Design and Implementation of MEMS Based Blood Viscometer for INR Measurement

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Abstract

The paper brings out the designing and implementation of blood viscosity monitoring device that gives us the INR to measure the effectiveness of anti coagulant medications .When a blood vessel is damaged, clotting cascade begins that results in blood clot. This process is affected by several medical conditions where it becomes mandatory for a patient to intake anti-coagulants. Thus to monitor patients drug dosage, this MEMS based Blood viscometer with a disposable strip can provide a convenient means to measure the blood clotting. Clotting is the normal function of blood in response to an injury. In abnormal conditions, anti-coagulant medications which delay the formation of blood clots should be administered to prevent thrombosis and embolism. Hence the time that the blood takes to clot needs to be monitored regularly so that the drug dosage can be optimized. Hence INR (International Normalized Ratio) is used to measure the effectiveness of anti coagulant medications. Existing hand held devices for blood coagulation PST (patient self test) work by inducing a chemical reaction and consequently measuring the gradient at the electrodes coated with compounds - a technology that has not fundamentally changed in many years. In contrast, this study presents a device which uses a new technique that stems from futuristic research on micro-technology and exploits the potential of MEMS to achieve high accuracy, robustness and ease of use of its disposable Smart strip coagulation test.

The main challenge of using COMSOL Multiphysics is the designing of cantilever beam and observing the effects of blood sample when placed over it. The cantilever made of piezoelectric material is held rigid at one end and flexes at the other end. When the blood sample is placed over the cantilever, due to clotting of blood, the strain and consequently the electric potential across the beam gets altered. By measuring the changes in electric potentials across the piezoelectric layer due to the increase in blood viscosity, the handheld reader can calculate the time taken by the blood to change from a solution to gel form, which the unit then converts and displays. The cantilever is designed using COMSOL Multiphysics and the corresponding effects of blood clotting are observed and analyzed by simulating a mass change on a cantilever surface as the sample blood droplet is dispersed and allowed to clot over time. Also, the potential developed across the piezoelectric cantilever beam (Figure1) can be obtained using an external circuitry which could be displayed in terms of INR. Thus the device designed shall be capable of monitoring the level of anti coagulants with a small blood sample quantity as low as a few µL using a disposable strip. We expect to implement the suggested hardware with incorporated MEMS assembly which shall display the INR value of blood within minutes.

Reference

Vladislav Djakov, "Novel Sensor Technology for Point of Care Diagnostics",2011

Figures used in the abstract

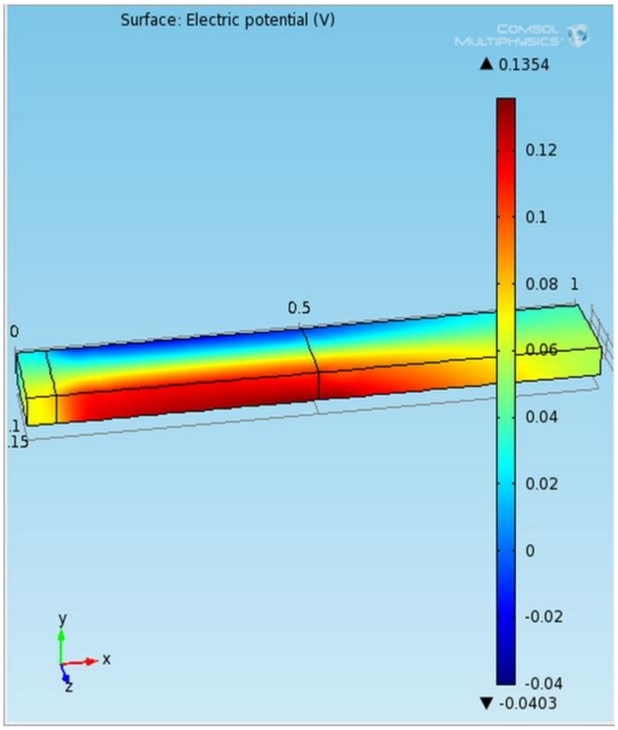

Figure 1: Electric Potential.