Interaction of Electromagnetic Radiation with Multi-Layer Coatings

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The introduction of advanced optical devices and research methods in various fields of science and technology leads to the need not only to create multi-layer metal-dielectric systems with new requirements to their properties, but also to their possible combinations.

The report deals with the problem of the interaction of electromagnetic radiation (EMR) with an arbitrary number of flat nanolayers sharing two dielectric half-spaces. Using impedance method, complex coefficients of reflection and transparency have been found, their modules and phases along with power values of these factors. It allows us to examine both frequency dependence of the coefficients at a fixed wave angle of incidence and angular dependence of the selected range of electromagnetic radiation. Relative magnetic permeabilities of layers are taken equal to unity, and to describe the frequency-dependent dielectric function of metals in model calculations Drude model is applied. Coatings were considered (nanolayers separating two half-spaces) produced from gold or silver, or altering layers of gold and silver, or combined coatings of metal / insulator. Both layers were taken of the same thickness of 20 nm, and the angle of incidence of the electromagnetic wave was $\theta_1 = 20^0$. Comparison with the corresponding dependences for single-layer coatings of gold or silver shows that the dependences of the reflectance versus wavelength have two maxima and two minima instead of one near plasmon frequencies of gold and silver. The order of the layers significantly affects the values of extremes.

Nanocoating were also investigated of eight and ten altering gold and silver nanolayers (thickness of layers is 10 nm). In this case, the angle of incidence was believed to be an option, and calculations were performed for incidence of light at different angles for two types of polarization. As an illustration of the calculations carried out, some results obtained are shown in graphs in Figs. 1 and 2.

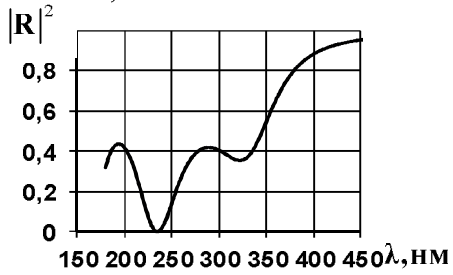

Fig. 1. The spectral dependence of the reflection coefficient at normal incidence waves to 8-layer coverage (polarizations coinside)

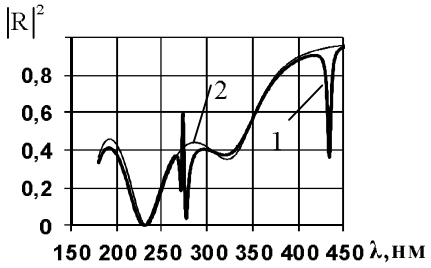

Fig. 2. Spectral dependences of reflection coefficient when wave falls at an angle 20° to 8-layer coverage: 1 – *p*-polarization; 2 – *s*-polarization.

It is seen from the dependences obtained that the frequencies of surface plasmons remain, but the transition between the maxima and minima in the presence of a dielectric is slower.