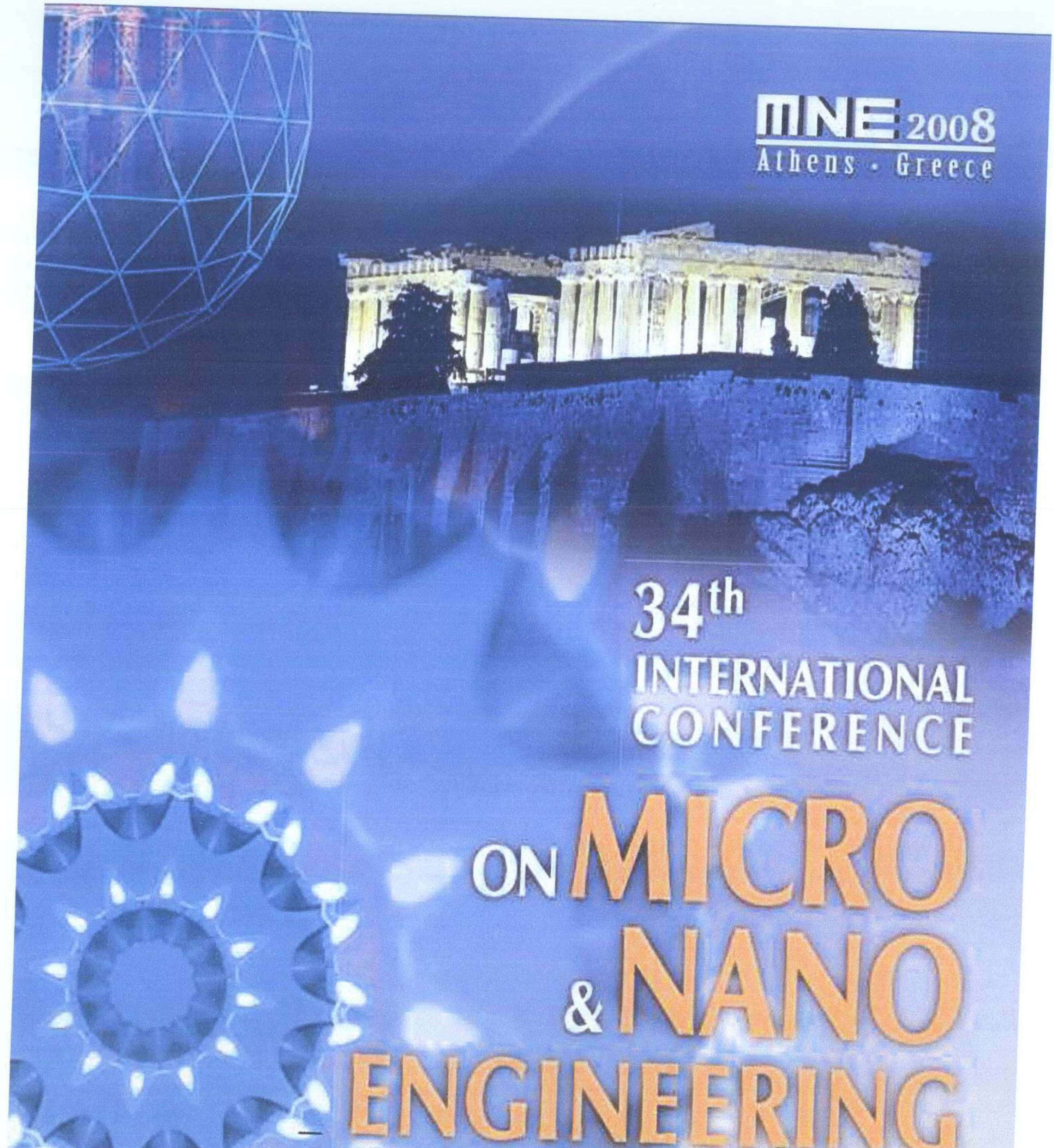
MNE 2008
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ON MICRO
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MEMS3-P 13

Sensitivity improvement of a microcantilever based mass sensor

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This article describes two approaches for sensitivity improvement of a micromachined cantilever resonatc for mass sensing applications. First, high order resonant modes have been used and then the devic dimensions were reduced. The obtained results show the high potential of this very simple device for hig sensitive mass sensor.

MEMS3-P 15

Wide frequency tuning range of MEMS resonators through on-wafer uniaxial stress

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The paper describes a new technique for achieving on-wafer large band tuning of MEMS beam resonators by applying a in-house developed technique for stressing these beams.

MEMS3-P 17

Thermally driven piezoresistive cantilevers for shear-force scanning probe microscopy

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This article will report on the fabrication, characterization and application of novel micromachined thermally driven micromechanical beam with piezoresistive readout for advanced high-speed atomic force microscopy. The fabricated cantilevers were utilized in measurements of HOPG surface in shear force mode of the atomic force microscopy.

MEMS3-P 19

Covalent surface functionalization of micro mechanical cantilever by organic capped TiO_2 and γ-Fe_2O_3 nanocrystals

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A solution based approach was set up to covalently immobilize in the dark and under UV-light dense nanoporous 3D arrays of TiO_2 NRs and Fe_2O_3 NCs onto the surface of UV-exposed micro mechanical cantilever made of a epoxy photoresist. AFM and XPS investigations show the cantilever topography and chemistry.

MEMS3-P 21

New SiC microcantilever electric connection array for single molecule electrical investigation

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[1]Lab. Photon. & Nanostruc., LPN/CNRS France, [2]Centre d'Elaboration de Matériaux & d'Etudes Structur., CEMES/CNRS, Toulouse, France

We present RF magnetron sputtering SiC array of 10 microcantilevers gold covered with a controlled curvature between 10.5um and 16um. SiC film internal stress value and distribution in depth is controlled by modifying sputtering conditions. The microcantilevers show a 100kohms resistance and a 15pF capacitance in between two electrodes.

MEMS3-P 23

90 Degrees bending angle of cantilever through in-plane driving

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MEMS & Nanotech. Lab., Dept. Mech. Eng., Chonnam Nat. Univ., Republic of Korea

We propose a complete new concept of cantilever actuation mode that is capable to meet various applications at the same time due to its advantages as relatively low spring constant, high resonant frequency, self-sensing, huge free end deflection and unprecedented bending angle as 90 degrees.

MEMS 4: VARIOUS APPLICATIONS

MEMS4-P 01

Nano engineering of magnesium hydride for hydrogen storage

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The objective of this paper is to show our results in the nanostructured magnesium hydride for hydrogen storage. Magnesium hydride is a promising material for hydrogen storage. However, relatively high temperatures are needed during hydrogen absorption and desorption cycle and both reactions are too slow for practical applications.

90 Degrees Bending Angle of Cantilever through In-plane Driving

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Originality

Most common cantilevers as actuation are driven by the deformation of bilayer structure, or the transverse force exerted through the deposited material or smooth beam surface. The structure of these cantilevers tends to be simple where a standard cantilever with or without deposited film bends under vertical load. The actuation methods for them can be generally divided into electrostatic, piezoelectric, thermal and magnetic, shown in Fig.1, where cantilevers with those actuation mechanisms serve to transduce the input signal or power into load hence realize self-bending or self-oscillation. However, these common cantilever structures are halted to versatile functions. Firstly, the most serious drawback is the deposited film, which results in non-single crystal silicon property for the beam thereby residual stress, low quality factor will be consequently aroused and the composite materials beam structure instead of single crystal silicon beam increases the numerical analysis complexity, additionally the deposited film is quite difficult to fabricate and precisely pattern; secondly, for a big displacement, a very high driving voltage and thick piezoelectric film are needed for piezoelectric actuation, which is against the unimorph beam principle. Regarding the thermal actuation, a big deflection is available, but a small amount of heat actuation way is favored for applications such as chemical identification of single molecules. No deposited film on the surface of the electrostatic actuation, but the driving force is too small to be employed for big deflection.

We present the concept of scanning force microscopy cantilevers with large deflection and ultra bending slope (nearly 90°) at the free end of the lever arm and pure single crystal silicon property exclusion of any types of surface deposition, which are realized through the new actuation mode. This novel cantilever bending actuation mode is firstly proposed totally differing from all of the conventional modes, the out of plane motion of the cantilever is achieved by integrated pre-bent cantilever with in-plane interdigitated comb-drive actuators [1], as demonstrated in Fig. 2, the horizontal comb-drive actuator actuation could be transferred to the pre-bent cantilever as a bending moment hence the in-plane actuation of the actuators offer the out of plane actuation for the cantilever, which allows to deflect and oscillate the cantilever by exerting AC or DC voltage input, additionally it enables self-sensing on interaction between sample surface and probe without any external sensors.

Motivation

With the further development and the wide applications of the scanning probe microscope [2], it is endowed with more functions such as chemical identification, and two–pass measure techniques. Thereby, a powerful and versatile cantilever is strongly required in SPM system to meet various environments and applications. Different characteristics of cantilevers are desired in different applications, some common factors are favored in most cases i.e. relatively low spring constant, high resonant frequency and big deflection. However, it is pretty difficult to compromise all of the above desired factors in a single versatile or switchable cantilever simultaneously for several applications. In terms of conventional cantilever for contact AFM mode, the spring constant is around 0.2 N/m, which is suitable for big deflection in atom manipulation or sample extraction for chemical analysis, but the resonant frequency is limited and it suffers from the cantilever tip abrasion and fragile sample's surface damage. In noncontact and intermittent contact modes, high resonant frequency and intact sample surface can be satisfied, but the high stiffness of the beam leads to small deflection to the order of several nanometers that is not able to be extended to universal applications. In this article we propose a new concept of cantilever actuation mode that is capable to meet various applications at the same time due to its advantages as relatively low spring constant, high resonant frequency, self-sensing and huge free end deflection.

Results

The unique comb-drive actuator structure for over 75 μm displacements is used to generate in-plane big actuation, promising cantilever a big deflection and high oscillation frequency, as demonstrated in Fig. 3. The simulation is shown in Fig. 4. The new system has the potential to be developed for chemical identification atomic force microscopy, data storage, nanolithography techniques. More detail of this work will be discussed in the conference.

Acknowledgements

This work is supported by Korea Science & Engineering Foundation through the NRL Program (Grant R0A–2007–000–10157–0).

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[2]Y. Sugimoto, P. Pou, M. Abe, P. Jelinek, R. Pérez, S. Morita, Ó. Custance, Nature 4461 (2007) 64-67.

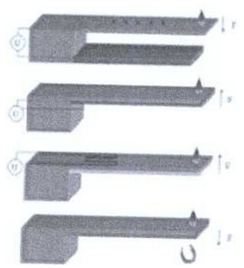

Figure 1. Schematic diagram of the system with cantilever integrated into micoscanner.

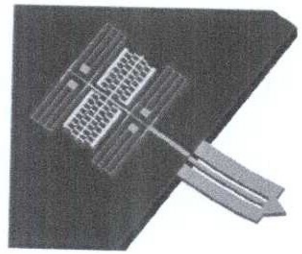

Figure 2. Working mechanism of the new system with self-three dimensional actuation.

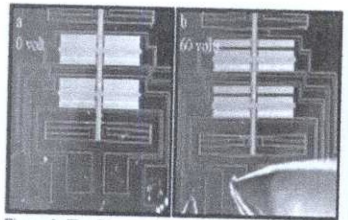

Figure 3. The 75 μ m ultra displacement of scanner driven under 60 volts DC voltage.

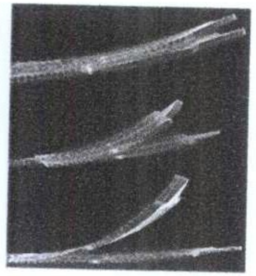

Figure 4. The simulation results of the process of the cantilever bending, allowing 90° bending slope.