MEMS and NEMS
Room: Hall D - Session MN-TuP

MEMS and NEMS Poster Session

MN-TuP1 Effects of Gate Fabrication Processes on Electrical Characteristics in Suspended Gate FET, *T. Kumada*, *H. Kasai, M. Edo, Y. Ichikawa*, Fuji Electric Advanced Technology Co., Japan

Suspended gate FET`s (SG-FET) are expected to have a number of applications such as switching devices and acceleration sensors. A key process in these devices is how to fabricate the suspended gate. We have studied influence of the gate materials, the gate structure and sacrifice layer etching on the electrical characteristics of the SG-FET. The SG-FET we have developed has a conventional planar type MOS FET except for the gate placed apart from the silicon oxide gate insulator; the gate has a bridge structure with supports put outside the gate insulator. The gap between the gate and the gate insulator was designed to be 0.5 - 1.0µm. In these devices, the stress of the gate materials deforms the gate and changes the gap from the designed value; it affects the electrical characteristics of the SG-FET. Thus we have studied the gate materials and the gate structure to reduce deformation of the gate. Another important key in the SG-FET is the fabrication process of the suspended gate. To make its bridge structure, we deposit a sacrifice layer on the gate insulator first, and then deposit the gate material on it. After patterning it to form the gate, we remove the sacrifice layer by etching. This etching process affects the electrical characteristics of the SG-FET because of contamination and damage of the surface of the gate insulator. We applied polyimide to the sacrifice layer, and studied the influence of the etching method and the etching condition on the characteristics. In this presentation, we will discuss the relationship between the fabrication process and the materials of the suspended gate and the electrical characteristics in detail.

MN-TuP2 Q-Factors of Suspended Al and Al-CNT Thin-Film Micromechanical Resonators as Function of Tensile Stress, *Y.J. Yi*, *J.H. Bak, Y.D. Kim, B.Y. Lee, S. Hong, Y.D. Park*, Seoul National University, Republic of Korea

We report on the Quality (Q) factor of micromechanical resonators, realized from suspended Al and Al-CNT nanolaminate thin-films,[1] as function of tensile stress. The doubly-clamped beam micromechanical resonators with varying dimensions are realized on GaAs substrate, which is selectively removed. Suspension of microresonators is preceded by UHV sputter deposition of Al and carbon nanotube (CNT) network assembly and patterning by standard e-beam and photolithography techniques. The frequency response of micromechanical resonators are characterized by a laser vibrometer-like set-up while the microresonators are actuated electrostatically. With significant difference in coefficients of thermal expansion, the suspended metallic thin-films have significant intrinsic internal stress as evident from fits to resonant frequency as function of beam dimensions measurements. The internal stress is further varied by post-fabrication thermal treatments as well as by chip-bending method.[2] Increase in Q-factors ultimately improves the force sensitivity of micromechanical resonator devices (i.e., mass sensing applications). Comparing the dependence of Q-factor to tensile stress of Al and Al-CNT thin-film microresonators allows for another avenue to study the mechanical enhancements due to CNT networks in the Al-CNT lamina.

[1] J.H. Bak, Y.D.Kim et al., Nature Materials advance online publication, 20 April 2008 (doi:10.1038/nmat2181).
[2] S.S. Verbridge et al., Nano Letters 7, 1728 (2007).

MN-TuP3 Test Instrument for the Tensile Fracture Strength of Micro-Nano Materials, *A. Kasahara*, *H. Suzuki, M. Goto, H. Araki, Y. Pihosh, M. Tosa*, NRIM, Japan

Recent nano-technology researches have created various advanced micro-nano materials. In particular, there have been many reports on nano-meter-scale tubes and wires such as carbon nanotubes and silicon wires. We have prepared long crystal silicon wires with a diameter of several tens of nano meters at a temperature lower than 523k by using the low-pressure low-temperature CVD method. To use these as materials for application to micro-nano electromechanical system, we need to fully understand their electric, chemical and mechanical properties. As for the electric properties, current-voltage characteristics have been measured with the multi probe system using STM measurement units, although but there is almost few technique established for the measurement of mechanical properties. We have been therefore developing a strength measurement equipment for micro-nano materials to determine the mechanical properties of micro-nano wires in a vacuum for SEM observation. We will report this result on the development of test instrument to measure the tensile strength that can be observed with a desk-top simple SEM.

MN-TuP4 Functionalization of Micro Mechanical Cantilever Sensors with TiO_2 and γ-Fe_2O_3 Nanocrystals, *C. Ingrosso*, *M. Striccoli*, CNR-IPCF Sez. Bari c/o Dip. di Chimica, Italy, *E. Sardella*, IMIP-Bari, Italy, *A. Voigt, G. Gruetzner*, Micro Resist Technology GmbH, Germany, *A. Agostiano*, CNR-IPCF Sez. Bari c/o Dip. di Chimica, Italy, *S. Keller, G. Blagoi, A. Boisen*, Technical University of Denmark, *M.L. Curri*, CNR-IPCF Sez. Bari c/o Dip. di Chimica, Italy

The oustanding flexibility of the surface chemistry of colloidal nanometer-sized particles[1] allows their reliable manipulation as building blocks and opens the access to the development of original supramolecular approaches, devoted to the mesoscale organization of nanoparticles in hierarchical structures. In this work, 3D arrays of organic-capped colloidal NCs were covalently immobilized on the surface of micro mechanical cantilever sensors made of a negative tone epoxy photoresist matrix. Mechanical cantilever sensors surface functionalized with a sensing active layer are very active in the detection of target molecules.[2] Q-sized colloidal NCs were immobilized at the surface of the miniaturized responsive components by means of the surface reactive residual epoxy at crosslinked photoresist matrix, which provide good accessibility to external interacting molecules, with an high immobilization capacity. The transferring of Q-sized colloidal NC properties to mechanically responsive miniaturized components represents an intriguing challenge, which disclose a great potential for extending the field of application of the ultrasensitive microfabricated mechanical cantilever sensors by exploiting novel transduction processes in molecule detection. Here, a simple solution-based method was adopted to modify the epoxy photoresist made cantilever surface with oleic acid (OLEA)-capped anatase TiO_2 nanorod (NR) and nearly spherical maghemite γ-Fe_2O_3 NC building blocks. The morphological evolution of the native epoxy surface upon the attachment of NCs was monitored by Atomic Force Microscopy (AFM), while the effective covalent anchoring of the nanoparticles was demonstrated by means of X-Ray Photoelectron Spectroscopy (XPS). The photo/catalytic, magnetic and optical functionalities of NCs[3] transferred to the high dense NC layout open the access to the development of novel MEMS/BIO-MEMS devices based on new bio/molecular recognition processes for bio/sensing or environmental purposes. Acknowledgements: The work was partially supported by the 7th FP EU project NOVOPOLY (STRP 013619)

[1] Yin, Y. et al. Nature 437, (2005), 664.
[2] Gfeller, K. Y.; Nugaeva, N.; Hegner, M. Biosens. Bioelectron. 21, (2005), 528.
[3](a) Narazaki, A.; Kawaguchi, Y.; Niino, H.; Shojiya, M.; Koyo, H.; Tsunetomo, K. Chem. Mater. 17, (2005), 6651. (b) Detlef, M. S.; Thomas, S. R. J. Magn. Magn. Mater. 302, (2006), 267.

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