18a-D4-8

Plasmon Coupling between Gold Curvilinear Nanorods and Straight Nanorods at Different Distances

Yukie Yokota[1] and Takuo Tanaka[1,2]

[1] RIKEN, Metamaterials Lab., [2] RIES, Hokkaido Univ.
E-mail: y-yokota@riken.jp

1. Introduction

Local-mode surface plasmon (LSP) resonances are collective oscillations of free electrons in small metal structures. The spectral properties of LSP depend on size, shape, and distance between metal nanostructures. In particular, it is well known that the LSP resonances of a closely-spaced dimer of two identical nanostructures strongly interact due to dipole-dipole coupling. Nevertheless, there are few reports about the spectral properties of LSP on a pair of two different-shaped nanostructures.

In this work we present detailed studies of plasmon coupling between hybrid gold nanostructures of curvilinear and straight nanorods using micro-fabrication techniques.

2. Experimental results and discussion

Gold nanostructure arrays were fabricated on the glass substrate using an electron beam lithography and lift-off technique. The thickness of gold nanostructures is fixed at 40 nm. The line widths of the all structures are the same as 70nm. As shown in inset of fig.1, isolated gold curvilinear nanostructures (a), hybrid nanostructures (b), and (c) were fabricated. In sample (b), the curvilinear nanostructure were fabricated with a gold nanorod, whose length corresponds to the arc height (h) of curvilinear (a), with 25 nm gap. In sample (c), the curvilinear nanostructure were fabricated with a gold nanorod, whose length corresponds to the arc length (l) of curvilinear (a), with 25 nm gap. Optical properties of the fabricated nanostructures were characterized by their absorption spectra, which were measured using a commercially available Fourier-transform infrared (FT-IR) spectrometer equipped with a microscope attachment.

When the linearly polarized light that oscillates y-direction (parallel to the long axis of rod of sample (b)) is illuminated, extinction spectra of samples (a) and (c) have one peak at the same wavelength of 1700 nm. Extinction spectrum of sample (b) represents two peaks (1400nm and 1700 nm) in the wavelength region. Extinction peak of sample (b) at 1400 nm is originated from vertical plasmon resonance of nanorods.

When the polarization direction of the incidence changes y-direction, the extinction spectra of samples (a), (b) and (c) becomes different as shown in Figure 1. Absorption peak of sample (a) and (b) are appeared at 1000 nm and their peak position is the same as that of the structure of the half of the arc length (l/2) of sample (a). Compared to resonant peaks of the sample (a) and (b), the extinction spectrum of sample (c) splits to two peaks and its center position is at around 970 nm.

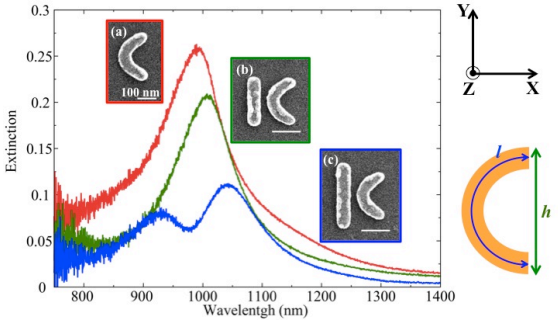

Fig.1 Extinction spectra of nanostructures (a), (b) and (c) under the linearly polarized illumination of x-direction. Electron micrographs of fabricated gold nanostructures and layout of sample (a) are also shown.

3. Conclusions

We fabricated gold hybrid nanostructures of curvilinear and straight nanorods with narrow gap. When the linearly polarized light that oscillates x-direction is illuminated, extinction spectrum of gold hybrid nanostructures, whose rod length corresponds to the arc length of curvilinear structure, splits to two peaks in near-infrared region.