

DETECTION OF SURFACE RESIDUAL STRESSES IN MATERIALS BY PHOTOACOUSTIC IMAGES OF MICROINDENTED AREAS

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The influence of the surface residual stresses on the photoacoustic images of indented ceramics and metals has been demonstrated. However, some details of the residual stress influence on the photoacoustic signal are not clear up to now. Therefore, in this work we have tried to clear up the situation by detailed theoretical and experimental investigations of the photoacoustic effect in indented ceramics and metals.

In a theoretical part of this work the theoretical non-linear model of the photoacoustic effect in stressed is presented. This theory expresses the influence of stresses on the photoacoustic signal by the dependence of elastic moduli and thermoelastic parameter of a material on stress. The developed theory has been used for analysis of experimental results and deformations produced by a.c. pump laser light due to the thermoelastic effect near the vertical crack tips in ceramics.

Experimental part of this work is based on a complex approach proposed by us recently which provides an opportunity to control thermal, thermoelastic and elastic parameters independently. This approach allows us to find out experimentally the mechanism of the residual stresses influence on the photoacoustic effect in various materials. It is demonstrated, for example, that in silicon nitride ceramic and composite $\text{Al}_2\text{O}_3\text{-SiC-TiC}$ ceramic the dependence of the photoacoustic signal on the stress is related with the influence of residual stresses on its thermoelastic parameter.

In this work an experimental photoacoustic and photothermal investigation of the residual stresses has been made mostly on Vickers indented samples. Various images obtained on the indented ceramic and metal samples demonstrate the influence of the residual stresses and cracks on the photoacoustic and photothermal signals. It is shown that joint photoacoustic and laser thermal wave measurements can be used for a complex characterization and imaging of stresses fields near Vickers indentations. Based on the obtained experimental data on samples with the residual stresses and developed theory non-linear elastic and thermoelastic parameters of materials have been estimated. It is shown that they are in a good correspondence with the parameters obtained by different methods.