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Compound Semiconductor Mechanical Devices
- Ultra-sensitive detection via nanomechanical motion -

NTT

Motivation

Semiconductor mechanical devices enable the pursuit of new technological innovations in nanoscience and nanotechnology. They provide the means to probe the fundamental nature of the world via the spectrally pure and exquisitely sensitive mechanical resonance. These systems permit diverse applications such as metrology, mechanical computation as well as pushing quantum mechanics into the macroscopic realm.

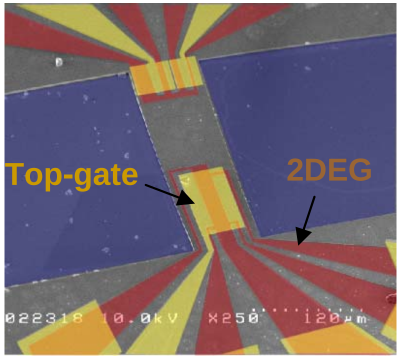
Originality

Mechanical oscillators realised in a GaAs crystal allow electro-to-mechanical transduction to be mediated via the piezoelectric effect. The piezoelectric transducer enables on-chip all electrical resonance actuation, detection of mechanical motion as well as enabling the resonance frequency to be tuned. Tensile stress introduced into a semiconductor heterostructure during crystal growth can enhance the mechanical resonance response resulting in improved detection sensitivities.

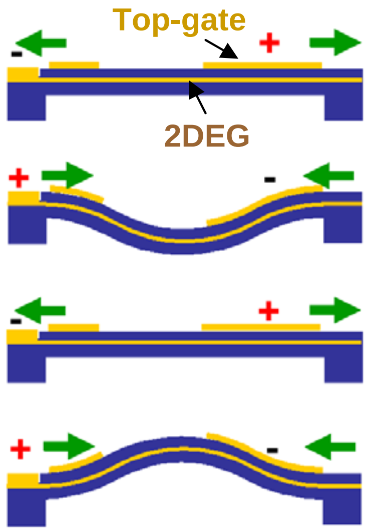
Impact

The opportunity exists to fabricate a new class of device which is highly integrated with superior performance resulting in enhanced sensitivity for the detection of ultra weak forces.

Parametric bifurcation detector



FET-embedded doubly clamped beam



Parametric excitation using the piezoelectric effect of III-V semiconductors

$$f_{gate} = 2\, f_{act}$$

Two stable vibrational states with 180° different phase

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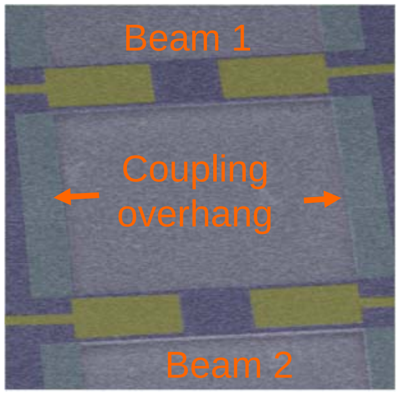
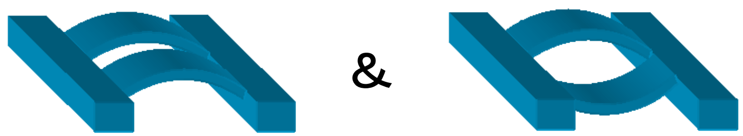
Ultra-sensitive detection via the transition of two states

Coupled micromechanical resonators



Mechanically coupled doubly clamped beams

Symmetric vibration & Anti-symmetric vibration



Coupled two vibrational modes

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Ultra-sensitive detection via the amplitude change by the symmetry lifting

サイエンスプラザ 2009 ナノサイエンスが拓く量子の世界

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