Short Communication

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Actuator for Nano biomedical Research

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ABSTRACT

In this work, we obtain the parameters of the actuator for nano biomedical research. We have mathematical model of the actuator with the piezoelectric or magneto strictive effect.

Keywords: Piezoelectric actuator, Magneto strictive actuator, Electromechanics, Parameter.

Introduction

Actuator for nano biomedical research is used to nanomanipulations in the scanning microscope, the nanoliter pump, the gene manipulator, the cell penetration tool, the microsurgery [1–16]. We obtain the transfer functions and the characteristics of the actuators on the piezoelectric and magneto strictive effect for control system of the nano deformation for nano biomedical research [17–28].

Transfer function

The equation of electromechanics [8, 11] for relative deformation S_i of the piezoelectric or magneto strictive actuator has the form

$$S_i = v_{mi}\Psi_m + s_{ij}^{\Psi} T_j$$

where v_{mi}, Ψ_m, s_{ij}^{Ψ}, T_j are the module, the control parameter, the elastic compliance and the mechanical stress, and i, j, m are the indexes. We have the second order differential equation [8, 12, 14] for the actuator in the form

$$\frac{d^2\Xi(x,p)}{dx^2} - \gamma^2\Xi(x,p) = 0$$

and the transfer function $W(p)$ of the actuator

$$W(p) = \Xi(p)/\Psi(p)$$

where $\Xi(p), \Psi(p)$ are transforms of Laplace the displacement and the control parameter, p, γ , x are the conversion parameter, the propagation coefficient, the coordinate.

We drew model of the actuator from decision the equation of electromechanics and the second order differential equation [12-15]. In result we have the mathematical model and the scheme of the actuator for nano biomedical research on Figure 1 with the piezoelectric or magneto strictive effect in the form

$$\Xi_1(p) = \left[1/\left(M_1 p^2\right)\right] \left\{-F_1(p) + \left(1/\chi_{ij}^{\Psi}\right) \left[v_{mi}\Psi_m(p) - \left[\gamma/\mathrm{sh}(l\gamma)\right] \left[\mathrm{ch}(l\gamma)\Xi_1(p) - \Xi_2(p)\right]\right]\right\}$$

$$\Xi_2(p) = \left[1/\left(M_2 p^2\right)\right] \left\{-F_2(p) + \left(1/\chi_{ij}^{\Psi}\right) \left[v_{mi}\Psi_m(p) - \left[\gamma/\mathrm{sh}(l\gamma)\right] \left[\mathrm{ch}(l\gamma)\Xi_2(p) - \Xi_1(p)\right]\right]\right\}$$

where $\Xi_1(p), \Xi_2(p), F_1(p)$, $F_2(p)$ are transforms of the displacements and the forces of the faces, M_1, M_2, l are the mass and the length.

We receive the transfer function of the transverse piezoelectric actuator in the form

$$W(p) = \frac{\Xi(p)}{U(p)} = \frac{k_t}{T_t^2 p^2 + 2T_t\xi_t p + 1}$$

$$k_t = \left(d_{31}h/\delta\right)/\left(1 + C_e/C_{11}^E\right), \quad T_t = \sqrt{M_2/\left(C_e + C_{11}^E\right)}$$

At $d_{31} = 2\cdot10^{-10}$ m/V, $h/\delta = 20$, $U = 50$ V, $M_2 = 4$ kg, $C_{11}^E = 2\cdot10^7$ N/m, $C_e = 0.5\cdot10^7$ N/m we obtain the parameters of actuator $k_t = 3.2$ nm/V, $\xi_2(\infty) = 160$ nm, $T_t = 0.4\cdot10^{-3}$ s.

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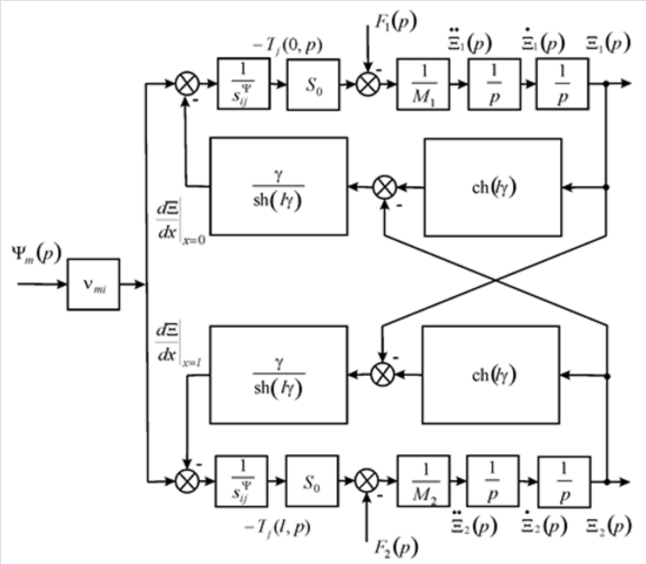

Figure 1: Structural scheme of actuator for nano biomedical research.

Conclusion

In this work, we receive the transfer functions and the parameters of the actuator for the control system of the nano deformation for nano biomedical research. We obtain the mathematical model of the actuator from decision the equation of electromechanics and the second order differential equation.

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