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PROGRAMME GUIDE

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P-MEMS-28 - Novel micromirror design with variable pull-in voltage

R. Beernaert[1], T. Podprocky[1], A. Witvrouw[2], L. Haspeslagh[2], A. Avci[1], J. De Smet[1], H. De Smet[1]

[1]Ghent University, ZWIJNAARDE, Belgium
[2]Interuniversity Microelectronics Centre, LEUVEN, Belgium

A novel micromirror design which can be used in a projection display is presented. The design permits variability of the pull-in voltage, which is proven by COMSOL simulation. Hereby the duty cycle of the mirror position does not depend on the amount of binary subframes. Grey levels can be chosen arbitrarily, allowing less severe speed requirements for the electronic layer below the MEMS, less image processing hardware and less memory. The mirrors with variable pull-in voltage were fabricated using SiGe as structural layer. The variable pull-in principle will be demonstrated by measurements on these SiGe mirrors.

NEMS

P-MEMS-29 - High-sensitive strain sensor using tunnelling effect in SU-8/CNTs nanocomposite

D-W. Lee[1], J-C. Lee[2]

[1]School of Mechanical Systems Engineering, Chonnam National University, GWANGJU, South-Korea
[2]Graduate School of Mechanical Engineering, Chonnam National University, GWANGJU, South-Korea

A strain sensor using a tunneling effect of carbon nanotube networks has been proposed for MEMS applications. The CNT network embedded into SU-8 is placed on the cantilever. The key issue in the strain sensor was the local and selective formation of the nanocomposite on the cantilever. As compared with traditional strain gauges, much higher sensitivity can be obtained with the nanocomposite sensors.

P-MEMS-30 - Fabrication of robust carbon nanotube microstructures by elastocapillary densification

M. De Volder[1], D. Vidaud[2], P. Sei-Jin[2], S. Tawfick[2], J. Hart[2]

[1]KULeuven/IMEC, LEUVEN, Belgium
[2]University of Michigan, ANN ARBOR, United States of America

Moved to parallel session 7C MEMS (Thursday 1 October, 16:00 – 17:30)

P-MEMS-31 - Carbon Nanotube Vertical Membranes for Electrostatically Actuated Micro-Electro-Mechanical Devices

A. Arun[1], M. Fernández-Bolaños[1], P. Salet[1], H. Le Poche[2], P. Pantigny[2], T. Idda[3], A. Ionescu[1]

[1]EPFL, LAUSANNE, Switzerland
[2]CEA LITEN, GRENOBLE, France
[3]LAAS - CNRS, TOULOUSE, France

Vertically aligned carbon nanotube (CNT) membranes are used as building blocks to realize electrostatically actuated MEMS. The fabricated CNT dense arrays are grown on adjacent metal electrodes and can be actuated by applying a DC bias. The conductive membranes deflect when actuated and a clear pull-in is observed, as in any conventional MEM device using metal parallel plates. We have performed S-parameter measurements as a function of the actuation voltage and we have observed a reduction in the insertion loss between the two electrodes with the increase in DC bias, indicating a significant change of the device capacitance.

P-MEMS-32 - Fabrication of nanomechanical devices by ion beam patterning and etching

F. Perez-Murano[1], J. Llobet[1], G. Rius[1], M. Gerbolés[1], X. Borrisé[1], N. Mestres[2]

[1]Institut de Microelectronica de Barcelona (IMB-CNM, CSIC), BELLATERRA, Spain
[2]Institut de Ciència de Materials de Barcelona, BELLATERRA, Spain

We evaluate the use of a novel approach for the fabrication of nanomechanical devices based on the direct exposure of silicon and polysilicon surfaces with a focused ion beam (FIB) in combination with reactive ion etching and wet chemical etching. Irradiated silicon areas are good masks for pattern transfer into silicon with nanometer scale resolution. Alternatively, the irradiated volume is employed as structural material for sub-100 nm width nanowires after isotropic silicon etching. The nature of the irradiated material in order to elucidate the mechanism of etching resistance is investigated.

P-MEMS-33 - Micromachining of Newly Designed AFM Probe Integrated with Hollow Microneedle for Cellular Function Analysis

N. Kato[1], T. Kawashima[1], T. Shibata[1], T. Mineta[2], E Makino[2]

[1]Toyohashi University of Technology, TOYOHASHI-SHI, Japan
[2]Hirosaki University, HIROSAKI, Japan

In order to realize cellular function analysis in a single living cell, we have been developing a newly designed probe for atomic force microscope (AFM), in which a conventional sharp tip is superseded by a hollow silicon dioxide (SiO2) microneedle connecting the root to a fluidic microchannel embedded into a silicon (Si) cantilever. In order to realize a bioprobe, we have developed the prototype bioprobes by using micromachining technology. In addition, The AFM image was obtained by using a fabricated AFM probe. The image proved capable of taking AFM images.

P-MEMS-38 - Dynamic characterization method of GaAs membrane resonator by direct excitation using scanning probe microscopy

K. Tamaru[1], K. Nonaka[1], M. Nagase[2], H. Yamaguchi[2], R. Kometani[1], S. Warisawa[1], S. Ishihara[1]

[1]The University of Tokyo, Graduate School of Engineering, Tokyo, Japan
[2]NTT Basic Research Laboratories, Kanagawa, Japan

High-resolution vibration detection technique is required to realize the full potential of nano/micro mechanical resonant structures. In this study, scanning probe (SPM) microscopy-based dynamic characterization method without the actuation device has been researched for an evaluation of nano/micro resonator. GaAs circular membrane structure with a diameter of 14 - 64 mm was used as a resonant structure. A vibration of GaAs membrane was excited directly using Coulomb force generated by an oscillating voltage between SPM probe and GaAs membrane. And a detection of nanometer-order amplitudes in megahertz-order frequencies was achieved by a novel direct excitation method using SPM probe.

High-sensitive strain sensor using tunnelling effect in SU-8/CNTs nanocomposite

Ji-Chang Lee[a] and Dong-Weon Lee[b]

[a] *Graduate school of Mechanical Engineering, Chonnam National University, Gwangju 500-757, Korea*
[b] *School of Mechanical Systems Engineering, Chonnam National University, Gwangju 500-757, Korea*
e-mail: mems@chonnam.ac.kr

Keywords: SU-8, Flexible, Piezoresistive, Tactile sensor

Summary

A strain sensor using a tunneling effect of carbon nanotube (CNT) networks has been proposed for MEMS applications. The CNT network embedded into SU-8 is placed on the cantilever as shown in Fig. 1. The key issue in the strain sensor was the local and selective formation of the nanocomposite on the cantilever. After microfabrication of the cantilever device with the SU-8/CNTs nanocomposite sensor, electrical resistance and strain were simultaneously and continuously measured using a simple measurement setup. The tunneling effect is considered to be the principal mechanism of the sensor under small strains. As compared with traditional strain gauges (Table 1), much higher sensitivity can be obtained with the nanocomposite sensors.

Motivation

CNT-based nanocomposites are increasingly being reviewed as a realistic alternative to conventional smart materials because they offer higher sensitivity and superior electrical and mechanical properties in comparing with traditional strain gauges. The conductance of a CNT can be dramatically changed by the introduction of structural change. This effect is caused by the change of chirality in a single-walled carbon nanotube. The main reason for developing the embedded strain sensing system in a composite structure using thin films is that it allows one to measure the static and dynamic response with a high sensitivity. However, at present, overall research on polymer/CNTs nanocomposite as a strain sensor is in the early stage. The topic of this research is focused on the fabrication and measurement of the SU-8/CNTs nanocomposite for cantilever sensors.

Results

Figure 1 shows the schematic diagram of a proposed high-sensitive strain sensor using tunneling effect in SU-8/CNTs composite. First, CNTS are well dispersed into SU-8 photoresist using several methods and the nanocomposite was then spin-coated on the cantilever. After patterning process, thick SU-8 was used for making a body structure. Process flow of key steps in the fabrication is shown in Fig. 2. The size of the cantilever is 400 μm in length, 90 μm in width and 5 μm in thickness. Optical images of the fabricated cantilever with the novel strain sensor are shown in Fig. 3. To investigate the relation between electrical resistance and strain for the SU-8/CNTs nanocomposite, we used a simple experimental setup shown in Fig 4. Unique and repeatable relationships in resistance versus strain were obtained using the fabricated cantilevers. Details of the research will be presented at the conference.

Reference

[1] C. S. Park, et al., Conference of Micro & Nano Engineering (2008) 573
[2] C. S. Park, et al., Applied Physics Letter 89 (2006) 223516
[3] J. K. Kim, et al., Microelectronic Engineering 85 (2008) 787–791

Acknowledgements

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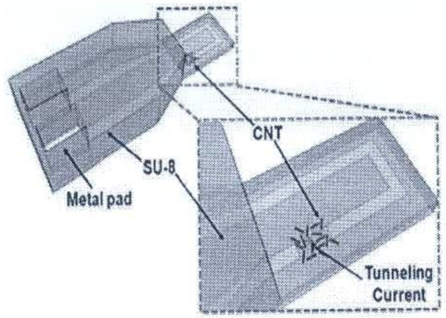

Figure 1. Design of High-sensitive strain sensor using tunnelling effect in SU-8/CNTs composite

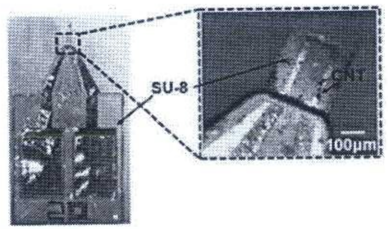

Figure 3. Optical images of the fabricated strain sensor using tunneling in SU-8/CNTs composite

Table 1. Comparison of several methods

Sensing method	Capacitive	Piezoelectric	Piezoresistive	Optical	Tunneling current
Value(A)	43	11	2	0.04	10^{-3}

Cantilever sensor properties

- Cantilever dimension : 400μm × 90μm × 5μm
- Cantilever body dimension : 1.7mm × 1.6mm × 200μm
- Spring constant(K) : 0.176N/m
- CNT concentration : 0wt% ~ 5wt%
- CNT : Iljincnt, 310F(MW)

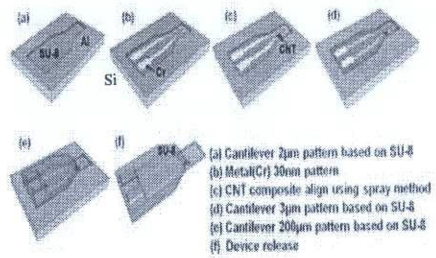

Figure 2. Process flow of key steps in the fabrication

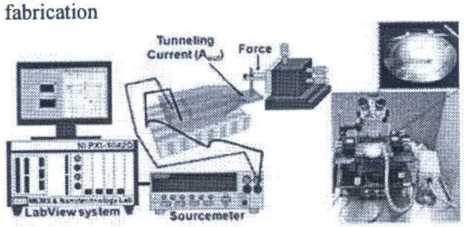

Figure 4. Experimental setup to evaluate the fabricated strain sensors

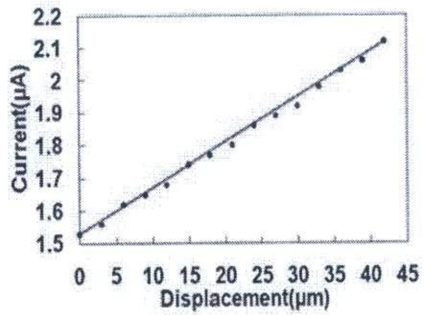

Figure 5. Experimental results