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Thickness measurement of submicron metal coatings on transparent substrate by laser optoacoustic method

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New nondestructive method for measurement of the thickness of submicron metal coatings on a transparent dielectric substrate is developed. Theoretical background includes the consecutive solution of the thermal and acoustic problems. The experimental part is based on the measurement of frequency dependence of the laser-ultrasound excitation efficiency on the metal coating thickness for the system where the coating is covered by a transparent liquid. Three chrome coatings of various thicknesses (0.2, 0.3 and 0.6 micrometers) deposited on a quartz substrate were tested experimentally. A rough estimate of their thickness was obtained from the sputtering time. Two different experimental modes were used: forward mode (laser pulses irradiate the metal film through the substrate, excited acoustical transients are detected in the liquid) and backward mode (both laser irradiation of the film and detection of excited acoustical transients are performed in the liquid). Spectral dependencies of the thermo-optical transformation efficiency were calculated analytically and obtained experimentally for both signal detection modes. The values of the film thicknesses were determined by the least squares fitting of the theoretical curves to experimental data. It is demonstrated, that the developed optoacoustic method can be used for metal coatings thickness measurement in the range of 50 nm - 5 microns with inaccuracy of 50 nm.