DOI: 10.3969/j.issn.1003-501X.2017.02.012

Plasmonic sensor based on Fano resonance

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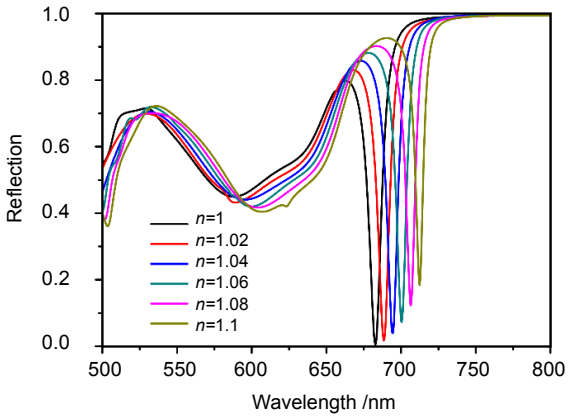

Reflection spectra of the gas filling asymmetric double elliptical cylinders. Their refractive index *n was* varied from 1.0 to 1.1 with increments of 0.02.

Abstract: Plasmonic sensor based on metallic nanostructures is a promising platform for applications, such as biology, chemistry, materiality and photonics due to their attractive properties. In particular, the local electromagnetic field enhancement in metal nanostructures is highly correlated to the surrounding environment, providing a new way for the realization of high sensitive biosensors. However, the sensitivity of plasmonic sensors is usually limited by broad spectral features due to large radiative loss of metallic nanostructures in visible region. As a result of the interference between super-radiation and sub-radiation patterns, the radiation loss of the Fano resonance system can be greatly reduced or even completely inhibited. Such characteristic promises the Fano resonance a series of excellent electromagnetic properties such as narrow spectral linewidth, strong electromagnetic field enhancement and high refractive index sensitivity. In this paper, we present a structure of three layers consisting of an ellipsoidal silver pair separated from the silver reflector by a layer of silica. Moreover, we introduce structural asymmetry to generate the Fano resonance by rotating one of the elliptical silver cylinders. The Fano resonance in this structure is raised by the interference of dipole resonance aroused by the incident light and quadrupole mode aroused by the asymmetry of the ellipsoidal pair. Here, the dipole mode and quadrupole mode represent the super-radiation and sub-radiation pattern, respectively. The corresponding results are based on the finite element method (FEM) with solver CST Microwave Studio. Electromagnetic wave incidents normally to the surface from the positive side of the *z* axis and polarization of the incident light are along the *x* axis. Calculated results show that the distinct Fano-like line shape with sharp peak as narrow as 10.8 nm (FWHM) appears around a wavelength of 681 nm, and also at the same wavelength, two anti-phase currents appears along two asymmetric elliptical cylinders which indicate the arose of Fano resonance. We should point out that when the structure is symmetric, there's on Fano resonance, and also with the increase of the asymmetry degree, the intensity of Fano resonance increases. According to formula for the refractive index sensitivity, the Fano mode exhibits refractive index sensitivity as large as 299 nm/RIU which is the basis of many applications. Moreover, due to the excitation of sharp spectral features, high figure of merit of 27.8 at the Fano resonance is obtained in a wide refractive index range of 1.0~1.1. The promising properties of this device would make it an effective high sensitivity microchip sensor.

Keywords: plasmon resonance; sensor; Fano resonance

Citation: Fang Jiawen, Zhang Ming, Zhang Fei, *et al.* Plasmonic sensor based on Fano resonance[J]. *Opto-Electronic Engineering,* 2017, **44**(2): 221-225.

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