18a-C4-5

Dual SPR-SERS Sensors Using Gold Nanoslits and Oblique Angle Deposition

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Abstract

Surface plasmon resonance (SPR) sensing is a real-time and label-free detection technique which has the potential to benefit numerous important fields, including medical diagnostics, environmental monitoring, and food safety. However, such a sensing technique is not suited for molecular identification. On the other hand, the surface-enhanced Raman scattering (SERS) spectroscopy is a highly specific technique to identify molecules [1]. In this study, we proposed the fabrication of multifunctional plasmonic biochips and established an optical platform to integrate plasmonic sensing and surface-enhanced Raman scattering techniques. Periodic metallic nanostructures with rough metal surfaces were made on a plastic substrate using nanoimprinting and oblique angle deposition technique [2]. The gold nanoslits with a period of 750 nm were made on a polymer film using a silicon template. A thin gold film was then deposited on the plastic film using the oblique angle deposition technique. The transmission spectra of the biochips with different deposition angles were measured. Transverse-magnetic polarized wave in the gold nanostructure with a deposition angle of 75° generated a sharp and asymmetric Fano resonance in transmission spectrum. It was due to the interference of broad-band cavity resonance in the grooves and narrowband surface plasmon resonance on the periodic gratings. We also measured the SERS spectra of para-mercaptobenzoic (pMBA) acid molecules on different plasmonic biochips. It was found that the SERS signal for the periodic nanostructure was 10 times the background SERS signal. The SERS signal increased by 5 times when the deposition angle was increased from 0° to 75°. In addition, the optical systems for measuring transmission and SERS spectra were integrated. The 785-nm laser light was normally incident on the plasmonic biochip. The reflected light and transmitted light were collected and measured by a charge-coupled device array spectrometer and Raman spectrometer, respectively. The quantification and qualification analysis of the sample can be accomplished at the same time by measuring the changes in transmitted intensity and SERS spectra. Therefore, the combination of plasmonic sensing and SERS spectroscopy provides a promising way for multifunctional chemical analysis to increase the reliability of biological detection and can benefit sensing applications.

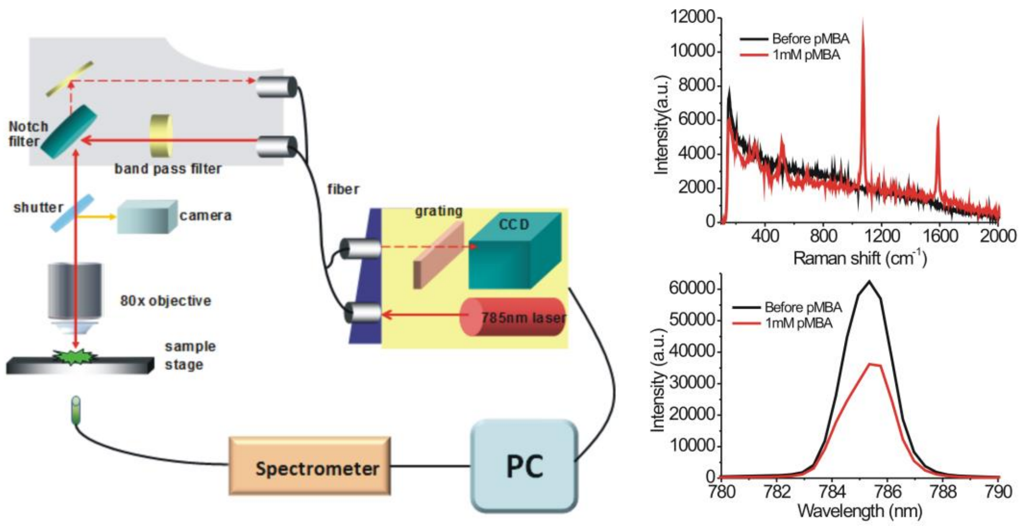

Figure 1. Optical setup for measuring transmission and SERS spectra.

Acknowledgements

This work was supported by National Science Council, Taipei, Taiwan, under Contract No. NSC-100-2120-M-007-006 and NSC-100-2221-E-001-010-MY3.

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