GaAs MEMS 梁共振器構造における内部モード間結合係数の測定

Experimental determination of the internal mode coupling coefficient in GaAs doubly clamped MEMS beam resonators

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Mode coupling effect in MEMS resonators is very attractive since it significantly modifies the performance of MEMS resonators. Previously, we have reported a giant enhancement in the thermal responsivity of the doubly clamped GaAs MEMS beam resonators by using the internal mode coupling effect[1,2], which indicates that the mode coupling effect is promising for realizing high-sensitivity thermal sensing, such as ultrasensitive terahertz (THz) detection at room temperature.

In this work, we experimentally determine the mode coupling coefficient in a GaAs MEMS beam resonator by measuring the coupling-induced resonance frequency shift[3]. The first bending mode of the MEMS resonator was driven in the self-oscillation mode by using a phase locked loop. Simultaneously we drove the MEMS resonator at the frequencies of higher resonance modes and measured the frequency shift of the self-sustained 1st bending mode. The frequency shift can be theoretically predicted to be;

$$\Delta\omega = \omega_k - \omega_{k,init} = \omega_{k,init} g_{kj} a_j^2 \qquad (1)$$

where g_{kj} expresses the mode coupling coefficient between the two modes. Figures 1a and 1b show the measured frequency shift of the first bending mode when the second and third modes were excited, respectively. By using the Eq. (1), the mode coupling coefficients were determined to be 1.4004～1.4198×10^{12}, and 1.3232 ～1.3683×10^{11}, for the mode 1-2 coupling, and mode 1-3 coupling, respectively. The reported results are useful for the design of advanced MEMS devices that utilize mode coupling effect as a working principle, such as high sensitivity sensors.

Ref. [1] Ya Zhang, et al., PR Applied 14, 014019 (2020). [2] Ya Zhang, et al., APEx 14, 014001 (2021). [3] Atakan B. Arı, et al., PR Applied 9, 034024 (2018).

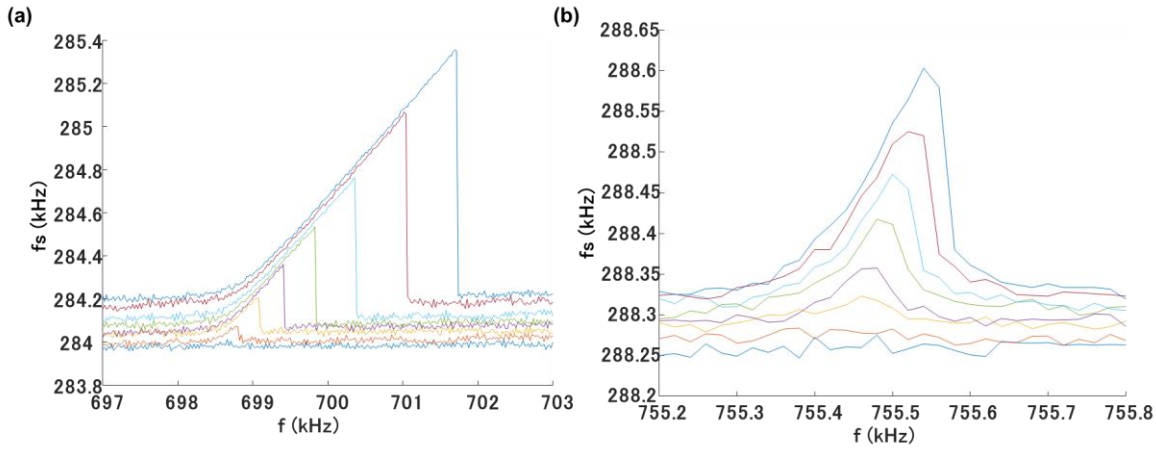

Fig.1 (a) (b)The measured frequency shifts when the second and third modes were excited, respectively.