Fabrication of Micro-cantiliver Based Sensor

Principal Investigator: Dr. Rajendra Patrikar
VNIT, Nagpur
Co- Principal Investigator: Mrs. Jayu Kalambe
RCOEM, Nagpur

Research Project at Indian Institute of Technology Bombay under Indian Nanoelectronics User Program (INUP) sponsored by DIT, MCIT Government of India.

1. INTRODUCTION

One of the most flexible mechanical sensor systems is the microcantilever based sensor. Conventional has the limitation of having high power consumption and sensitivity, Microcantilever technology have the solutions to some of this limitations. By reducing the dimensions of the sensor to the nanometer scale, the sensor can become faster, cheaper and more sensitive. Differential stress at the surface to the beam of the cantilever causes the bending of cantilever. The cantilever bending can be detected by different read-out methods, such as optical reflection, piezoresistive, Interferometric, piezoelectric and capacitive [1-3]. In this work the direct electrical detection is used, which has an advantage of reduced complexity. Main objective towards this project is to demonstrate the application of Micro-cantilever as a temperature sensor. The design of the device is based on electrostatic actuation of a vertically deflecting cantilever and the readout method employed is electrical i.e current is used to detect the temperature. Fabrication of single layer Aluminium, Polysilicon and bi-layer cantilever (Polysilicon-Gold) and thorough electrical characterization of these sensors was done to verify the functionality of the sensor.

2. Microcantilver Fabrication

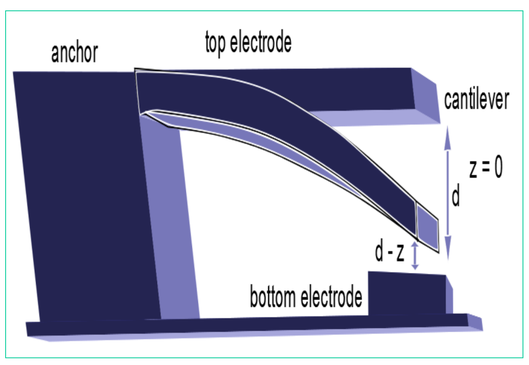

Fig.1. Microcantilever based sensor with bottom electrode

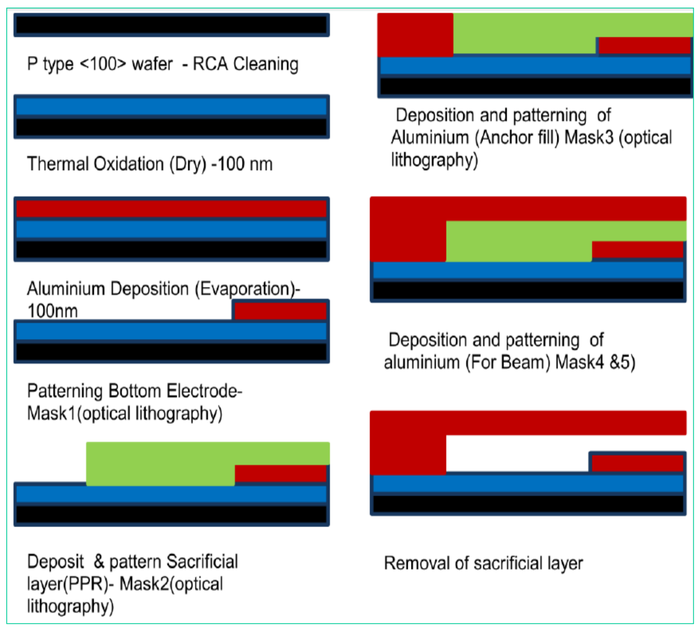

Fig.2. Process flow for Aluminium Cantiliver

A. Fabrication of Metal Cantiliver

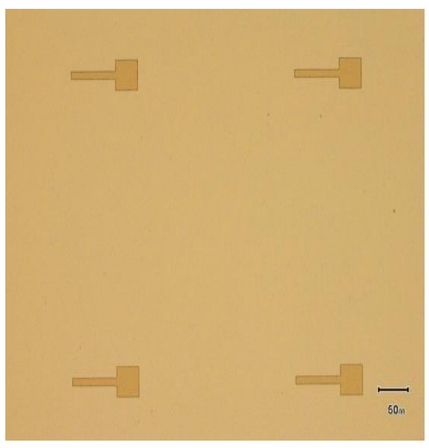

Fig.3. 1st level of Al patterning

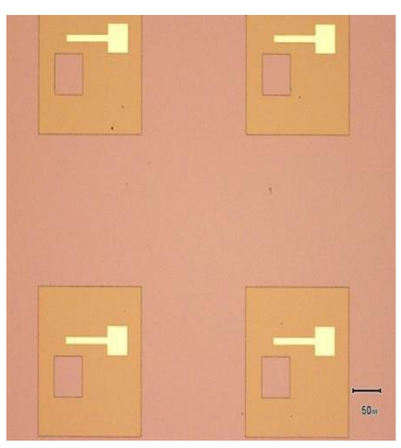

Fig.4.2nd level of S1813 resists patterning

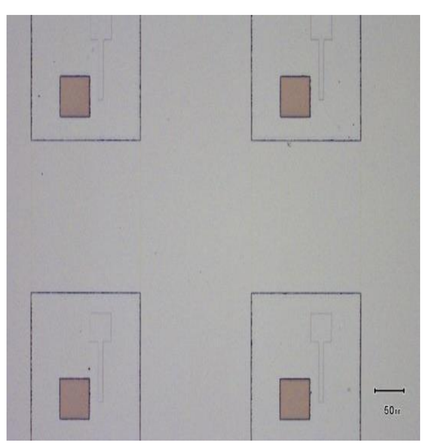

Fig.5. 3rd level of Al patterning

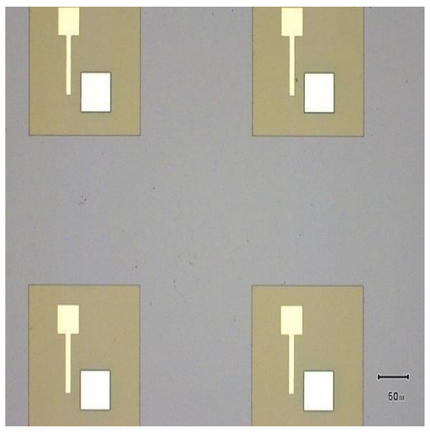

Fig.6.4th level UV Exposure and development.

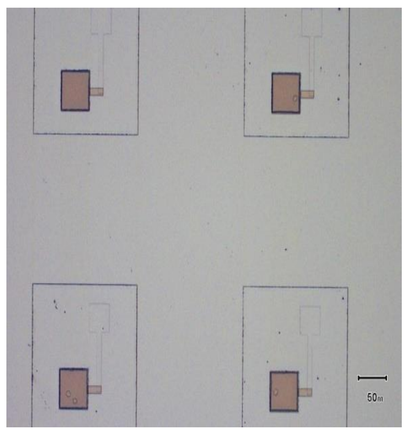

Fig.7. 5th level Al Patterning

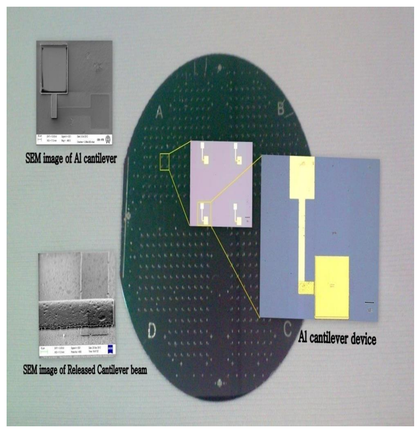

Fig.8.Fabricated microcantilevers after optimization process

B. Images of Microcantiliver after Plasma Ashing

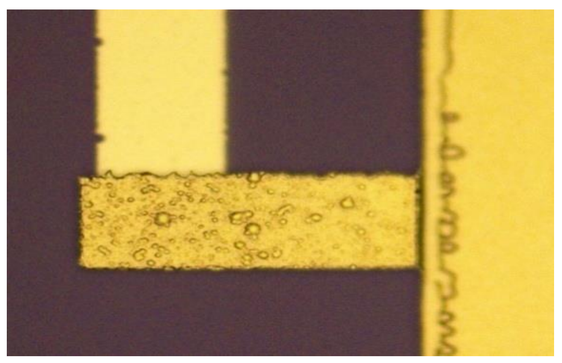

Fig.9. Surface Image

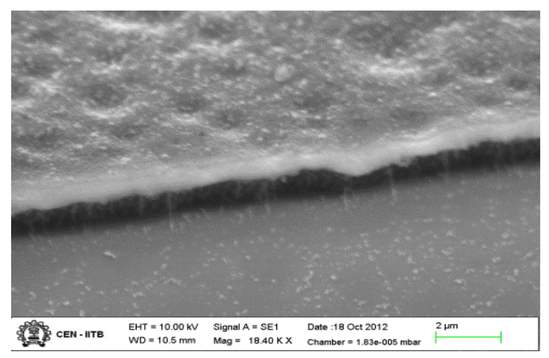

Fig.10. SEM Image

C. Plasma Ashing at different Watts and Time Period

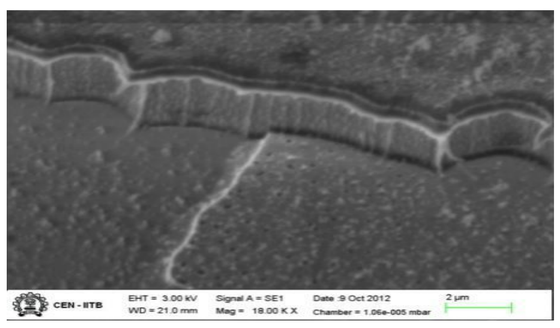

Fig.11.80 watt,50 sec

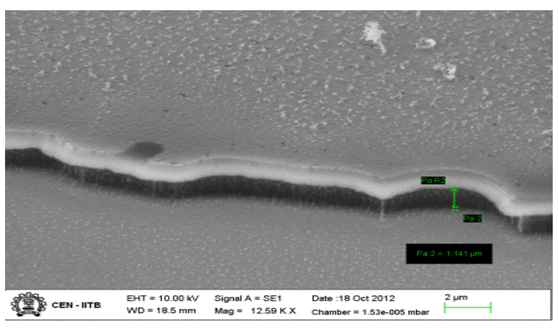

Fig.12.100watt,10min

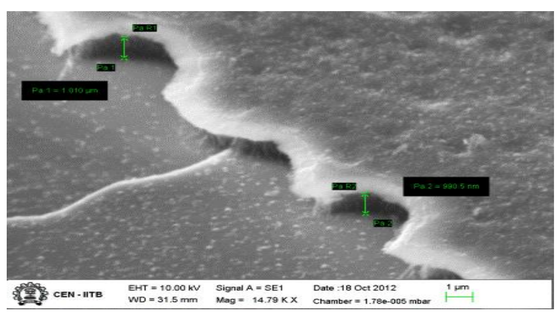

Fig.13.100watt,15 min

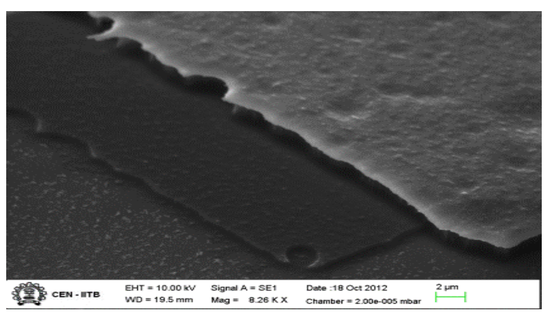

Fig.14.100 watt,30 min

4. Experimental Results for single layer and bi-layer cantilevers

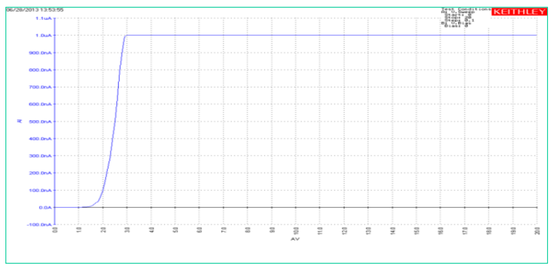

Fig.15. I-V Characterization of single layer

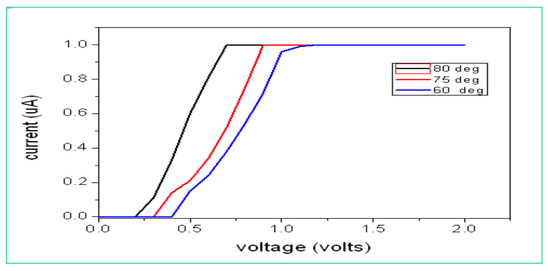

Fig.16. Temperature dependent I-V Characterization of single layer structure

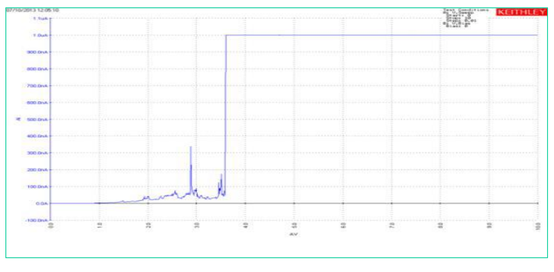

Fig.17. I-V Characterization of Bi-layer Structure

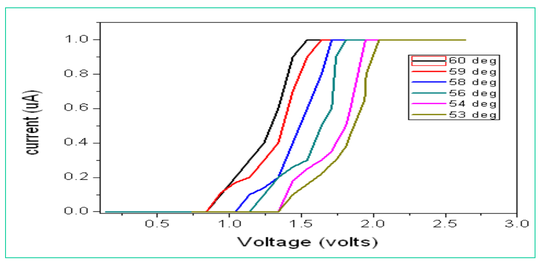

Fig.18. Temperature dependent I-V Characterization of bi-layer structure

CONCLUSION : In this work microcantilever sensors with electrical readout method has been designed and developed. The processes for fabrication with five step lithography were developed for each of these microcantilevers. Electrical characterization of these microcantilevers was performed. The device was prestressed with the voltage and different temperatures could be detected. Experimental results are validating the use of the microcantilever for temperature detection. The operating range for temperature sensing application is improved in bi-layer structure which is experimentally demonstrated. These measurements probably are useful in other sensors such as biosensor and accelerometer development.

REFERENCES :

[1] Anja Boisen, Søren Dohn, Stephan Sylvest Keller, Silvan Schmid and Maria Tenje, "Cantilever-like micromechanical sensors" Rep. Prog. Phys. 74(2011) 036101, pp 30
[2] L.G. Carrascosa and M. Moreno, "Nanomechanical biosensors : a new sensing tool," Trends Anal. Chem., vol. 25, 2005, pp. 196–206.
[3] C.A. Savran, T.P. Burg, J. Fritz, and S.R. Manalis, "Microfabricated mechanical biosensor with inherently differential readout," Applied Physics Letters, vol. 83, 2003, pp. 1659-1661.

Acknowledgement: Authors would like to acknowledge Centre for Excellence In Nanoelectronics And Nanoelectronics Device Characterization Laboratory (IITB, Powai, Mumbai) for its support for this work.