STABILITY OF THE RATE OF SCANNING A LAMINATED OPTICAL DEFLECTOR

D. N. Kosolap, P. F. Sukhodoev, M. V. Srybnik, and V. A. Miroshnichenko

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Laminated optical deflectors, being rather simple and effective devices, are used for deflecting the beam in laser radiators. One the designs of a laminated optical deflector is shown in Fig. 1 [1]. It consists of a base 4, two active sheets 2 fastened in cantilever fashion in it with a reflector 1 on the free end, which are placed in a field winding 3. The active sheets are made of piezoelectric ceramic or magnetostriction alloys with a different sign of elongation. With placement of such sheets joined by their planes in the appropriate field of an alternating quantity, one of them periodically shortens and the other lengthens, which leads to bending of the sheets and to reciprocal motion of the reflector 1.

One of the most important characteristics of the deflector is stability of the beam scanning rate, since with the use of a deflector in automatic machines and measuring equipment, the stability of the scanning rate affects the measurement error. In [2] the scanning rate is represented as:

$$\nu_{sc} = f\alpha_{max}, \tag{1}$$

where f is the frequency of oscillation of the sheets of the deflector; α_{max} is the maximum angle of deflection of the beam.

A high stability of ν_{sc} can be achieved by realizing feedback with respect to ν_{sc} in the system exciting oscillations of the deflector. But such a variant requires additional devices and complicates the design.

Another variant is stabilization of parameters f and α_{max}. Oscillations of a highly stable frequency can be excited in the deflector by means of an oscillator with a quartz resonator. However, the stability of α_{max} will depend on the mechanical properties of the materials of sheets 2 (Fig. 1) and effect on the deflector of the environment (temperature, pressure, humidity, etc.). Since it is technically easy to isolate the deflector from the effect of the environment, we will examine the effect of the mechanical properties of materials of sheets 2 on the stability of α_{max}. The sheets will experience a dynamic load and be subjected to fatigue [3]. Fatigue leads to a change in the elastic properties of the sheets and to a change in α_{max}. The phenomenon of fatigue has been insufficiently studied; however, the assumptions that most subjected to fatigue are materials whose deformations under a dynamic load reach the plastic zone were confirmed in [4]. The presence of plastic deformations depends both on the properties of the materials and on the magnitude of the load being applied. Consequently, the effect of fatigue can be reduced if the magnitude of the load is decreased and material with maximum elastic properties is selected for making the sheets. Reduction of the load leads to a decrease of the resolution of the deflector, which is undesirable. A positive effect can be achieved by the correct selection of the material of the sheets.

The authors tested deflectors made of various materials. Mechanical flexural vibrations were excited in the deflector (Fig. 1) at the resonance frequency. The changes in the angle of deflection of the beam were recorded during operation of the deflector. The results are given in the graph in Fig. 2, where on the axis of the abscissas is n - the number of vibrations performed by the deflector - and on the axis of the ordinates is the ratio α/α_0 of the current angle of deflection of the beam α to the angle α_0 at the time of turning on. The following materials of the sheets correspond to curves 1, 2, 3: No. 1 - optical glass; No. 2 - high-carbon steel U8; No. 3 - bimetal (Ni and permalloy).

Of greatest interest from the viewpoint of stability of ν_{sc} is specimen No. 1 made of optical glass with dimensions 46 × 3.5 × 1.8 in the form of a rectangular sheet fastened cantilever fashion in the base. Mechanical vibrations were excited in the glass specimen by an electromagnet acting on a steel sheet with dimensions 10 × 3.5 × 0.8 fastened on the free end of the glass sheet. The winding of the electromagnet contained 200 loops of PEV-1.0 wire and had dimensions: diameter 10 mm; length 25 mm; thickness of winding 5 mm. The core was a rod of steel St. 3. A 1.5-A current of rectangular form (meander) flowed through the winding. The gap b between the

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