LITERATURE CITED


INVESTIGATION OF THE DYNAMIC CHARACTERISTICS OF FUNCTIONAL CERAMICS WITH THE USE OF FIBER LASER VIBROMETRY


The article describes a contactless method of investigating cyclic deformations with the aid of a laser vibrometer based on measuring the Doppler shift of the frequency of laser radiation reflected by the surface of a piezoelement. It explains the results of investigations of the instability of the piezomodule d31 of the piezoceramic TsTBS-3 under the effect of temperature, obtained by the laser vibrometer.

Fiber light guides make it possible to extend substantially the potentialities of the practical use of optical methods of measurement in the mechanics of deformed solids. In

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Institute of the Strength of Materials, Academy of Sciences of the Ukrainian SSR, Kiev.
the present article we describe one of the methods of applying a laser Doppler vibrometer with an optical fiber sonde with which the characteristics of ceramic structural elements of powerful piezoelectric energy transducers in hydroacoustics can be measured.

One of the fundamental characteristics of piezoelectric ceramics is the piezomodule \( d_{31} \) which characterizes the ability of material to be deformed in an electric field. The magnitude of the piezomodule \( d_{31} \) is determined by the ratio of the voltage applied to the piezoelement to the amplitude of the mechanical oscillations excited in it.

When ceramic material is heated in the process of cyclic loading of a structural element, its piezoproperties change, and this affects the emitted acoustic power. Temperature effects change the piezomodule and consequently the emitted power of the piezoelectric energy transducer.

The use of a laser vibrometer with optical fiber sonde in the present investigation was made necessary by the peculiarities of measuring the parameters of oscillations of a specimen of piezoceramics: small oscillation amplitude (a few micrometers) and high oscillation frequency of the piezoceramics (\( \sim \)20 kHz). We investigated experimentally the instability of the piezomodule \( d_{31} \) of the piezoceramic TsTBS-3 in heating and cooling.

The operating principle of the laser vibrometer is based on measuring the Doppler shift of the frequency of the laser radiation reflected by the moving surface of the piezoelement. The maximal Doppler shift of the frequency \( f_{d\max} \) is in one-to-one correlation with the amplitude and frequency of the mechanical oscillations of the piezoelement by the ratio

\[
 f_{d\max} = 4\pi Af_s/\lambda,
\]

where \( A \) is the oscillation amplitude of the surface of the piezoelement; \( f_s \) is the oscillation frequency; \( \lambda \) is the wavelength of the laser radiation.

Thus, to determine the mechanical deformation of the investigated specimen at a point, it is necessary to measure the maximal Doppler shift of the frequency of the laser radiation reflected by a moving surface. With the use of the light guide channel we investigated the vibration characteristics of parts of the surfaces of structural elements with complex shape.