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利用形態 : 機器利用

利用課題名(日本語) :

Program Title (English) : Coherent-interaction-enhanced hot-electron generation under modal strong coupling conditions

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1. 概要(Summary)

Modal strong coupling between the Fabry–Pérot nanocavity and localized surface plasmon resonance (LSPR) has been studied, and was found to be helpful for enhancing the photocurrenet efficiency[1]. Also, quantum coherence was found to be crucial in the natrual photosynthesis process[2]. Therefore, we fabricated a well designed Au nanodisk (Au NDs)/TiO_2/Au film (ATA) structures with various particle number density (PND), and revealed that the coherence effect enhanced the hot-carrier generation of the system by checking the optical properties by the absorption spectrum and the hot electron transfer efficiencies by the transient reflection measurement.

2. 実験(Experimental)

【利用した主な装置】

超高速スキャン電子線描画装置(Elionix ELS-F130HM), ヘリコンスパッタリング装置(ULVAC MPS-4000C1/HC1), 高分解能電界放射型走査型電子顕微鏡(JEOL JSM-6700FT), 原子層堆積装置 (Picosun, SUNALE-R), EB 加熱・抵抗加熱蒸着装置 (EB-580)

【実験方法】

A 100-nm Au film was deposited onto SiO_2 substrate by sputtering, and then about 200 nm TiO_2 layer was deposited by atomic layer deposition (ALD). Au nanodisks with different CR were fabricated by using an electron-beam lithography and lift-off processes, after the ozone treatment, it was finally inlaid by 7 nm of TiO_2 by ALD.

3. 結果と考察(Results and Discussion)

From the transient signal, it could be realized that the maximum signal increases with the PND of the structures increases (Fig.1a). In addition to the saturated absorption spectra (Fig.1b), we speculated that there is a coherent interaction between the Au NDs and the cavity, which leads to the saturation of the absorption intensities and enhanced the hot-carrier generation.

(a) (b)

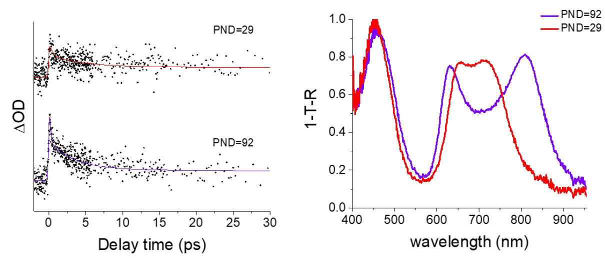

Fig.1 (a) transient curves for ATA with various PND, and (b) the corresponding absorption spectra.

4. その他・特記事項(Others)

[1] X. Shi, K. Ueno, T. Oshikiri, Q. Sun, K. Sasaki, H. Misawa, *Nat. Nanotechnol.,* 13, 953–958 (2018).

[2] Jean-Luc Brédas, Edward H. Sargent, Gregory D. Scholes, *Nat. Mater.*, 16, 35-44 (2017).

共同研究者: S. Zu, X. Shi, T. Oshikiri, H. Misawa (Hokkaido Univ.)

5. 論文・学会発表(Publication/Presentation)

1) Yen-En Liu et al, Annual meeting on photochemistry 2020, Sep. 10th, 2020.

2) Yen-En Liu et al, The 21th RIES-HOKUDAI international symposium. Dec. 10th, 2020.

6. 関連特許(Patent)　　なし