LOCALIZED SURFACE PLASMON RESONANCE IN GOLD NANOISLAND AND NANOPOROUS GOLD SUBSTRATES

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Abstract

We measure the extinction spectra of nanoporous gold (NPG) by nitric acid dealloying from Au-Ag film and sputtered gold nanoisland in both transmission and reflection modes. We can control the nanoisland feature size by changing the deposition time and the porous size by varying dealloying condition. We found two peaks from extinction spectra. One less than 500nm corresponds to the resonant absorption of gold and the other ranging from 520nm to NIR represents the localized surface plasmon resonance (LSPR) excitation from different nanostructure. The shift band determines the adequate incident wavelength for surface-enhanced Raman spectroscopy (SERS).

Introduction

A surface plasmon is an electro-magnetic wave propagating alone the surface of a thin metal layer. The surface plasmon can absorb or scatter the incident light and resulting an extinction peak. If the plasmon resonance occurs on nano-scale fine structure, it is called localized surface plasmon resonance. The extinction peak may vary due to different dielectric media or different surface structures [1, 2]. The extinction peak can be used to identify the laser wavelength for Raman spectroscopy. The band shift property has been applied on organic and biologic molecule detection. In this paper, we demonstrate the ability of LSPR measurement as a quick refractive index sensing tool.

Methods

The LSPR measurement has been done in reflection and transmission modes. Transmission mode can measure highly transparent material like thin gold coating on coverslips. A broadband white light is collimated and shine on the sample. The light is scattered and absorbed by the thin gold coating and the transmitted light is collected by fiber to a spectrometer (Thorlabs CCS200). In contrast, mirrorlike substrates such as silicon or thick gold on coverslips need to be measured by reflection mode. The white light is guided from one branch of a multimode fiber optical coupler (FIS MMC38550129C) to the combined port. The sample is placed very close to the fiber and the reflected light is collected by the same fiber and delivered to the other branch which is connected to the spectrometer.

The gold nanoisland is sputtered on hydrofluoric treated silicon or piranha cleaned coverslips by Hummer sputter coater system (Technics). The NPG formation contains two processing steps. First is the convention top-down deposition of Au-Ag film on substrate. The less noble metal is then dissolved in concentrated nitric acid. The leftover gold will form a porous structure during the process. The pore and ligament sizes can be controlled by changing the dealloying time and temperature [2, 3]. The NPG film can also be synthesized by dealloying a white gold leaf [4].
Fig. 1. The extinction spectra of gold nanoisland on coverslip in air and in IPA (n = 1.3776). On peak at ~475nm is independent of gold thickness and dielectric surroundings. The other at ~550 - 650nm shows the red shift of different refractive index or gold layer thickness.

Results and Conclusion

We have identified different strategies for measuring LSPR of transparent and reflectional materials. The extinction spectra of NPG and gold nanoisland have been measured in different refractive index dielectrics. We observed two extinction peak and band shift from different dielectric media and surface structure. The nanoisland on coverslip is easy to make. Combining with LSPR, it is a convenient method for refractive index detection. The NPG has great potential in SERS molecule detection. We can find the suitable laser wavelength for best SERS enhancement.

References