課題番号　:F-15-HK-0054
利用形態　:共同研究
利用課題名（日本語）　:
Program Title(English)　:Surface-enhanced Raman single molecule spectroscopy using nano-engineered silver particles
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1. 概要（Summary）

In this collaboration project, lithographically fabricated nanostructures are used for surface enhanced Raman spectroscopy (SERS). The experiment is intended to verify the recently proposed theoretical model of optomechanical contributions in single-molecule SERS. As the theoretical calculation suggests, dimer structures made of silver nanodisks are optimal for demonstrating the predicted phenomena. The challenges of such an experiment comes two folds: (1) nanostructure fabrication with a nanometer precision; (2) position of single molecules at the gap of nanodisk dimer structure with a nanometer precision.

2. 実験（Experimental）

【Main equipment】

High-resolution electron beam lithography system (ELS-F125-U, Elionix), Helicon sputtering system (MPS-4000C1 /HC1, ULVAC), Atomic layer deposition (SUNALE-R, Picosun), FE-SEM (JSM-6700FT, JEOL)

【Methods】

To fabricate such nanodisk dimer structures with high precision, e-beam lithography has to be employed. Two patches of dimer structures have been fabricated. The first patch was bare silver dimer nanostructures without any surface coating. Large arrays of dimer structures with different gap sizes (0, 3 nm, 5 nm, 10 nm, and 20 nm) and disk diameters (60 nm, 70 nm, 80nm, 90 nm and 100 nm) were prepared. The thickness of the nanodisk structure was 40 nm. However, silver material can easily be oxidized in air. Though extreme care was taken during packing and transportation, the sample turned out difficult for thiol-containing Raman probe molecules to bind on the silver nanostructures. Therefore, only a small portion of the dimer structures showed detectable SERS signal.

3. 結果と考察（Results and Discussion）

In order to prevent surface oxidation of silver during tranportation, the second patch of silver dimer structures was further coated with a nanometer thin Al_2O_3 layer using atomic layer deposition (ALD) technique. A schematic illustration of design for nanodisk dimer structures with a nanometer thin Al_2O_3 layer and SEM image are shown in Fig. 1. The thin Al_2O_3 layer protects silver from oxidation, but also makes probe molecule more difficult to bind onto the nanostructure. We are still working on this, to find a reliable method to position our probe molecules specifically in the gap region of the nanodisk dimer structure. We are still working on this issue.

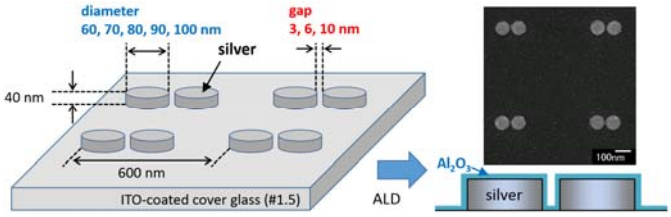

Fig. 1 A schematic illustration of design for nanodisk dimer structures on a ITO-coated glass substrate with a nanometer thin Al_2O_3 layer using atomic layer deposition (ALD) technique. The inset shows a scanning electron microscope image of the structures.

4. その他・特記事項（Others）

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5. 論文・学会発表（Publication/Presentation）

なし

6. 関連特許（Patent）

なし