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SYSTEM DESIGN AND SIGNAL PROCESSING

VOLUME 2

Editors
Md. Raisuddin Khan
Md. Mozasser Rahman
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CHAPTER 32

A REVIEW ON MODELING AND SHAPE CONTROL OF PIEZOELECTRIC LAMINATED COMPOSITE PLATE USING FINITE ELEMENT METHOD

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32.1 Introduction

This chapter provides literature review of works that have been done by numerous researchers in the field of modeling piezoelectric materials in smart structures and its utilization in various control applications, especially shape control. Nevertheless, before going further, some fundamental knowledge of piezoelectric materials are presented first.

32.2 Piezoelectric Materials

The piezoelectric effect was first discovered by Jacques and Pierre Currie in 1880. They discovered that certain crystals have the ability to develop electric charges when mechanical stresses are applied on surface of the crystal and the vice versa [1]. Since then, many new piezoelectric materials have been constantly discovered and developed. The latest progress in the development of piezoelectric material is that by using single crystal growth technique, a high strain and high electric breakdown piezoelectric material can be developed [2].

There are two types of piezoelectric effect, direct piezoelectric effect and converse piezoelectric effect. The direct piezoelectric effect is the ability to generate electrical charge in proportion of an externally applied mechanical force. The converse piezoelectric effect is exactly the inverse of the direct effect, which is by applying electric fields across the thickness deformations are produced on the piezoelectric material. These intrinsic properties allowed piezoelectric material to operate as sensors or actuators. The direct piezoelectric effect has been used widely in sensor design and the inverse piezoelectric effect has been applied in actuator design [3]. The following figures demonstrate the piezoelectric effects. Fig. 32.1a shows the piezoelectric material without electric charges or mechanical stresses. Fig. 32.1b shows a voltage of same polarity with the polling direction appears between the electrodes when the material is compressed. Fig. 32.1c shows a voltage of opposite polarity with the polling direction appears between the electrodes when the material is stretched. Fig. 32.1d shows the material expands when a voltage with opposite polarity to the polling direction is applied to the material. Fig. 32.1e shows the material contracts when a voltage with same polarity to the polling direction is applied to the material.