A sensitive MEMS bolometer with high temperature stability

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Thermal sensors are widely used in the infrared and terahertz(THz) range owing to the ability of detecting photons with very small energy. Sensitive thermal sensors are commonly also easily affected by the environmental temperature fluctuation since they cannot distinguish the temperature changes coming from the light or from the environment. Temperature stabilizing techniques are often employed to get a stable performance of thermal sensors, which however increase the complexity of the sensors.

In this work, we reported an uncooled sensitive MEMS bolometer with a high temperature stability. The MEMS bolometer senses the temperature change by measuring a shift in the mechanical resonance frequency caused by the thermal stress in the MEMS beam, as shown in Fig. 1(a), and can detect a temperature change as small as ~1 μK even at room temperature[1,2]. Meanwhile, since the environmental temperature fluctuation only gives an overall thermal expansion of the device, which does not contribute to the thermal stress in the beam, thus does not change the resonance frequency much. The frequency shift caused by local temperature rise of the beam is much larger than that caused by environmental temperature rise, as shown in Fig.1(b). The deposition of a stress-compensation layer will furthermore improve the thermal stability without significantly degrading its thermal sensitivity.

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Ref. [1] Y. Zhang, et al., APL 108, 163503 (2016). [2] Y. Zhang, et al., JAP, 125, 151602(2019).

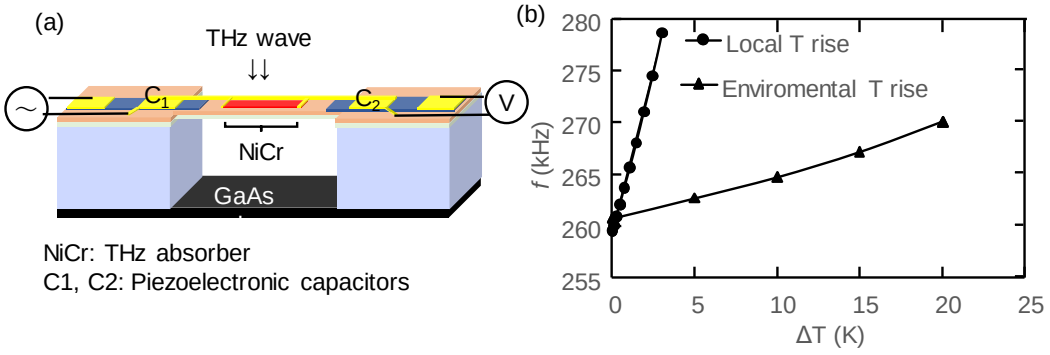

Fig.1 (a) schematic structure of MEMS bolometer (b) Resonance frequencies of the MEMS resonator as a function of local temperature rise and environmental temperature rise