

643. Rod-shaped piezoelectric actuator with radial polarization

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Abstract. This paper analyzes contact point trajectories of the rod-type piezoelectric actuator, which has circular cross-section and is characterized by the non-uniform polarization. Radial polarization is used to achieve flexural oscillations in perpendicular planes and to increase number of degrees of freedom of the contact point movement. Particular electrode pattern of the actuator was determined and contact point trajectories were studied under different excitation regimes. A prototype of piezoelectric actuator was developed and experimental measurements of contact point trajectories were performed. The results of numerical modeling and experimental study are compared and discussed.

Keywords: piezoelectric actuator, multi-DOF, radial polarization.

1. Introduction

One of the current trends of technological development of the piezoelectric actuators is associated with miniaturization and reduction of design complexity [1]. The main objective of such systems development is to design a micro-scale system that has particular functionality and simple structural design. Development of the miniature actuators with multiple degrees of freedom (multi-DOF actuators) is relevant for such devices as mobile phones, personal digital assistants, cameras and etc. [1, 2].

Various design principles are used for the development of actuators but the majority of multi-DOF actuators are based on superposition of longitudinal and flexural vibrations of the structure [1, 2].

Present study reports results of investigation of a piezoelectric actuator that is characterized as a metal rod excited by piezoelectric cylinder with radial direction of polarization. Design of the actuator is based on bulk cylinder-type piezoelectric actuator with central wired electrode proposed by prof. R. Bansevicius [3, 4,7] but the developed version has some improvements. Metal rod is introduced as new design element and hollow piezoceramic cylinder is used instead of the bulk cylinder into design and is used as vibrator while hollowed piezoceramic cylinder is used for excitation and control of the vibrations. Operating principle of the actuator is based on superposition of longitudinal and flexural modes.

The performed work demonstrates that the proposed radially-polarized piezoelectric actuator is an effective solution for generation of a multi-DOF motion and the actuator can control contact point trajectory by means of a specific topology of the electrodes and excitation regimes. The paper presents results of the numerical modeling as well as experimental obtained in the course of testing of the fabricated prototype of the actuator. The research work is finalized with formulation of the conclusions.

2. Design of piezoelectric actuator

Proposed piezoelectric actuator consists of a core metal rod placed inside piezoceramic hollow cylinder coated by thin silver electrode (Fig. 1). The outer diameter of the core rod is fit