Transmission Surface Plasmon Resonance Image Detected by Smartphone Camera

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Transmission surface plasmon resonance image (TSPRi) using plasmonic grating structure was investigated by the combination with smartphone camera. Since a detected range of smartphone camera was capable of detecting under visible light region, the TSPR substrate that provided a corresponding TSPR excitation wavelength was developed. The TSPR excitation at 650 nm was acquired from gold-coated CYTOP grating substrate. Fig. 1A shows TSPR spectra of the developed substrate (AFM image is shown in the inset of Fig. 1A). The TSPR excitation was observed entire visible light region up on the light incident angle. At light incident angle of 5°, TSPR excitation wavelengths were observed at 930.6 and 574.1 nm. When the light incident angle was turned to higher angle, two surface plasmon (SP) modes that were SP^0 and SP^{-2} were observed as shown in Fig. 1B. Although the calculated SP dispersion curves did not perfectly fit with the experimental results, the shifts of TSPR excitation wavelengths were relevant to those calculated SP modes. When the light incident angle was turned to 30°, both SP modes were coupled to single mode resulting in the huge increase of TSPR intensity (Fig. 1C). The SP coupling effect was confirmed by the shift of TSPR excitation from conventional modes (water (CYTOP)/Au grating substrate) of SP^0 and SP^{-2} modes to SP coupling mode (water/Au grating/CYTOP substrate), as shown in Fig. 1B. The smartphone camera was then used as a detector. Fig. 1E shows transmission images and intensities of the developed substrate. The extraordinary transmitted signal at the light incident angle of 30° and at the wavelength of 675 nm that was TSPRi was observed. The transmitted signals detected by smartphone camera corresponded very well with spectroscopic data. This technique could be further developed for portable devices for sensor applications.

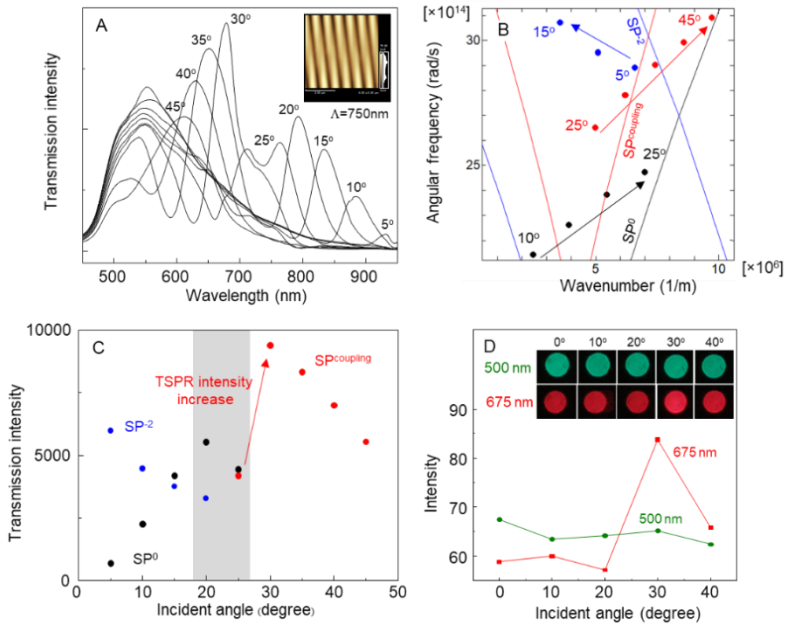

Fig. 1 (A) TSPR spectra of gold-coated CYTOP grating substrate. (B) SP dispersion branch of conventional mode of SP^0 (black) and SP^{-2} (blue) and SP coupling mode (red), experimental and calculated results are shown in dots and line, respectively. (C) TSPR intensity plots against the light incident angle. (D) Transmitted images and their intensities at the light incident angle from 0° to 40° and the wavelength of 500 nm (green) and 675 nm (red).

References: (1) C. Lertvachirapaiboon, *et al.*, *Jpn. J. Appl. Phys.*, 56 (2017) 017002, (2) C. Lertvachirapaiboon, *et al.*, *Sens. Actuators B*, 249 (2017) 43, (3) C. Lertvachirapaiboon, *et al.*, *Biosens. Bioelectron.*, 99 (2018) 415.