Modeling of Silicon Piezoresistive Pressure Sensor: Application to Prevent Some Diabetes Complications

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Abstract

In this study, several analytical solutions describing the mechanical behavior of a silicon micro membrane deflection, perfectly embedded and subjected to a uniform and constant pressure have been proposed. These analytical models are the satisfactory solution, which enables a fast and reliable analysis giving the designer an overview of device performance. The principle of the paper is to design, obtain analytical solutions and compare the results with the simulation using COMSOL software for a rectangular diaphragm deflection Figure 1. The relationship between the deflection and the applied pressure is used in the design of a piezoresistive pressure sensor Figure 2. It consists of using piezoresistive gauges connected in a Wheatstone bridge. The modeling results were used to design a biomedical sensor. This device, ones inserted in the soles of a shoe permits the measure the pressure of a diabetic foot Figure 3. Many studies have shown that the measurement of plantar pressure may reveal information that could avoid some diabetes complications Figure 4. High plantar pressure in diabetic patients plays a crucial role in the development of plantar ulcers. They may cause possible amputations of diabetic's foot. This information may help to understand the cause, the treatment, and the foot damage prevention of diabetic patients. Our model, allows measuring the pressure at any point of the membrane. This pressure allows us to have information on the status of a diabetic foot. This applied pressure is transformed into a voltage by a display system which consists of a piezoresistive pressure sensor that indicates its reply to through a display circuit (LED), which lights up when the voltage indicating the applied pressure exceeds its threshold value. The lighting of the LED means there is a high plantar pressure causing an anomaly in the diabetic foot. The patient should consult his doctor immediately. This simple system is a very effective prevention tool.

Reference

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Figures used in the abstract

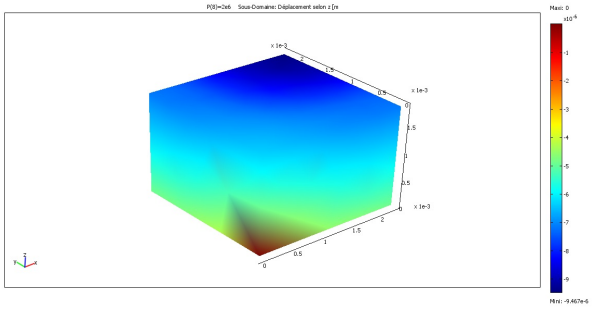

Figure 1: Deflection variation vs applied pressure at room temperature.

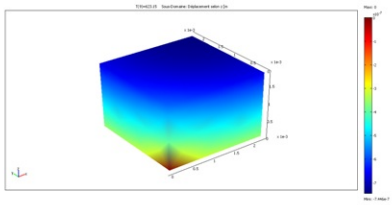

Figure 2: Deflection variation vs temperature at rest p=0.

Figure 3: Location of the sensor within the sole of the boot.

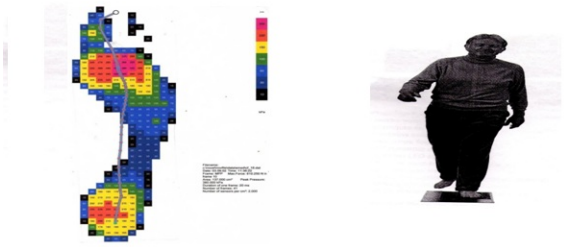

Figure 4: Several plantar pressure.