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利用形態	:共同研究
利用課題名（日本語）	:
Program Title (English)	:Optically properties of nanoblock dimers from capacitive coupling, charge transfer plasmon to fused dipole mode
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キーワード／Keyword	:リソグラフィー

1. 概要(Summary)

We study the coupling behavior of gold nanoblock dimers. In particular, we characterize three different coupling regimes: capacitively coupled, conductively bridged, and fused dimers, and further investigate the transitions between the three regimes.

2. 実験(Experimental)

【Main utilized facilities】

High-resolution electron beam lithography system (EBL, ELS-F125, Elionix); Helicon sputtering system (MPS-4000, ULVAC); FE-SEM (JSM-6700FT, JEOL).

【Method】

Planar gold (Au) nanodimer structures were fabricated by EBL and lift-off techniques on glass substrates. Dark-field scattering spectroscopy was used for the measurement of each dimer and the spectra were correlated to high-resolution SEM images one by one.

3. 結果と考察(Results and Discussion)

The nanoblock dimers consisted of two nanoblocks with a designed edge length of either 80 or 100 nm and a thickness of 30 nm. The designed gaps were defined as the corner-to-corner distances and varied from -35 to 12 nm. The longitudinal (L-) mode of the dimer reveals the gap distance and electrical conductivities between the two nanoblocks in a dimer. The optical properties of the dimers can be categized into three regimes: capacitively coupled, conductively bridged, and fused dimers.

The capacitively coupled regime refers to the dimers with an obvious gap (>1 nm). Their spectra are dominated by bonding dipole plasmons (BDPs) and redshift as the gap sizes decrease. In the conductively bridged regime, two nanoblocks are almost or slightly touch, and thus the spectral modes are very sensitive to their geometries even with in the same design. For example, for the same designed gap of -4 nm, the scattering spectra are quite different, as can be found in Fig. 1, in which the corresponding SEM images are also shown. The appearance of screened bonding dipolar plasmons (SDPs) suggests that a junction between the two nanoblocks is formed so that the electrons can oscillate through. The charge transfer plasmons (CTPs) should also appear when the junction or sub-nanometer gap is formed. But in Fig. 1 the CTP is out of the spectral window due to its very low energy. In terms of junction conductivities, a dimer transits from a conductively bridged to fused structure when electrons can freely oscillate in the whole structures with low resistance. In this case, the CTPs or dipolar mode of the largely fused dimers can be found at low energy, and SDP or quadrupole mode can be found in the high energy. Our findings provide insight into the plasmon engineering of nanoblock dimers.

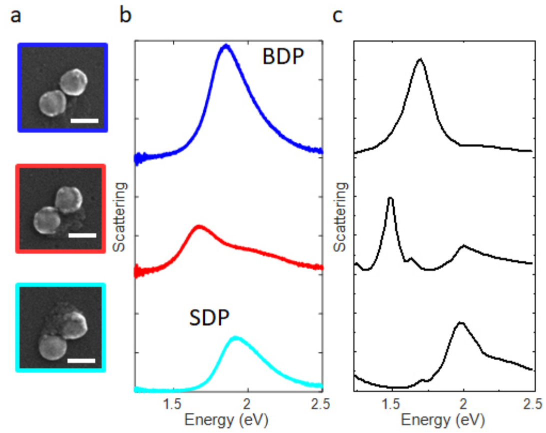

Fig. 1. SEM images (a) and the corresponding L-mdoe scattering spectra of both experiments (b) and numerical simulations of dimers with a designed gap of -4 nm and length of 80 nm. The real gap used in simulations are 4, 0, -1 nm from top to bottom.

4. その他・特記事項(Others)

・Collaborators: Q. Sun, K. Ueno, H. Misawa

5. 論文・学会発表(Publication/Presentation)

なし

6. 関連特許(Patent)

なし