Gap plasmon resonance in a film-coupled floating gold nanowire

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Few-nanometer gaps between metals often produce large field enhancements and are thus widely used to design nanostructures for practical applications[1]. For the largest field enhancements, it is critical to realize uniform and smooth nanoscale gaps that promise strong gap plasmon resonances at a designed wavelength. However, it is still very challenging to fabricate such nanostructures with ordinal methods.

Here, we focus on the fabrication and characterization of a metal-air-metal (MAM) nanocavity with few-nanometer gap separations. We use a gold nanowire (NW) slide floating over a gold substrate to construct a MAM geometry (Fig. 1). As the floating NW can locally be viewed as a MAM nanocavity with more or less constant gap, the optical response of various gaps can be observed within one fabricated structure. We show the resonance feature of this structure by spatially measuring the scattered light along the NW.

The floating NW (see Fig. 2a) was fabricated by employing a pick-and-place method in nanoscale dimensions[2]. Figure 2b shows a dark-field image of the 440-nm-wide NW for TM illumination. We observed that the NW shows various scattering colors along the wire-length-axis. Spectral analysis was performed by focusing on the scattered light from sixteen positions (P_1-P_{16}) on the NW as shown in Fig. 2c. From these spectra, we clearly observed resonance peaks and the trend of their red-shift as the position number increases. As a MAM nanocavity is driven by TM-polarized light, these spectral features indicate the gap-dependent resonance modes. We will also discuss extracted gap sizes from the observed spectra, as well as the underlying resonance nature by applying intuitive resonance models.

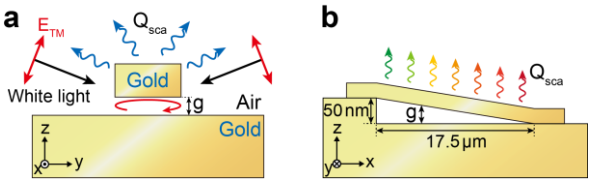

Figure 1. Schematic of the cross section (a) and side view (b) of a film-coupled floating gold NW.

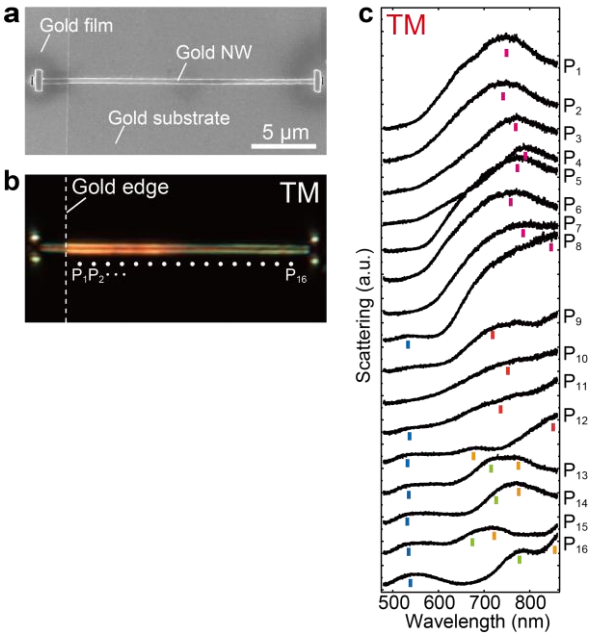

Figure 2. (a) Scanning electron microscopy image of the fabricated structure. (b) Dark-field image of the NW illuminated by TM-polarized light. (c) Experimental scattering spectra. The spectra were measured at the sixteen positions (P_1-P_{16}) of the NW.

References

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