テラヘルツボロメータ応用に向けた GaAsP MEMS 両持ち梁構造における歪み量のチューニング

Strain tuning in GaAsP MEMS beam resonators for terahertz bolometer applications

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We reported a room temperature, all electrical driving and detecting, very sensitive thermometer using a GaAs doubly clamped microelectromechanical (MEMS) beam resonator for bolometer applications [1]. When the MEMS beam is heated by THz radiation, its resonance frequency is shifted by a temperature rise and the signal is detected by the piezoelectric effect [2]. Increasing the quality factor (Q) of the mechanical resonance is advantageous for improving performance of the MEMS bolometer. Previously we reported that introduction of large tensile strain induced by lattice mismatch between $GaAs_{1-x}P_x$ (x = 0.06) and GaAs improves the Q-factor of the MEMS resonators by 6 times, when compared with that of the unstrained GaAs resonators. However, since the MEMS beams become 'hard' with large tensile strain, the resonance frequency of GaAsP MEMS resonators also increased by several times, resulting in a significant decrease in the thermal responsivity of the MEMS resonators.

In this work, we have introduced a small amount of tensile strain in the MEMS beam by tuning the ratio of phosphorus, achieved high Q-factor of MEMS resonator, and avoided the responsivity decrease. We have introduced a preloaded tensile strain by using a lattice mismatch between $GaAs_{1-x}P_x$ (x = 0.01) and GaAs, as shown in Fig. 1(a). Samples with beam length varying from 80 to 1,000 μm have been fabricated using GaAs and GaAsP (Fig. 1(b)). By using GaAsP as the beam material, the Q-factor of the MEMS resonators varies from 9,000 to 20,000 for different beam lengths, whereas the unstrained GaAs samples exhibited a Q-factor ~4,000 (Fig. 1(c)). When we apply a heat to the MEMS beam, the GaAsP samples showed a similar thermal responsivity to that of GaAs samples (Fig. 1(c)). More detail will be presented at the meeting.

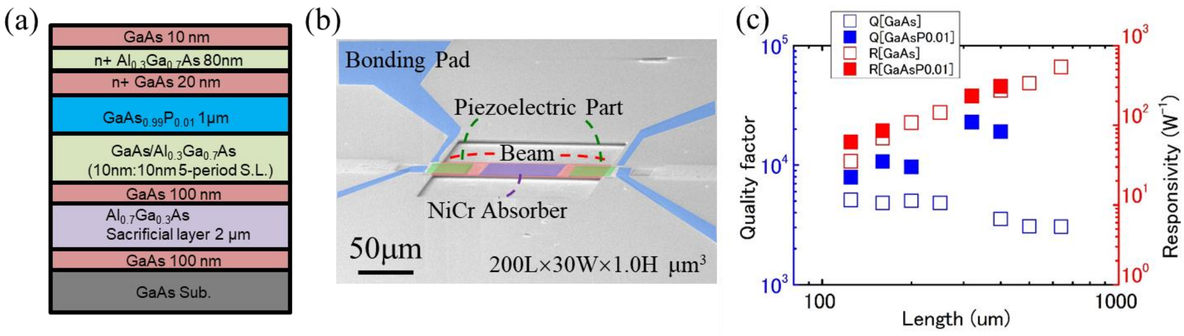

Fig.1 (a) The wafer structure for the $GaAs_{1-x}P_x$ MEMS resonator. (b) Scanning electron microgragh of a GaAsP sample (c) Q-factor and thermal responsivity of the GaAs and GaAsP samples measured at the fundamental resonance frequency

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