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Program Title (English) :Manipulation of surface plasmon resonance of Al nanodisks through O_2 plasma treatment
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1. 概要(Summary)

Aluminum (Al) exhibits localized surface plasmon resonance (LSPR) frequency from UV to visible region.[1] Besides, a dense natural oxide layer (2-4 nm) formed on its surface acts as a self-protecting layer which will maintain it over time, sustaining a stable LSPR. These unique advantages make Al nanoparticles attractive for various applications.[2,3] The manipulation of the LSPR on Al nanoparticles is important for its practical applications. Here, we present an interesting method to manipulate the LSPR of Al nanodisks using O_2 plasma treatment. We study the effect of the size, shape and dielectric environment on the LSPR of Al nanodisks.

2. 実験(Experimental)

【利用した主な装置】

Electron-beam lithography (Elionix ELS-F130HM), Compact Sputtering (ACS-4000, ULVAC), Helicon Sputtering (MPS-4000C1/HC1, ULVAC), Dry etching (RIE-101iPH, SAMCO), SEM (JEOL JSM-6700FT), STEM/TEM (JEOL ARM-200F),

【実験方法】

The Al nanodisks array with size of 120 nm, thickness of 35 nm and period of 240 nm was fabricated on ITO glass substrate by electron-beam lithography, followed with thermal evaporation and lift-off. For investigating the influence of oxygen plasma on Al nanodisks, the sample was placed in a chamber which was evacuated to 10 Pa and filled with oxygen at a flow rate of 2.0 sccm performed with radio frequency (RF) power at 200 W for 0, 4, 6, and 8 minutes. The cross-section of Al nanodisks was prepared by focus ion beam system and examined by scanning transmission electron microscopy (STEM).

3. 結果と考察(Results and Discussion)

The influence of oxygen plasma treatment on the extinction spectra of Al nanodisks array is shown in Fig. 1 (a). As the oxygen plasma exposure time increase from 0 to 8 min, the extinction spectra of Al nanodisks array blue shift monotonously with a decrease of extinction intensity. Fig. 1b shows the cross-sections of Al nanodisk under O_2 plasma treatment of 0 and 4 min. A simulation using finite difference time-domain (FDTD, Lumerical Solutions) was performed for further understanding the effect of O_2 plasma treatment on the LSPR manipulation. The experiment results and the FDTD simulation show that the modulation of LSPR bands of Al nanodisks can be attributed to the synergistic effects of volume shrinking, aspect ratio reduction, morphology variation and etching effect of oxygen plasma treatment.

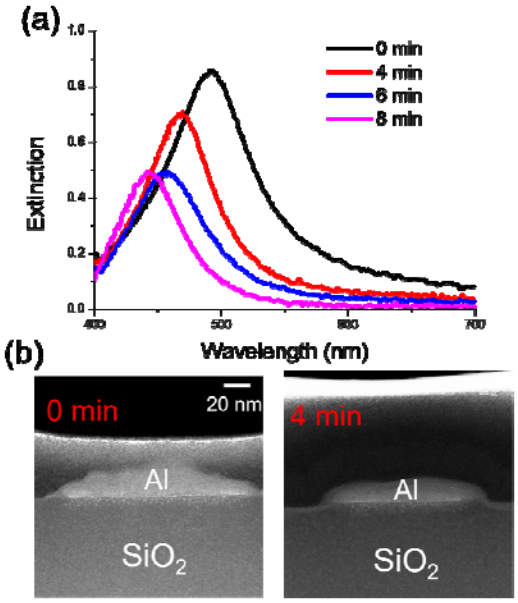

Figure 1. (a) Extinction spectra of Al nanodisks fabricated on ITO glass under O_2 plasma treatment with 0, 4, 6 and 8 min. (b) Cross-section of Al nanodisk after O_2 plasma treatment with 0 and 4 min.

4. その他・特記事項(Others)

・*参考文献*

[1] C. Langhammer, et al., *Nano Lett.,* **2008**, 8, 1461–1471

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5. 論文・学会発表(Publication/Presentation)

なし

6. 関連特許(Patent)

なし