Localized Surface Plasmon Resonance in Gold Porous Films

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Gold porous (por-Au) films are the nanocomposite porous films with Au nanoparticles (NPs) produced by the method of pulsed laser deposition with a YAG:Nd^{3+} laser (λ=1.06 mkm, j=15 j/sm^2, t_i=10 ns, f_i=25 Hz) in an argon atmosphere with a pressure of 70 Pa and laser shot number 1500 [1]. The aim of this study is the adoption of wide information abilities of the modulation polarimetry technique developed in [2] for diagnostic of localized surface plasmons resonances (LSPR) in por-Au films. The angular and spectral characteristics of polarization difference $\rho(\theta, \lambda)=R_s^2-R_p^2$ of reflection coefficients for *s*- and *p*-polarized radiation are measured in the ranges of wavelengths λ=400÷1000 nm and incidence angles θ=20÷60 degree. Two types of LSPR are detected: the first is on isolated Au NPs in the short-wavelength range and the second is between Au NPs caused by dipole-dipole interaction, when the dipole fields of plasmons on one Au NPs induces the surface plasmons oscillations in neighboring. The LSPR of the second type is observed in the long-wavelength range at the incidence angles above the critical angle of total internal reflection ($\theta > \theta_{cr} \sim 43^0$) under the phase synchronous condition fulfillment. A separation of the contributions of different resonant mechanisms is performed by means of analysis of characteristics $\rho(\lambda)$. The corresponding frequency dependencies of $\rho(\omega)$ are decomposed into elementary components from Gaussian functions with fundamental frequencies ω_1 and ω_2, ω_2' and the oscillation relaxation times γ_1 and γ_2, γ_2', respectively, for the first and second type of LSPR, which are observed at the certain incidence angles of *s*-, *p*-polarisations. The extremum of $\rho(\lambda)$ at $\theta < \theta_{cr}$ is shifted in the long-wavelength range, if the incidence angle is increased. This indicates on the existence of radiative modes of LSPR with the first type. The dispersion characteristics $\omega(k)$ of surface plasmons are shown for nonradiative modes: one branch for the first resonance type and two branches for the second resonance type, respectively. The obtained experimental results contain the information about the morphological peculiarities of por-Au films and the inhomogeneous space distribution of Au NPs. The interaction of electromagnetic radiation with por-Au films has a LSPR character which is determined by the topologic size effect.

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