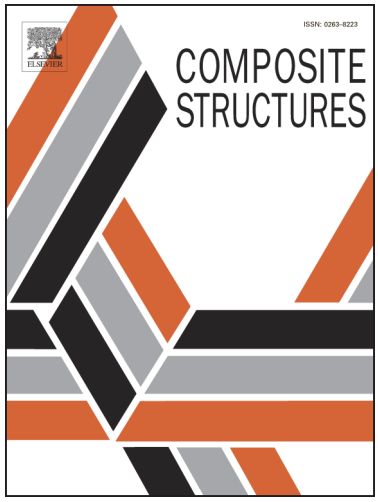


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# Numerical prediction of effective electro-elastic properties of three-dimensional braided piezoelectric ceramic composites

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**Abstract**: In this paper, a novel three-dimensional (3D) braided piezoelectric ceramic composites (BPCC) is developed to improve the mechanical properties of piezoelectric ceramics. Based on the reasonable three-cell model and finite element method, the numerical model of the 3D BPCC in displacement-electric coupling field is established. The effect of fiber volume fraction on the effective electro-elastic coefficients is investigated. The differences in the effective electro-elastic coefficients between the 3D BPCC and continuous straight fiber reinforced piezoelectric ceramic composites (SFPC) are demonstrated. Numerical results show that the 3D BPCC has excellent overall mechanical properties and electrical properties.

**Keywords:** piezoelectric composites; 3D braided composites; effective electro-elastic properties; displacement-electric coupling field; finite element method

## 1 Introduction

As an important functional material, piezoelectric ceramics has the advantages of high dielectric coefficients, large piezoelectric effect, high electro-mechanical coupling factor and simple preparation process. It has been widely used in the fields of sensing, driving, vibration control, structural health monitoring, etc [1-3]. However, the ions in piezoelectric ceramics are mainly bound by covalent and ionic bonds, which lead to high brittleness, low toughness and high defect sensitivity, also cause the poor stability and reliability of the smart devices [4-6].

In order to reduce the mechanical defects of piezoelectric ceramics, Bent et al. [7] proposed the piezoelectric fiber composites, the polymer matrix was used to improve