Quasi double layer terahertz meta-absorber for bolometric applications

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Absorber is a crucial element for realizing high-sensitivity terahertz (THz) thermal sensors. THz absorbers using metamaterials can realize perfect absorptions in designed frequency range, are therefore suitable for many applications, such as active THz imaging. However, the conventional meta-absorbers usually use double- or multiple-layer structures, i.e., dielectric films with a thickness of several micrometers are sandwiched in metal film and/or metal slat structures. However, these structures are very thick, are therefore not suitable for the using in micro-sized thermal sensors, such as GaAs MEMS bolometers[1,2].

In this work, we propose a quasi- 2.5-dimensional meta-absorber for bolometric applications. We do not use externally deposited loss dielectric materials, instead, we directly etch the GaAs substrate to form a quasi-double layer structure, and thin metal films (Au/NiCr: 60nm/5 nm) are deposited on both layers, as schematically shown in Fig. 1(a). The metal slat layer induces THz resonances and the metal film layer reduces the THz transmission and confine the THz field in the GaAs dielectric. FEM simulations show that the structure has a high absorption coefficient of ~80% at the resonant peak, indicating that the proposed quasi-double layer structure work probably similarly as the conventional double- or multi-layer metamaterials. Furthermore, the proposed structure can reduce the thermal conductance and heat capacity of micro-bolometers since the etching process increases the porosity of the materials, is therefore very promising for realizing high sensitivity THz thermal sensors.

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

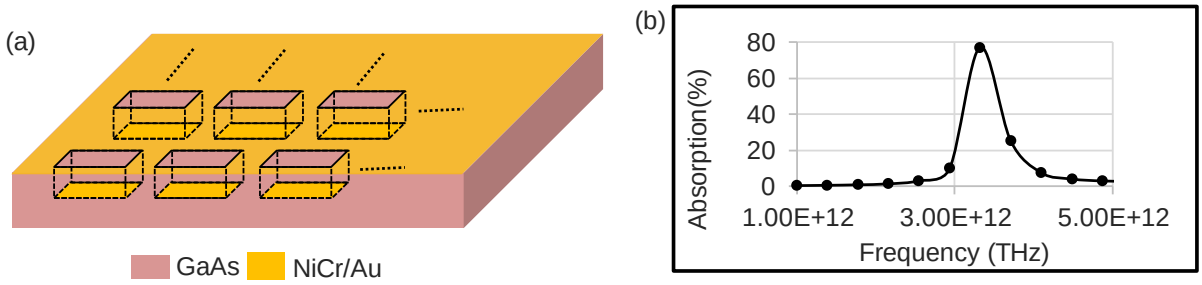

Figure 1 (a) Schematic structure of the quasi-double layer meta-absorber. (b) Absorption coefficient of the quasi-double layer meta-absorber as a function of frequency.