# Design and analysis of a novel sensing method based on flexoelectric effect

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## Abstract

The flat shape sensors like strain gages and piezoelectric fibers have been wildly used in the deformation sensing, energy harvesting, building healthy monitoring due to the advantages such as small size, low weight, and high precision. These methods request highly paste technology, smooth surfaces, and suitable installation space. Sometimes it will bring additional stiffness. As a similar electro-mechanical coupling phenomenon to piezoelectricity, the flexoelectric effect describes the linear relationship between electric polarization and strain gradient. This phenomenon exists in all dielectric materials, and has a good potential in sensing and measurement.

In this paper, we provide a novel strain sensing method based on flexoelectricity. When measured object made by solid dielectric material produces a strain gradient field, it will generate electric polarization and output electric charge due to flexoelectric effect. This method just need to put the electrodes on the upper and lower surfaces of test area and measure the value of the output electric charge. Then we can get the average strains of test area without any other sensor or device installed on the specimens. A rhombic mechanism is adopted as measured specimen. The relationship between the loading force and the average strain on measuring area is given by theoretical derivation. The FEM simulation is built to analyze the stress condition. To verify the feasibility of this sensing method, the specimen is fabricated by polyvinylidene fluoride (PVDF), and the output electric charge caused by loading force is experimentally maeasured. The experiment results show that output electric charge increases with the increase of loading force and the linearity is good. In this work, we propose a novel sensing method with flexoelectricity. This approach is very easy to implement and will not bring the additional stiffness. It is especially suit for unconventional measured object like thin slab, narrow area or rough surface.

**Keywords:** Flexoelectric Effect, Sensor, Measuring Method, Strain Gradient, Simulation