Non-Stationary Temperature Distribution of Anisotropic Optical Thermoelement Based On Bi

Gutsul I.V., Gutsul V.I.

Chernivtsi National University, Chernivtsi, Ukraine

In the paper we provide the investigation of non-stationary temperature distribution of anisotropic optical thermoelement (AOT) which has the shape of rectangular parallelepiped, fabricated from the thermoelectric anisotropic Bi crystal with the length *a*, height *b* and width *c*. The uniform ray current with density q_0 falls at the upper side of thermostat which has thickness b_1, fabricated of optically transparent material in the observed spectral range of wave lengths. The upper side of AOT is in thermo optical contact with the lower side of thermostat which has the temperature T_0. The lateral sides of AOT are isolated adiabatically. The homogeneous monochromatic ray current with density q_0 passes through the thermoelement volume and flow out of its lower side. The part of this current of energy Δq is absorbed by thermoelement volume creating the temperature gradient. This, in its turn, causes the appearance of themoelectromotive force which definitely determines the magnitude of falling ray current density q_0. The kinetic coefficients of AOT material are assumed as temperature independent.

The non-stationary temperature distribution in AOT is obtained from the equation of thermal conductivity

$$\frac{\partial T}{\partial t} = A^2 \frac{\partial^2 T}{\partial y^2} + B\, e^{-\gamma(b-y)}, \qquad (1)$$

where $A^2 = \frac{\chi_{22}}{C_0 d}$, $B = \frac{q_0 \gamma}{C_0 d} \exp[-\gamma_1 b_1]$, C_0 – specific thermal capacity, d – density of AOT material, χ_{22} – component of thermal conductivity tensor, γ – absorption coefficient of the thermoelement material, γ_1 – absorption coefficient of the thermostat material. The boundary and primary conditions for the equation of thermal conductivity (1) are the following

$$\left.\frac{\partial T}{\partial y}\right|_{y=0} = 0; \quad T\big|_{y=b} = T_0; \quad T\big|_{t=0} = T_0 . \qquad (2)$$

The solution of equation of thermal conductivity (1) is obtained as a sum of general solution of homogeneous equation and partial solution of non-homogeneous one. The obtained solution proves that the temperature distribution inside of AOT shows the complicated non linear dependence both on coordinate y and time t. Besides $T(y,t)$ depends on anisotropic coefficient of thermal conductivity χ and on the absorption coefficient γ of the AOT material and one of the thermostat material γ_1 .