Chapter Three: Material and Method

3.1 Preface :

There are four piezoresistive microcantilever designed named as PZR10, PZR20, PZR30 and PZR40 respectively as shown in Figure (3.1).

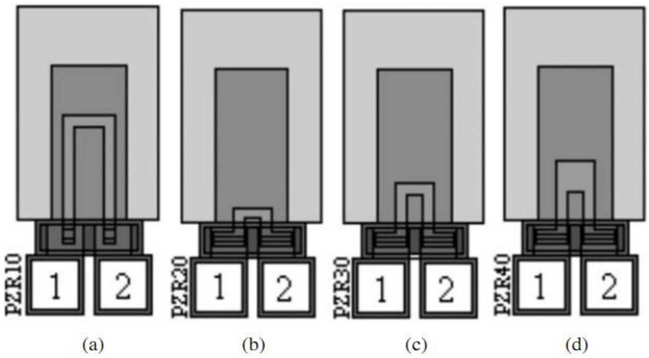

Figure (3.1). Piezoresistive microcantilever; (a) PZR10 (b) PZR20 (c) PZR 30 (d) PZR40 microcantilever design

The difference between these four designs is the thickness of the BPSG sacrificial layer : 0.6µm and 1.2µm; and the length of the piezoresistor which is at 100µm, 130µm, 160µm and 190µm.Hoever, the length and width of microcantilever beam design used in the simulation is fixed at 195µm x 70µm. The purpose of the simulation, which was carried out using ANSYS package, was to study the effect of varying the thickness on the deflection and the stress imposed on the beam, due to a pressure of 2Pa assumed to be acting on the surface of the beam. Surface stress of 2Pa were selected as the minimum value in this study because the surface stress changes at this level have been observed in many microcantilever chemical/biosensors [18].

The simulated microcantilever size is 75µm in width. The deflections of four different length of microcantilevers (100µm, 130µm, 160µm and190µm) when a 2Pa surface stress is applied on the surface of each piezoresistor is studied in this simulation

3.2 Modelling of the cantilever :

A simple model of the piezoresistive microcantilever is created by ANSYS preprocessing tools. as shown in Figure 3.2

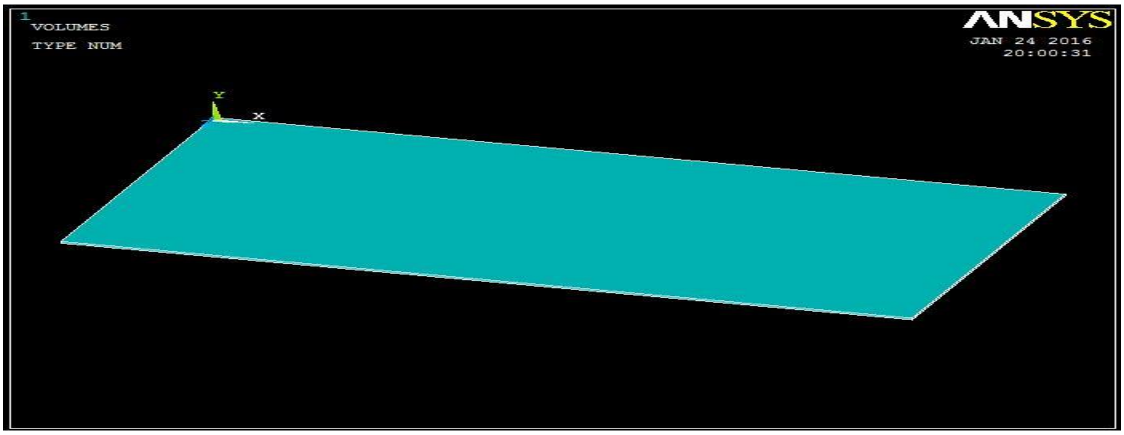

Figure (3.2) the simple piezoresistive microcantilever design use in simulation

3.3 Element type :-

Element type represent the required shape of element , it Is specified by the mesh dimension either 1D,2D OR 3D, also it is microcantilever beam by analysis field , SOLID226 has been used as element type.

3.4 Material properties defining:-

ANSYS treats the material according to its properties which makes the definition of material properties accurately very important to have good result the following table (3.1) shows the material properties:

Table (3.1): Materials properties

Properties / Material	Electric Module	Poison Ratio	Density Kg/m^3	Thermal Conductivity (k),w/m.c	Thermal expansion Coefficient t(α), 1/c	Specific heat Capacity	PiezoResistive - Coeffs (1/MPa)
Si	185	0.28	2300	157	2.33×10^{-6}	6400	0
Polysilicon	$1.69\times10^{+5}$	0.22	2.32×10^{-15}	$1.48 \times 10^{+8}$	2.8×10^{-6}	$7.12 \times10^{+14}$	Pi _ 11: 10^{-9} Pi _ 12: 10^{-11} Pi _ 44: 10^{-4}
BPGS	$70 \times10^{+4}$	0.3	2.5×10^{-15}	$2.2 \times 10^{+5}$	4×10^{-17}	$7.5 \times10^{+14}$	–
Si_3Ni_4	383 ×١٠٣	0.27	2700	0.19×10^{6}	0.8×10^{-6}	0	0

3.5 Mesh :

Meshing is an integral part of the computer-aided engineering (CAE) simulation process show in Figure (3.3). The mesh influences the accuracy, convergence and speed of the solution. Furthermore, the time it takes to create and mesh a model is often a significant portion of the time it takes to get results from a CAE solution. Therefore, the better and more automated the meshing tools .

The procedure for generating a mesh of nodes and elements consists of three main steps:

- Set the element attributes.
- Set mesh controls (optional). ANSYS offers a large number of mesh controls, which you can choose from to suit your needs.
- Generate the mesh.

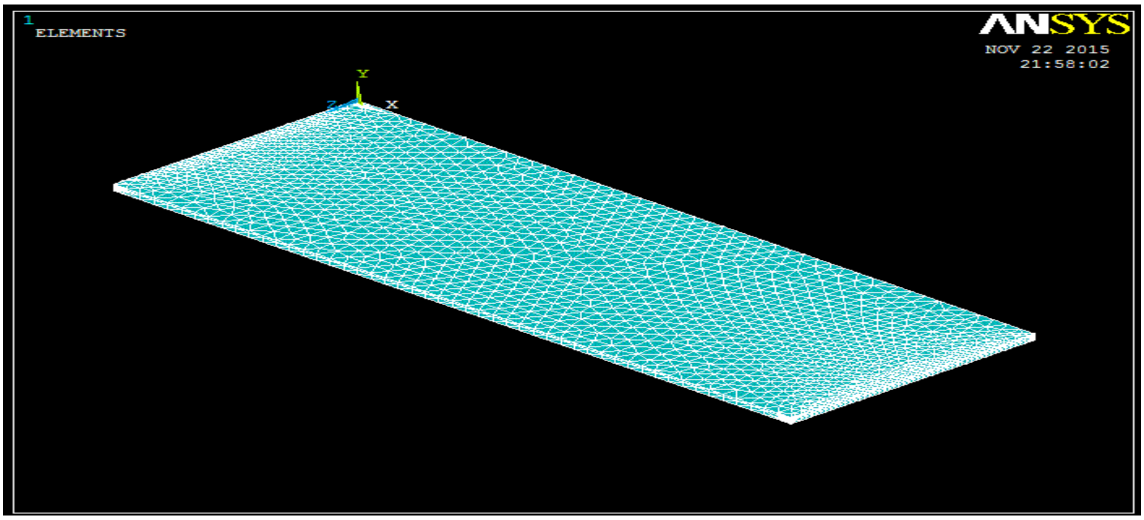

Figure (3.3): Mesh of the microcantilever beam

3.6 Define Loads:

In this stage both boundary conditions and thermal and structural loads are applied. The following figure (3.4) represents geometry with applied load.

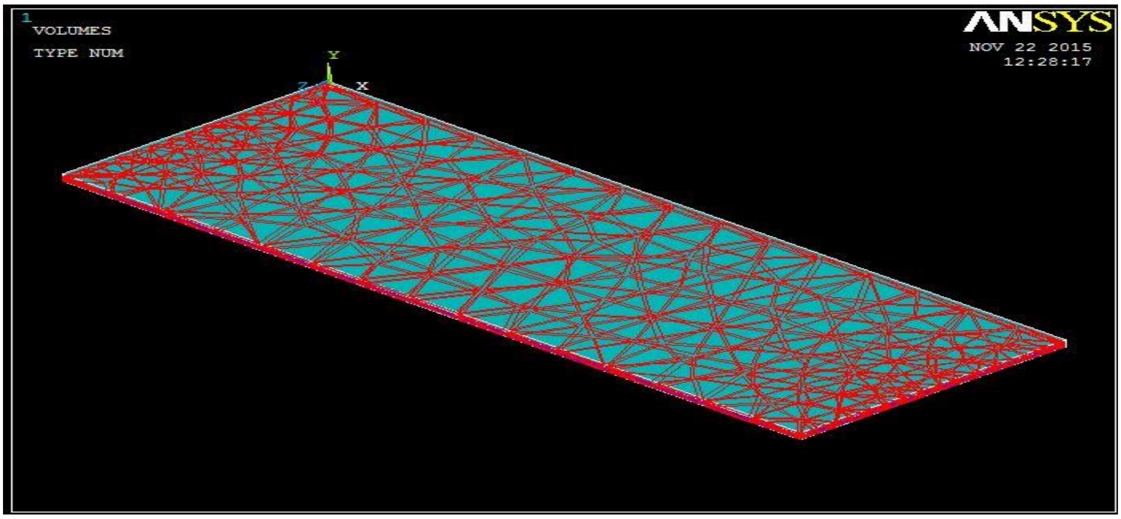

Figure (3.4): applying loads on nodes

3.7 Processing:-

In this part the program is solving the equations of loads and boundary conditions.

3.8 Post processing:-

In this part the plot of the results and analysis mesh displacement in the microcantilever beam show in figure (3.5). Both of process and post process will be shown in chapter four.

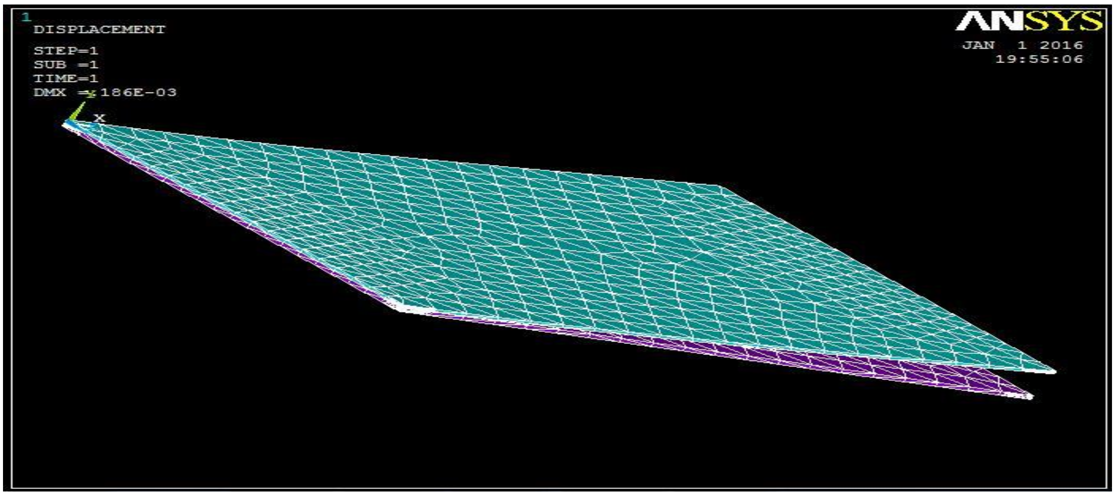

Figure (3.5): Mesh displacement in the microcantilever beam