1022. Investigation of novel design piezoelectric bending actuators

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Abstract. Two piezoelectric bending actuators of a novel design are presented and analysed in the paper. Numerical modelling and experimental study of the piezoelectric bending actuators were performed to verify operating principle and to investigate dynamic characteristics of the actuators. Numerical calculations are performed by using finite element method. Results of experimental study of piezoelectric actuators are compared with the results of finite element simulations. Results of the numerical and experimental research are analysed and discussed.

Keywords: piezoelectric bimorph, amplitude-frequency response, dynamic characteristics.

1. Introduction

Piezoelectric cantilever bending actuators are widely used in many micromanipulation and microrobotic applications due to high resolution and fast response time [1]. Classical examples of piezoelectric cantilever bending actuators have unimorph, bimorph and multimorph configurations. Such actuators with a simple design are capable of producing large stroke under low electric voltage and provide high mechanical force/load sensitivity as sensory devices [2].

A bimorph bender consists of two piezoelectric thin plates with polarization perpendicular to the interface plane (Fig. 1a). One plate is expanding while another is contracting when electric field is applied on the electrodes of the actuator. Since there is constraint at the interface of these two plates, bending deformation occurs in the whole structure. Similarly, bending can be produced in the unimorph actuator, where the transverse deformation of the piezoelectric plate is constrained by the passive elastic plate (Fig. 1b). Therefore, bimorph and unimorph structures can be used as actuation elements. Triple layer benders, which consist of two piezoelectric layers and a sandwiched central elastic layer (Fig. 1c) can be used to improve the mechanical reliability. However, in any case, the interfaces in the bimorph, unimorph or triple layer benders are mechanically weak locations. Delamination may occur after being driven for a period of time under periodic excitations due to the relaxation and debonding of the adhesive materials [1-3].

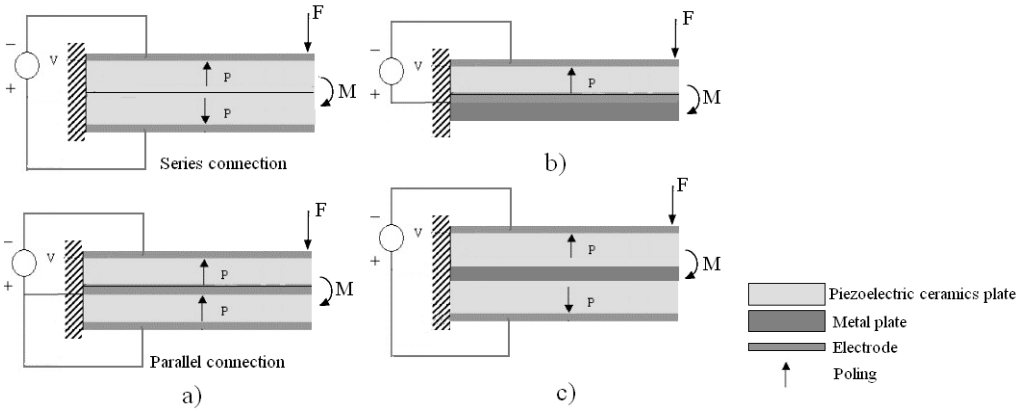

Fig. 1. The schemes of piezoelectric bending actuators: a) piezoelectric bimorph, b) piezoelectric unimorph, c) piezoelectric triple layer bender [1-3]