Influence of the thermal nonlinearity of a liquid on the optoacoustic transformation in the system of dielectric substrate/ submicron metal coating/ liquid

Diploma thesis abstract

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Influence of thermal nonlinearity of a liquid on the optoacoustic (OA) transformation in three-layer system consisting of a metal film deposited on a dielectric substrate and being in the contact with the liquid is considered. The OA conversion efficiency depending on the type of immersion fluid, the thickness of the metal layer and the laser fluence is analyzed numerically. Energy limits for the influence of thermal nonlinearity on the thermooptical excitation of ultrasound are estimated. The function σ of the relative deviation of the frequency dependent efficiency of OA conversion, which characterizes the relative magnitude of the linear and nonlinear OA responses of the system is calculated. The empirical expression that allows to estimate the magnitude of σ, depending on the thickness of the metal coating and the laser fluence is obtained. Estimation of the error introduced by changing the thermal conductivity of the metal is performed. It is shown that the effect of thermal nonlinearity can be used as an additional tool for diagnostics of coating thickness, when the exact value of thermal conductivity of the metal coating is not specified.

An experimental study has been performed with chrome coatings of different thickness deposited on a quartz substrate. Water and ethanol were used as immersion liquids. Dynamics of temporal profiles of the excited OA signals vs. laser fluence is demonstrated. It has been shown that the measured transfer functions of OA conversion are in a good agreement with the theoretically calculated ones within an experimental error up to beginning of explosive boiling of the liquid.