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利用形態　　　　　　　　　　：共同研究

利用課題名（日本語）　　　　：

Program Title (English)　　　: Surface-enhanced Raman scattering of crystal violet induced from gold nanocylinder arrays

利用者名(日本語)　　　　　　：

Username (English)　　　　　: Gang Bi, Lee Wang, Jiarong Qiu

所属名(日本語)　　　　　　　：

Affiliation (English)　　　　: Department of Information and Electronic Engineering, Zhejiang University City College

1. 概要（Summary）

Raman scattering from molecules absorbed on periodic metallic nanoparticles is strongly enhanced due to excitation of localized surface plasmon resonance. In this study, the periodic gold nanocylinder arrays with 121 nm diameter, 6.3 nm gap, and 34 nm thickness were fabricated on some normal glass by electron beam lithography and lift-off techniques, and some crystal violets were coated on the nano-array using the dipping and drawing method. Surface-enhanced Raman scattering spectra with and without gold nano-particle arrays were well characterized.

2. 実験（Experimental）

The gold nanocylinder array with periodical structure is fabricated on clear silica glass substrates by electron beam lithography (EBL) system at Hokkaido University. A supporting substrate followed by the gold nanoparticle array on the silicate glass is immersed in an aqueous solution of crystal violet (10^{-4} mol/L) for 15 min. The Raman scattering spectrum of specimen with gold nanostructure was characterized by FTIR, and the result is compared to the one of specimen without gold nanoparticles.

3. 結果と考察(Results and Discussion)

Figure 1(a) shows the surface morphology of gold nanoparticle array was characterized using scanning electron microscope (FE-SEM) (JSM-6700FT, JEOL, Japan). The gap between two metal nanocylinders is 6.3 nm. The diameter and thickness of each nanoparticle in periodical structure is 121 nm and 34 nm, respectively. Figure 1(b) shows the experimental and simulated extinction spectrum of the gold nanocylinder. One can see the peak of experimental LSPR located in 769 nm as show solid line, while the peak of simulated extinction spectrum is nearby 776 nm as show dashed line in Figure 1(b). We can see that the experimental extinction spectrum nearly matches one of the calculated. Figure 1(c) shows the SERS spectra of crystal violets adsorbed on the surface of gold nanocylinder arrays for excitation wavelength of 780 nm. The signal of Raman spectra was measured from a single molecule in a 10 μm^3 scattering volume, ×100 immersion objective with 0.05 s integration time. In order to compare to the effect of localized surface plasmon resonance, we also measured the SERS spectra of crystal violets without gold nanocylinder arrays. Since the SERS spectrum of crystal violets without gold nanocylinder arrays was very weak. The enhancement factor (EF) and the peak of the excitation by fitting a Gaussian line shape to these 10 data points of the SERS was also calculated.

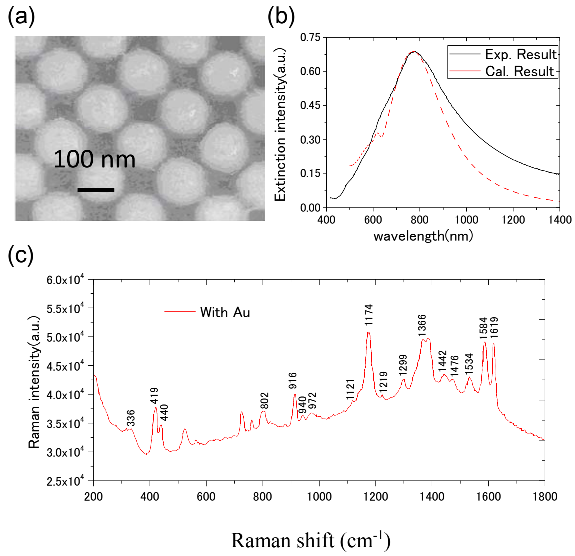

Figure 1(a) SEM image of gold nanoparticle array, (b) experimental and simulated extinction spectrum of the gold nanocylinder, (c) SERS spectra of crystal violets adsorbed on the surface of gold nanocylinder arrays.

4. その他・特記事項（Others）

共同研究者等（Coauthor）: L. Wang, M. Huang, K. Ueno, H. Misawa, J.-R. Qiu

5. 論文・学会発表（Publication/Presentation）

(1) G. Bi et al., J.-R. Qiu, *Opt. Commun.*, **294**, 213-217 (2013).

6. 関連特許（Patent）

なし。