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Program Title (English)　:An ultrabroad terahertz metamaterial filter based on multiplexed metallic bar resonators
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1. 概要（Summary）

An ultrabroad terahertz (THz) metamaterial filter based on multiplexed metallic bar resonators is designed and fabricated in this work. We demonstrate the tunability of resonance frequency of metallic bar structures by varying the bars length. The bandwidth of terahertz filter can be significantly broadened by the multiplexed configurations.

2. 実験（Experimental）

【Main utilized equipment】

High-resolution electron beam lithography system (EBL, ELS-F125-U, Elionix); Helicon sputtering system (MPS-4000C1/HC1, ULVAC); FE-SEM (JSM-6700FT, JEOL).

【Method】

The metallic bars were fabricated on glass by EBL followed by metal sputtering and lift-off process. The optical properties were characterized by a fiber-coupled THz time domain spectroscopy (THz-TDS) in Nankai University.

3. 結果と考察（Results and Discussion）

With the help of numerical simulations, we found that multi-bars with different lengths a promising way to achieve high performance broadband filter. And then we experimentally demonstrated it. Figure 1 (a) presents a SEM image of a detail of the multiplexed gold bar structure (n = 5). The length (L) of the five bars in one unit cell vary from 95 to 55 μm. The width and thickness of the bars are the same as 0.5 μm and 50 nm, respectively. The transmission spectrum of the combined five kinds length of bar in a unit cell metamaterial is shown in Fig. 1 (b). A broadband response with the center frequency of 1.39 THz is constructed and matches well with simulated spectrum, which is clearly the addition of the resonance responses from individual bars. The position of the five resonance dips in the overall frequency response spectrum match with the resonance dips from individual samples. The bandwidth of this filter is 1.07 THz about 8.2 times greater than the bandwidth of the isolated case (L = 95 μm). We attribute the broadband broadening effect to the multiplexed resonance of five gold bars, which demonstrates that the relative bandwidth of the filter can be greatly improved by adding the number of gold bars in a unit cell. Meanwhile, the broadband filter with arbitrary wide bandwidth can be realized by assigning metallic bars with different lengths to the corresponding location.

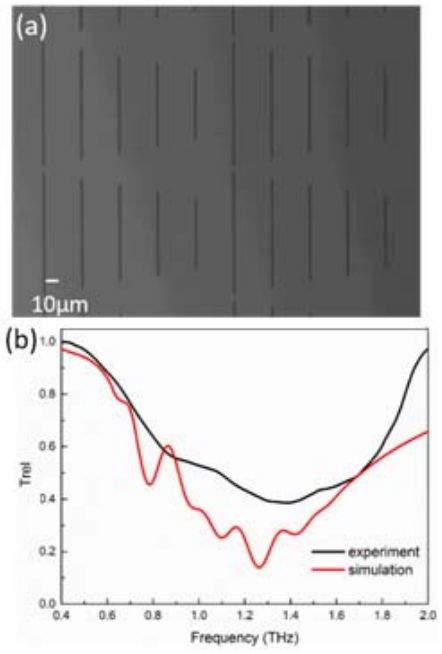

Fig. 1 (a) SEM image of a detail of the multiplexed gold bar array with five different length bars. (b) Transmission spectra (T_{rel}) of the overall multi-bar metamaterials.

4. その他・特記事項（Others）

Collaborator: Quan Sun, Kosei Ueno and Hiroaki Misawa

5. 論文・学会発表（Publication/Presentation）

N/A

6. 関連特許(Patent)

N/A