

Early Detection of Cancer using Nano-Fabrication Technology MEMS Cantilever Sensor

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ABSTRACT

Lots of available biosensor are not portable for the detection of disease for that bulky instruments are required. To overcome these problems, we can use microstructure based biosensor. The sensor is Micro electro Mechanical Sensor (MEMS) based cantilever. Here, in this article simulating cantilever by changing chemical materials and parameters. For the different cancer diseases like Brest cancer cu(copper) and for heart cancer gold material were used to simulate cantilever. Laser beam and photo detector technology are bulky and costly also. Instated of that cantilever having dimension are width 1 micro meter, length 4 micrometer and height of cantilever is varies in between 25 to 50 nm which gives huge sensitivity. In this paper simulation of the cantilever based on various materials as per the changes in resistance and capacitance effect analysis, cancer tissues behaviour, and identify the exact state of cancer.

Keywords: Micro electro Mechanical Sensor (MEMS), Cancer, Cantilever Sensor, Nanofabrication, Copper

1. Introduction

Oral cancer is spreading worldwide with heighten serious troubles. Out of 135 cr. People's more than 1.1 million people get affected by the cancer and 0.7 million peoples are deaths due to the cancer. As per the IARC report cancer is one of the widely spread disease [1]. Most common cancer type in India is breast cancer in women and oral cancer in men. In India all ages' females who suffering from breast cancer is 27.2 % and men's who suffering from oral cancer is 16.1 %. Breast and Oral cancer rank is 1 and 2 in India. Due to more utilization of tobacco in various Indian states the oral cancer is cases are comes under observation [2]. India has 33.33% active oral cancer cases as compare to world and men's having 50 ages is generally affected by the oral cancer [3][4]. Incident and morality rates for breast cancer is 24.1% and 13.4% similarly lip and oral cavity Incident and morality rates are 9.1% and 5.6% are shown in the Figure 1 and 2[1]. Due to small in size, low cost, fast growing with highly precision MEMS devices provides measuring tissues density and temperature and improves the surgical outcomes [5]. In 1900's peoples uses microscope and electron microscope to see small thing but facing problems to see very small things.

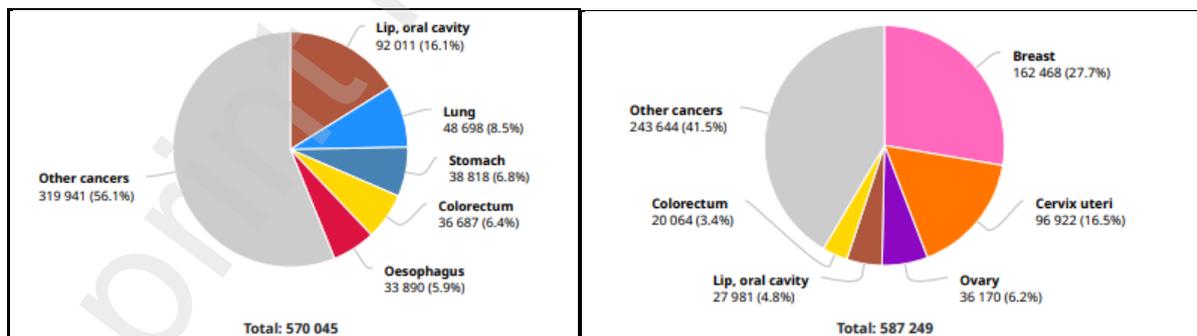


Fig. 1:- In India Total number of cancer new cases in males all age groups [1].

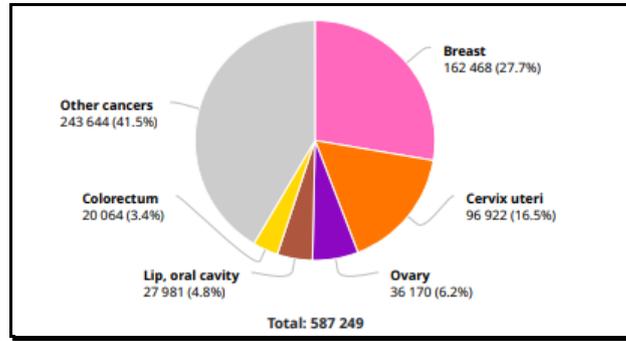


Fig. 2:- In India Total number of cancer new cases in women's all age groups [1]

If people's wants very advanced technology they use MRI Machine and obtain huge sensitivity detection of various types of anomalies. But MRI Machine is not a biosensor. Biosensors are newly called as nano biosensor. These nano biosensors are even smaller, can detect lower concentration things also. Human body hierarchy of structure is start with DNA, intercellular process running within cell then there is various collection of organ. Various cancer diseases has already manifested in the organs. Due to less sensitivity devices and losses which can identify very late exact stage of diseases (cancer). Nano biosensor allows us to indentify exact stage of early cancer development. By selecting 25 to 50 nm cantilever height we can obtain extra ordinary sensitivity which detects early stage of cancer detection.

2. Biopsy

Biopsy is typically indicated for obtaining a final diagnosis on the basis of histopathological features [6] with the assistance of thus final diagnosis, treatment planning is completed. Biopsy also plays a very important role in establishing prognosis of malignant and premalignant lesions and conditions. Also knowing the prognosis helps in determining the morbidity and mortality of a patient also as efficacy of the treatment. [7]

Working of Biopsy

Doctor recommends biopsy when he fined suspicious while physical exam or test. Biopsy is main way to diagnosis the cancer treatment. To perform biopsy doctor need small tissues from human body to remove tissues doctor requires surgery sometime.

Image-Guided Biopsy: When the affected area is deeper inside the body at that time doctor uses Images-Guided biopsy method. With help of imagining techniques using needle doctor guides affected area location in human body. This depends on the amount of tissues needed, possible diagnosis and other factors. Doctor uses one of the following types of imagining techniques to find the affected area from body

A. Ultrasound:

It helps doctor to look the tumors when not visible in the X ray. For biopsy method doctor often uses needle. Ultrasound is usually used for the quick and most don't require special preparation.

B. CT scan:

Using CT scan we can identify the exact state of cancer but it is bulky and costly instrument.

MEMS: These devices used to identify the early stage of cancer. Due to more sensitive materials

3. Working and Selection of Material for Micro cantilevers:

To obtain extra ordinary sensitivity we used cantilever based sensor generally it detects these nano gram to pico gram level material related easily. When we deal with such very low level concentration it requires amplification before the molecule can be detected. Using this sensor technology in vacuum we should able to measure 100s of zepto-gram level masses. Human cells are larger as nano gram as compare to virus and bacteria.

Why cantilever based Biosensor:

The key point is MEMS don't need reference electrode and MEMS gives huge sensitivity and it is very popular in different nanofabrication technology.

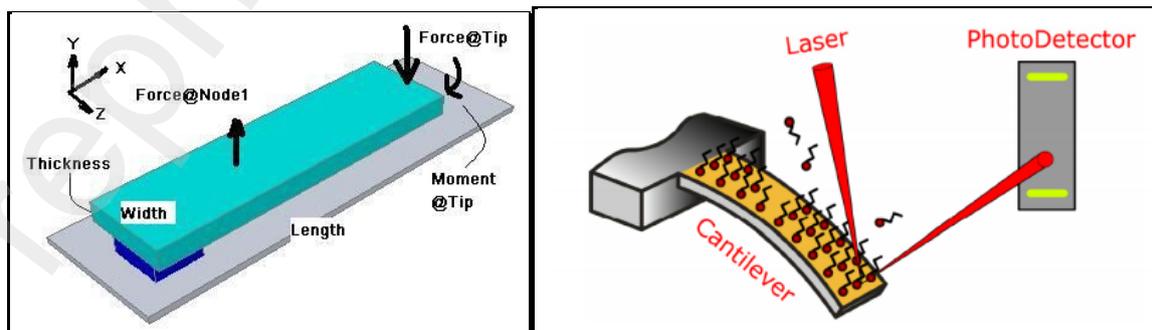


Fig. 3: - Cantilever based Biosensor.

Dimension of cantilever are width is 1 micro meter and length is 4 micro meters to obtain huge sensitivity cantilever height is in between 25 to 50 nano meter. Once bio modules have landed on cantilever surface bounce off a laser beam and use a photo detector to measure the location. By comparing flat cantilever and bended cantilever the position of photo detector changes. After biomolecules reached on the surface of cantilever oscillation starts in the cantilever then photo detector observes the changes in the laser beam and calculate how much deflection takes place. To measure the deflection we should calculate change in the resonant frequency. The assembly of laser and photo detector are bulky in nature so it is difficult to miniaturize. By observing cantilever sensor change in resistance we can identify whether biomolecule landed or not. As we know that capacitor is inversely proportional to distance between two parallel plate using same formulas we can observe the deflection in cantilevers.

How Does cantilever works:

1. Change in deflection before landing biomolecule Mathematical model

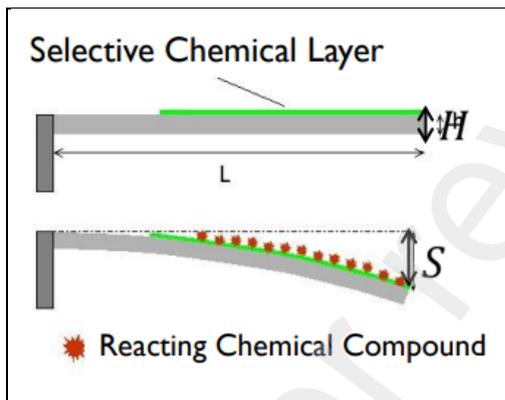


Fig. 4: - Cantilever Reacting Chemical Compound Works

Originally it's undeflected and green layer is that the selective layer which recognizes the molecule a bit like DNA layer was present and target DNA came and sure to it or an antibody could be present so as to catch that focus on bacteria. that's the green which is that the receptor layer then once the red biomolecules have are available , the mass has changed and therefore the whole is deflected in engineering so as to know what proportion deflection takes place. Calculate the external force associated with it using formula given below.

$$\frac{d^2y}{dt^2} + \gamma \frac{dy}{dt} + k(y - y_0) = F_{ext}$$

2. Readings of cantilever:

All readings taken under sugar cantilever simulation tool this tool can do statics and parameter sweep analysis for cantilever with customized geometry and load distribution. Algorithm sugar is based on the nodal analysis which is faster than finite element analysis with comparable accuracy within linear region.

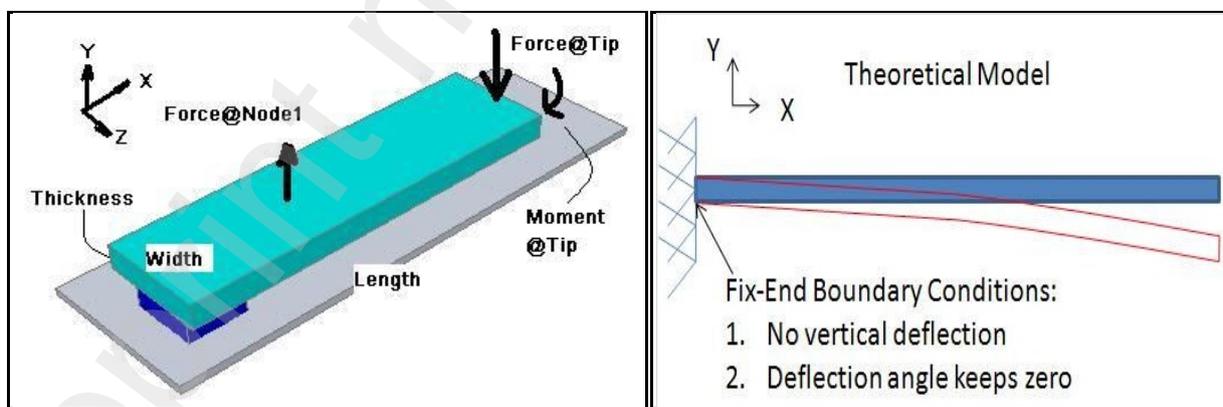


Fig. 5 - Experimental Modal.

Table 1 Design Cantilever with mention parameters

Material Name: Au (Gold)		Material Name: Cu(Copper)
Material Property		
Poisson Ratio	0.415	0.34
Youngs Modulus	7.9e+10	121x 10 ⁶
Geometric Property		
Length	100e-6	100e-6
Width	2e-6	2e-6
Thickness	2e-6	2e-6
Statics Analysis		
Azimuth	37.5	37.5
Elevation	30	30

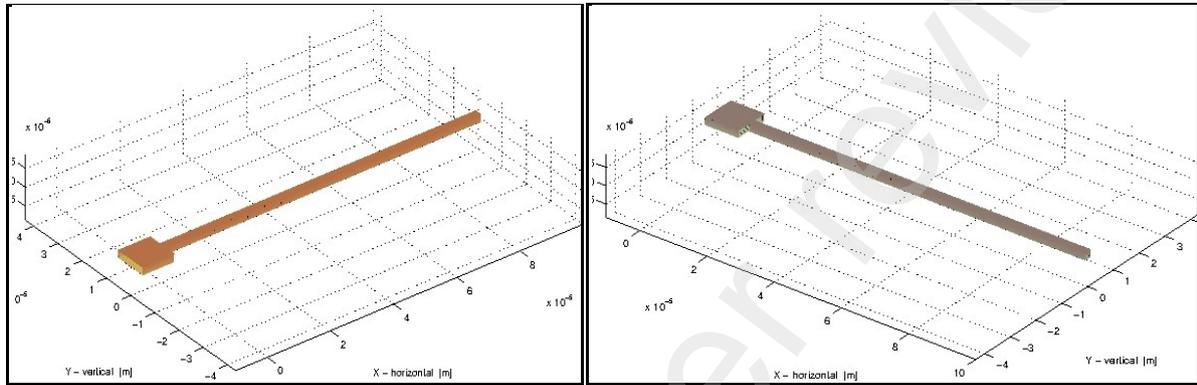


Fig. 6 – Reading of Cantilever.

Conclusion:

The tissues taken from the body is observing under microscope and after analysis of result doctor can able to understand the origin of the cancer and defines the cancer grade in between 1 to 4 scales. Low-grade (grade 1) cancers are generally the least aggressive and high-grade (grade 4) cancers are generally the most aggressive. Here we use MEMS cantilever having dimension width is 1 micro meter, length is 4 micro meter and height is 25 to 50 nm. Which show extra ordinary sensitivity and detects nano gram to pico gram level material easily. MEMS cantilever are identify very early stage of the cancer using gold and copper material and dimension. Here we observe that cantilever sensor measure changes in mass and stiffness of the beam flowing the capture biomolecules. Due to nanofabrication technology we can deal with very small concentration of masses and diagnose the patient properly. This is very difficult in the conventional cancer detection instruments. Due to early detection of cancer stage doctor can diagnoses the patient and provides suitable medicine at very stage.

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