Mathematical Determination of Temperature on a Cuboid Crystal in Photoacoustic Interaction

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Introduction

- Temperature of an isotropic cuboid crystal of elastic material in photoacoustic interaction is mathematically presented.
- This theoretical determination is carried out by applying the finite Marchi-Fasulo integral transform method within the crystal size limitations of a homogeneous cuboid crystal.
- The results are obtained in terms of infinite series and the numerical calculations are carried out by using MATHCAD -7 software.

Situation of the Cuboid Crystal

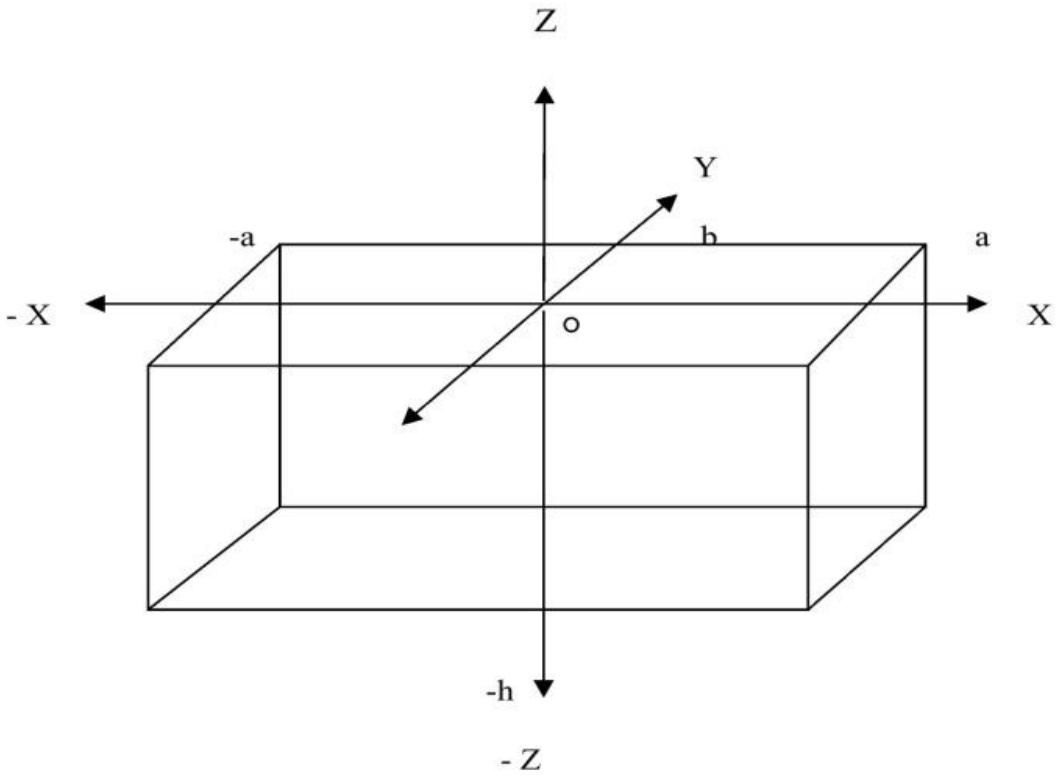

Fig. 2 : Cuboid Crystal in Photoacoustic interaction

Mathematical Determination

Consider that *U(x, y ,z ,t)* is the airy stress function which satisfies the differential equation,

$$\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)^2 U(x,y,z,t) = -\lambda Y\left(\frac{\partial^2}{\partial x^2}+\frac{\partial^2}{\partial y^2}+\frac{\partial^2}{\partial z^2}\right)^2 T(x,y,z,t)$$

Here $T(x,y,z,t)$ denotes the translational temperature of the crystal satisfying the following differential equation,

$$\frac{\partial^2 T}{\partial x^2}+\frac{\partial^2 T}{\partial y^2}+\frac{\partial^2 T}{\partial z^2}+\frac{\theta(x,y,z,t)}{k}=\frac{1}{\alpha}\frac{\partial T}{\partial t}$$

By applying the finite Marchi - Fasulo transform, the calculation becomes,

$$\frac{d\overline{\overline{T}}^*}{dt}+\propto q^2\overline{\overline{T}}^* = \propto (\emptyset+\frac{\overline{\overline{\theta}}^*}{k})$$

Result

- $\mathrm{T(x,y,z,t)} = \frac{\mathrm{k}}{\mathrm{c}^2}\sum_{\mathrm{m,n=1}}^{\infty}\left[\frac{\mathrm{P_m(x)}}{\lambda_\mathrm{m}}\right]\left[\frac{\mathrm{P_n(y)}}{\mu_\mathrm{n}}\right][\phi_1(z)\Psi_1(t) - \phi_2(z)\Psi_2(t)]_+ \frac{2k\pi}{h^2}\sum_{\mathrm{l,m,n=1}}^{\infty}\left[\frac{\mathrm{P_m(x)}}{\lambda_\mathrm{m}}\right]\left[\frac{\mathrm{P_n(y)}}{\mu_\mathrm{n}}\right]\left[\frac{l}{\cos l\,\pi}\right]\left[\frac{1}{1+cl\pi^2}\right][n_1(z)\Psi_3(t) - -n_2(z)\Psi_4(t)]$

Conclusion

The exact expressions for the transient translational temperature on the surface of a cuboid crystal in a photoacoustic cell is mathematically determined using Marchi - Fasulo method in terms of thermal conductivity of an elastic material of the crystal.