

課題番号 : F-21-HK-0056
 利用形態 : 機器利用
 利用課題名(日本語) : 結合条件下におけるプラズモン誘起フォトクロミック反応
 Program Title (English) : Plasmon-induced photochromic reactions under coupling regimes
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 キーワード/Keyword : リソグラフィ・露光・描画装置、成膜・膜堆積、分析、フォトニクス

1. 概要(Summary)

Localized surface plasmon resonances (LSPRs) show near-field enhancement effect which facilitates molecular detections as well as photochemical reactions. The reaction rate of two-photon photochromic reactions of diarylethene are extraordinarily enhanced by the near-field enhancement effect of the Au nanogap dimer. However, the effect of the resonance conditions between plasmons and molecules on photochemical reactions have been little discussed so far. Therefore, the purpose of the study is to fabricate plasmonic nanostructures that resonate with photochromic molecules and to clarify the plasmon-induced one-photon photochromic reactions of merocyanine under the coupling regime.

2. 実験(Experimental)

【利用した主な装置】

超高精度電子ビーム描画装置 100 KV

多元スパッタ装置

【実験方法】

Silver nanostructures have been fabricated by electron beam lithography (EBL) and lift-off techniques. LSPR band can be controlled by the height of silver nanostructures. PMMA film including merocyanine was spin-coated on the nanostructured substrate. Photochromic reactions from MC to SPI was induced by the 633 nm or 488 nm CW laser.

3. 結果と考察(Results and Discussion)

The extinction spectrum in SPI form did not change because the absorption is in the ultraviolet wavelength range. However, in the case of MC form, significant spectral splitting could be observed as shown in Figure 1(a) and 1(b). Since the LSPR peak changes depending on the height of the silver nanostructure, the tuned condition in which the resonance wavelength overlaps with MC (Figure 1(a)) and a detuned condition without overlapping between them (Figure 1(b)) were presented. The dispersion curve, in which the split peak energies

are plotted against the LSPR wavenumber as shown in Figure 1(c), shows the anti-crossing behavior which is characteristic of strong coupling. Besides, photochromic reactions were explored with the different degree of coupling between LSPR and MC excited by the 633 nm and 488 nm CW laser, respectively. It was clarified that the reaction rate changed depending on the degree of coupling, and the reaction rate decreased significantly under the condition that LSPR and MC were strongly coupled.

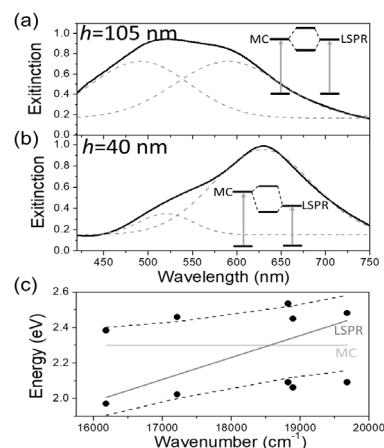


Figure 1. Extinction spectra of MC-LSPR hybrid systems under tuned (a) and detuned conditions (b), respectively. (c) The dispersion curves of the strong coupling system.

4. その他・特記事項(Others)

共同研究者: 上野貢生 (北大院理)

5. 論文・学会発表(Publication/Presentation)

1. Y. Xu, K. Imaeda, K. Ueno "Plasmon-induced photochromic reactions under resonance conditions", 光化学討論会ポスター発表, Web 開催, 9月 (2021).
2. 福本雄真, 許 殷豪, 高橋佑輔, 今枝佳祐, 上野貢生, "制御された金属ナノ構造を用いたプラズモン誘起光反応計測", 日本分析化学会第70年会, Web, 9月 (2021).

6. 関連特許(Patent)

なし