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Program Title (English)　：Optical properties of metallic optical antennae in terahertz frequency
利用者名（日本語）　：
Username (English)　：Luca Razzari, Anna Mazhorova, Matteo Clerici, Roberto Morandotti
所属名（日本語）　：
Affiliation (English)　：INRS-EMT, University of Quebec

1. 概要（Summary）

Terahertz waves (THz) and infrared light have received considerable attention for use in many applications such as transmission imaging and fingerprint spectra with an important contribution in the bioengineering and security field. Therefore, the development of a compact and efficient THz detector that works at room temperature is essential for the development. In the present study, we have explored spectral properties of metallic optical antennae in THz frequency using THz time-domain spectroscopy and elucidated electromagnetic field intensity distribution of their structures using finite-difference time-domain (FDTD) simulation.

2. 実験（Experimental）

Optical antenna structures made from gold were fabricated by electron beam lithography and lift-off techniques on a silicon substrates. The spectral properties of the fabricated optical antenna structure was measured by Terahertz time-domain spectroscopy using a femtosecond laser (λ_P: 800 nm, f: 80 MHz, τ: 20 fs).

3. 結果と考察（Results and Discussion）

A scanning electron microscope of the optical antenna structure around its gap position is shown in Figure 1(a). The length and width of the gold nanoline structure are 80 μm and 250 nm, respectively. The gap distance between two gold nanoline structures is 70 nm. Extinction spectrum of the fabricated optical antenna structure is shown in Figure 1(b). The resonant spectrum is peaking at around 0.6 THz. Importantly, the phase relaxation time for the resonance was estimated at about 0.8 ps from the spectrum width. Although data is not shown here, the resonance band is peaking at 1.15 THz in the case of the gold nanoline structure whose length is 44 μm. Namely, it became clear that resonant frequency is strongly dependent on the length of optical antenna structure. Moreover, it was also confirmed that resonant frequency changes based on change of the distance between two structures (gap distance). We elucidated that an electromagnetic field is localized at both ends and near a gap of the structure in alignment with incident polarization from the electromagnetic field analysis by FDTD simulation. Therefore, the spectrum property of optical antenna structure of having resonance in a terahertz frequency is similar with that of the localized surface plasmon resonance in visible and a near-infrared wavelength region.

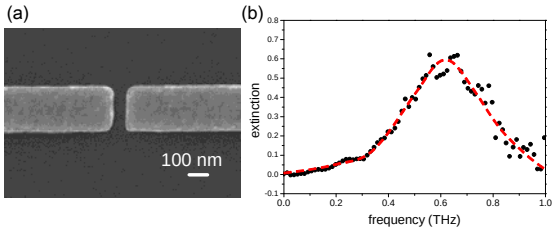

Fig. 1 (a) Scanning electron microscope image of optical antenna structures around gap position. (b) Extinction spectrum of the fabricated optical antenna structure.

4. その他・特記事項（Others）

・共同研究者等（Coauthor）：K. Ueno, S. Nozawa, H. Misawa

5. 論文・学会発表（Publication/Presentation）

(1) S. Nozawa, L. Razzari et al., 第 61 回応用物理学会 春季学術講演会、青山学院大学、神奈川、3 月 (2014).

6. 関連特許（Patent）

なし。