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利用形態　:機器利用
利用課題名（日本語）　:メタマテリアルによるテラヘルツ波の高度応用
Program Title (English)　:Application of the metamaterial for Terahertz wave devices
利用者名（日本語）　:邱紅松, Khoa Phan, 加藤康作, 中嶋誠
Username (English)　:H. S. Qiu, K. Phan, K. Kato, and M. Nakajima
所属名（日本語）　:大阪大学　レーザー科学研究所
Affiliation (English)　:Institute of Laser Engineering, Osaka University.
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メタマテリアル/Metamaterial

1. 概要（Summary）

Substantial enhancement of terahertz magnetic near-field achieved by the metamaterial resonator is demonstrated. The magnetic near-field at the resonant frequency is enhanced by more than 30 times through the combination of the waveguide and the metallic micro-resonator. The resonant frequency can be tuned by adopting different resonator designs. The strong terahertz magnetic near-field enables the excitation of large-amplitude spin dynamics and can be utilized for an ultrafast spin control.

2. 実験（Experimental）

【利用した主な装置】

LED 描画システム(LED Lithography)

RF スパッタ成膜装置(RF Sputtering)

【実験方法】

We patterned the double split ring resonator (D-SRR) as is shown in Fig. 1(a) using the LED lithography and fabricated them on the $Tb_3Ga_5O_{12}$ (TGG) crystal by the means of the RF sputtering. The resonator consists of a 300-nm-thick gold layer and a 10-nm-thick titanium buffer layer. After the fabrication, we deposited a 50-nm-thick Al_2O_3 layer to isolate and protect the resonators.

The double-SRR is electrically excited by the THz pulse, generating an out-of-plane magnetic near-field. The magnetic near-field is probed directly via the magneto-optic sampling with a $Tb_3Ga_5O_{12}$ crystal. The symmetric design of the D-SRR structure provides a doubled signal and cancels the bulk effect in the measurement.

3. 結果と考察(Results and Discussion)

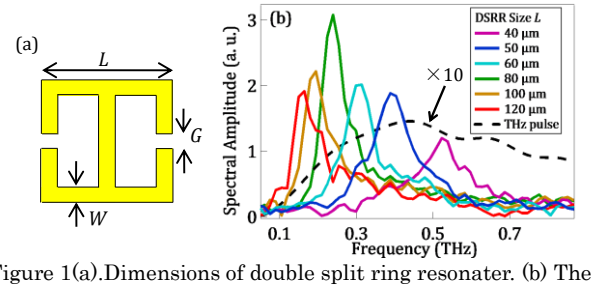

Figure 1(a).Dimensions of double split ring resonater. (b) The spectra of the enhanced THz magnetic near-field.

The Fourier transformed spectra for various DSRR sizes are shown in Fig. 1(b). The frequency of the enhanced peak is inversely proportional to L. For comparison, the dashed curve shows the magnetic field of the incident THz wave. The spectral amplitudes at the resonant frequencies are enhanced by one order of magnitude. In particular, when L is smaller than 80 μm, the spectral amplitudes are enhanced by more than 30 times. Note that in the experiment, the detected value of the near-field reflects the average in the probe-beam-spot area with a diameter of 20 μm. In contrast, the calculation suggests that the induced magnetic near-field at a point near the four corners beside the middle arm of the double-SRR is more than two orders of magnitude stronger than the incident field.

4. その他・特記事項（Others）

謝辞

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5. 論文・学会発表（Publication/Presentation）

論文

1. H. S. Qiu *et al.*,“Enhancing terahertz magnetic near field induced by a micro-split-ring resonator with a tapered waveguide” Opt. Lett., 43(8), pp.1658-1661 (2018),.

学会発表

1. H. S. Qiu *et al.,* “Terahertz Magnetic Field Enhancement by a Tapered Metallic Waveguide,” The 6th Advanced Lasers and Photon Sources, ALPSp14-31, Yokohama, Japan (April, 2017).

6. 関連特許（Patent）

なし。