Optomechnical actuator driven and probed by mechanically-linked optical nanocavities

NTT NPC[1], NTT BRL[2] °F. Tian[1,2], H. Sumikura[1,2], E. Kuramochi[1,2], H. Taniyama[1,2], M. Takiguchi[1,2], and M. Notomi[1,2]

E-mail: Feng.Tian@lab.ntt.co.jp

Introduction: Almost all the cavity-optomechanical devices utilize both optical and mechanical resonances in one component, and their driving and probing operations by light share the same input and output channels [1]. Such configuration is helpless in certain applications. For example, if we want to optomechanically control the spontaneous emission from copper doped silicon [2], it will be very hard to detect the emission from one channel device because much stronger driven light will flood the emission.

Device and results: We fabricate an optomechanical device with two optically-isolated sets of coupled one-dimensional photonic crystal cavities, and the two sets of cavities are mechanically linked by a folded nanobeam spring, shown in Fig. 1(a). Working schematic of the device is shown in Fig. 1(b). When light (λ=1550nm, propagation mode of driving cavities) is launched into the driving set of coupled cavities, optical gradient force will drive the entire movable structure and the displacement of movable cavity in probing set will be transduced by resonance (λ=1250nm, 3rd order even mode of probing cavities) shift of the coupled cavities. In measurement, the driving light is modulated by the stimulus of vector network analyzer (VNA) which is used to sweep the RF spectrum. The measured resonance spectrum of fundamental in-plane mode is plotted in Fig. 1(c) (inset is FEM-simulated motion), where the mechanical resonance frequency is 1.18 MHz (matched with FEM-simulated value) and the *Q* value is 5900. The device works well on purpose, where the mechanical resonance is excited by driving light and the resonance signal is transduced to probing cavities which is optically-isolated from driving cavities.

Conclusion: The device has a unique configuration of optically-isolated driving and probing channels for optomechanical operation and is an available platform for optomechanically-controlled spontaneous emission which contributes to the study on interactions among optical field, mechanical resonance, and atom two-level system. Besides, the mechanical performance of the spring can be designed freely without influence on optical cavity dimensions.

Reference and acknowledgement: [1] D. V. Thourhout et. al., Nature Photon. **4**, 211-217 (2010). [2] H. Sumikura et. al., Sci. Rep. **4**, 5040 (2014). This work was supported by JSPS KAKENHI Grant Number 15H05735.

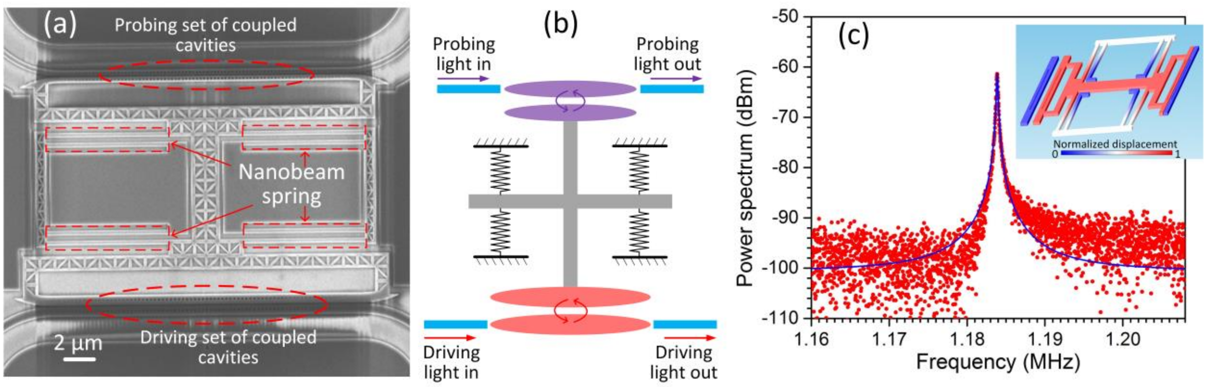

Fig. 1(a) SEM image of the actuator. (b) Schematic of the actuator configuration. (c) Resonance spectrum of the fundamental in-plane mechanical mode probed by probing cavities. Inset: FEM simulated motion of fundamental in-plane mechanical mode.