THz ボロメータ応用に向けた MEMS 梁共振器におけるピエゾ抵抗検出
Piezoresistive detection of MEMS beam resonators for THz bolometer applications

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Terahertz (THz) detectors are one of the crucial components in the THz technologies. Recently, we reported a room temperature, high-speed THz bolometer using a GaAs doubly clamped MEMS beam resonator [1-3]. Figure 1(a) shows a schematic of the MEMS bolometer structure, which detects the frequency reduction induced by heating of the beam and works as a very fast and sensitive thermometer. We use piezoelectric capacitors on both ends of the MEMS beam to drive and detect the vibration of the beam [4]. However, the output voltage from the piezoelectric capacitor is very small (typically; ~1 μV), because it is shunted by the stray capacitance of measurement cables. We need to use a buffer amplifier to suppress the effects of stray capacitance. In this report, we propose to use the piezoresistive detection scheme, instead of the piezocapacitive effect, to detect the MEMS beam vibration.

We use a two-dimensional hole gas (2DHG) as the piezoresistive material to detect the MEMS beam vibration. Due to the anisotropic and nonparabolic valence band structure of 2DHG at p-type modulation-doped AlGaAs/GaAs interfaces, 2DHG exhibits a large piezoresistive effect, as shown in Figure 1(a). The piezoresistor R_x is placed at right end of the MEMS beam, whose resistance changes when the MEMS beam has a strain. The detection circuit is shown in Figure 1(b). By comparing the resistance of R_x and a reference resistor R_0, an output voltage V_o can be obtained as the vibration signal. Figure 1(c) plots the resonance spectra of the fabricated GaAs MEMS resonator measured by using the piezoresistive detection scheme, at various driving voltages. The vibration signal as large as several mV has been achieved, which is three-orders of magnitude higher than that for the piezocapacitive detection scheme. This result indicates that the piezoresistive detection scheme is very promising for the MEMS bolometer applications.

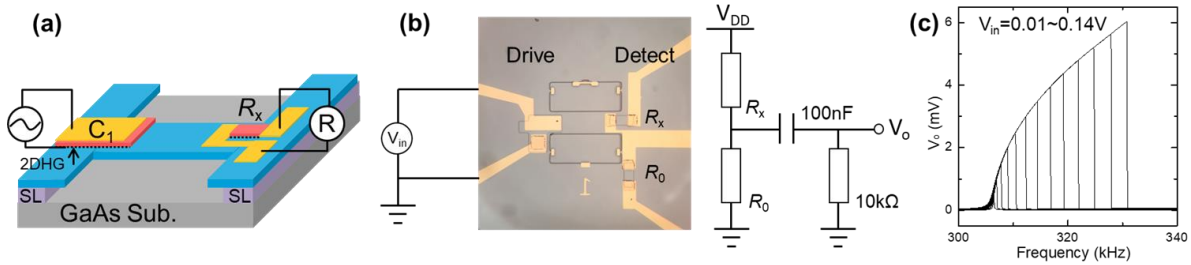

Fig.1 (a) Schematic of MEMS resonator with piezoresistive detection scheme. (b) Measurement circuit of piezoresistive detection. (c) Resonance spectra of GaAs MEMS resonator measured by using the piezoresistive detection scheme. The driving voltages increases from 0.01V to 0.14V.

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