【Grant-in-Aid for Scientific Research(S)】
Science and Engineering (Engineering I)

Title of Project : Nanomechanical Structures Research and its Applications to Devices

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Research Area : Engineering, Mechanical Engineering

Keyword : Nanomechanics, nano/microfabrication, nanoresonator, NEMS

【Purpose and Background of the Research】

Almost all systems and devices have achieved their advanced functions and high performances by downsizing their elemental structure sizes. As the size reaching down to nanometer scale, a wide range of nanotechnology researches aiming at realizing novel nanodevices are conducted.

Due to their small scales, nanomechanical structures have great potential in realizing innovative mechanical devices and machines utilizing their new properties. In this project, we conduct fundamental investigations into fabrication and characterization technologies to examine the dynamic properties of nanomechanical resonators. This research work called "nanomechanics" will stimulate the research and development of various nano-scale electromechanical systems (NEMS). (Fig.1)

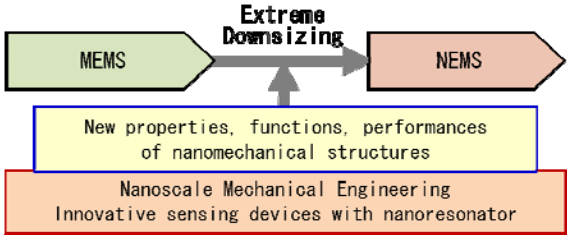

Fig.1 Concept and strategy of the project

【Research Methods】

To realize innovative NEMS, we will design, fabricate and characterize dynamic properties of nanoresonators using semiconductors or carbon materials. (Fig.2)

Planned research items of this project are; (1) Refining and merging fabrication technologies of the electron beam 2D patterning and the focused ion beam 3D structure deposition, (2) Vibration measurement and characterization of the dynamic properties of resonant nanostructures (i.e. resonant frequency, amplitude, and Q factor), (3) Surface engineering to evaluate the influence of the surface state on the resonant properties, (4) Strain engineering to make drastic resonant property improvement by applying tensile stress into the resonators, and (6) Trial development of ultra-small resonator-based sensing devices with high detection performances.

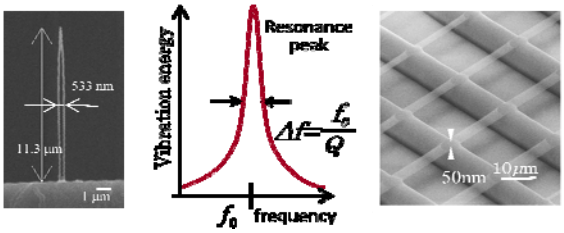

Fig.2 Nanoresonators and dynamic property

【Expected Research Achievements and Scientific Significance】

Utilizing these technology infrastructures, the extreme sensing techniques using nanomechanical structures, which have only been utilized for scientific research tools under ultimate low temperature in high vacuum, will be evolved into the development of actual devices for engineering use. The technologies will contribute to create a variety of ultra-small nanomechanical devices with low power consumption, such as ultra-sensitive sensors for mass, force, temperature, mechanical switches, optical integrated circuits, and so on.

【Publications Relevant to the Project】

- K. Tamaru, H. Yamaguchi, and S. Ishihara: Direct Actuation of GaAs Membrane with the Microprobe of Scanning Probe Microscopy, Jpn. J. Appl. Phys. **48** (2009) 06FG06.
- R. Kometani and S. Ishihara, Nanoelectromechanical device fabrications by 3-D nanotechnology using focused-ion beams, Sci. Technol. Adv. Mater. **10** (2009) 034501.
- H. Yamaguchi, S. Warisawa and S. Ishihara, Improved resonance characteristics of GaAs beam resonators by epitaxially induced strain, App. Phys. Lett. **92**, 251913 (2008)

【Term of Project】 FY2010-2012

【Budget Allocation】 158,300 Thousand Yen

【 Homepage Address and Other Contact Information】

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