A method of detecting gap and dynamic force based on flexoelectricity

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Abstract

Flexoelectricity which exists in all dielectric materials is defined as a strain gradient-induced electric polarization. In this letter, a method of detecting gap and dynamic force based on flexoelectricity is proposed. Since strain gradients are large near gaps, the flexoelectric effect is prominent there. The beams with different gaps are then designed. Under the same load of bending moment, the beams with different gaps have different strain gradient distributions, and the electric charge is different with each other. To obtain the stress-strain distributions, theoretical and finite element analyses are then developed. And the feasibility of this method is verified. The experimental system is set up as follows: a circular sine wave load with bias value is applied to the specimens and the strain gradient-induced electric charge curve is measured. Compared with the beam without gap, the relationship between electric charge and gap depth can be obtained. Dynamic force monitoring is also important in engineering applications. The beam without gap is developed to monitor dynamic force. And charge outputs of the beam without gap shows good linearity with the loading force. The result agree well with the theoretical estimation. The work expands the application range of flexoelectric effects and provides a new direction for gap monitoring.

Keywords: Flexoelectricity; Strain gradient; Gap; Dynamic force