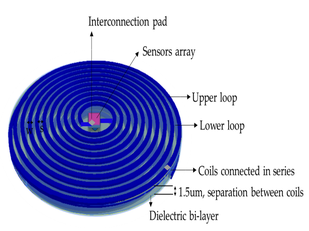


The internal dual-layer coil was implemented to increase the L and Q values in a reduced physical area.

The magnetic coupling link across three layer of biological tissue (skin, fat and muscle) was calculated considering: two planar circular coils and a 13.56 MHz resonance frequency.

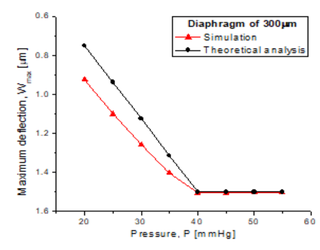


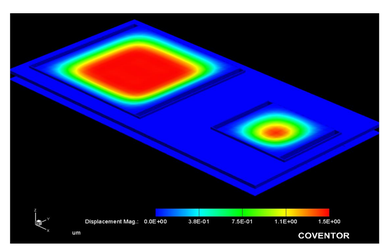


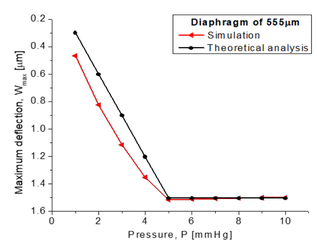


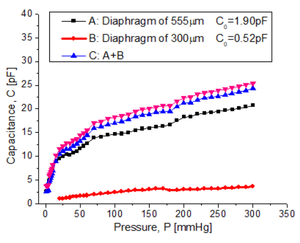
RESULTS

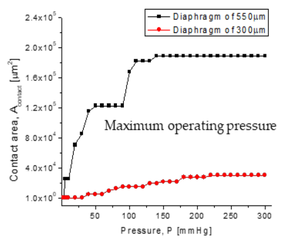
The capacitive array was analized using the CoventorWare software for evaluated the mechanical deformation of both diaphragms.





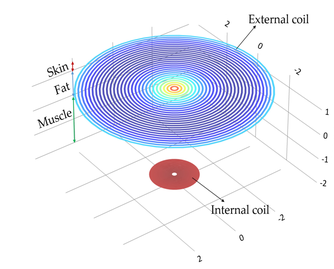


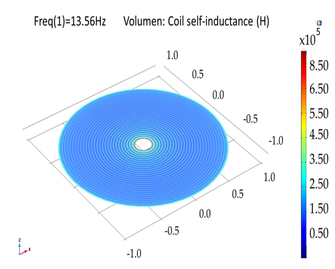


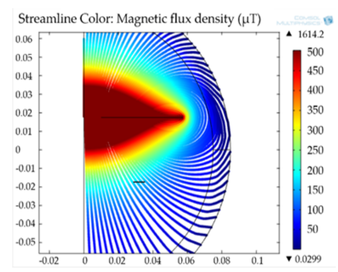


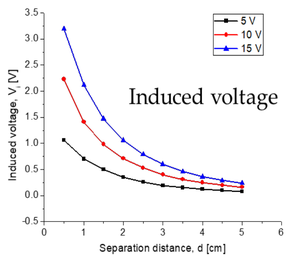
Parameters	Structure 1	Structure 2
Contact pressure	5 mmHg	40 mmHg
Maximum operating pressure	200 mmHg	300 mmHg
Lateral length of the diaphragm	555 µm	300 µm
Thickness of the lower electrode	2 µm	2 µm
Thickness of the top electrode	1 µm	1 µm
Air gap	1.5 µm	1.5 µm
Oxide thickness	0.2 µm	0.2 µm

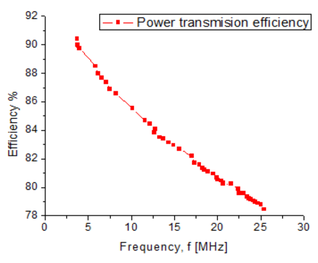
The inductive coupling link was modeled considering that the external coils found outside the human body but establishes contact with the surface skin and the internal coil is mounted within the left ventricle at a depth of 3.5cm.











Parameters	Value
Resonance frequency	13.56 MHz
Mutual inductance	3.38 µH
Magnetic flux density	150 µT
Coupling efficiency	0.054
Radiation distance	3.5 cm
Power transmission efficiency	90.7%

CONCLUSIONS

1. A wireless full-range TMCPS has been successfully designed and modeled as a proposal solution to continuous ventricular pressure monitoring.

2. The thin-film monolithic approach, allows combining two manufacturing technologies: surface micromachine and flexible electronics.

3. The system shows a dinamic and full 5-300 mmHg pressure range and 90% power transmission efficiency.

4. The fabrication process was designed according to the PolyMEMS INAOE technology, featured by a low-temperature processing, considering materials for achieved biocompatible performance.

REFERENCES

https://mega.nz/#!ePhWjaLZ!xNmzHq3UI4ljSnkyH46QFNgTM4v8P-3V_BAE5tG8rBc

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